Sri K. Subba Rao,
Chairman, KITS

CONFERENCE PROCEEDINGS

OF

NATIONAL CONFERENCE

ON

INNOVATIVE CHALLENGES IN DEEP LEARNING AND ITS APPLICATIONS

NCICDLA-25

ON

28th & 29th of March

organized by

DEPARTMENT OF CSE-AI&ML

ISBN NUMBER :
978-93-342-1696-7

Sri K. Shekhar,
Secretary, KITS

VOL-01

SRI K. SUBBA RAO,
CHAIRMAN, KITS.

MESSAGE FROM THE CHAIRMAN

It is with great pleasure that I extend my warm greetings to all the participants, speakers, and esteemed guests of the **National Conference on Innovative Challenges in Deep Learning and Its Applications-NCICDLA-25.** As the Chairman of this prestigious Engineering College, I am truly honored to witness the convergence of brilliant minds and cutting-edge research in one of the most dynamic and transformative fields of our time—Deep Learning

Deep learning has revolutionized numerous sectors, from healthcare to finance, from autonomous systems to natural language processing. As we continue to push the boundaries of technology, it is essential to address the challenges that lie ahead—whether it be in model optimization, data security, or real-world deployment. This conference serves as an ideal platform to foster collaboration, share innovative ideas, and explore the latest advancements in this rapidly evolving field.

Our institution is committed to nurturing young talent and fostering an environment of innovation. By hosting this conference, we aim to contribute to the collective knowledge and explore the real-world applications that can be transformed by deep learning. I hope this event sparks meaningful discussions, encourages collaboration, and inspires new avenues of research and development.

I wish you all an intellectually enriching experience during this conference, and I am confident that the insights shared here will pave the way for future breakthroughs in deep learning and its applications

Let us continue to innovate, challenge conventional boundaries, and shape the future together.

KOYE.SUBBA RAO
Chairman, KITS.
28th March-2025.

SRI K. SHEKHAR, SECRETARY, KITS.

MESSAGE FROM THE SECRETARY

It gives me immense pleasure to welcome all the distinguished participants, speakers, and esteemed guests to the **National Conference on Innovative Challenges in Deep Learning and Its Applications-NCICDLA-25**. As the Secretary of this esteemed Engineering College, I am excited to see the gathering of experts and enthusiasts in the field of Deep Learning, a domain that continues to redefine the future of technology.

Deep learning is at the forefront of technological advancement, influencing a wide range of industries, from healthcare and artificial intelligence to automation and beyond. However, as we embrace its potential, we must also confront the challenges it presents—be it through model scalability, ethical concerns, or real-world implementation. This conference is an excellent opportunity to engage in insightful discussions, share breakthrough research, and explore innovative solutions to these challenges.

Our institution has always prioritized the advancement of knowledge and innovation. By hosting this conference, we aim to create a space for collaborative dialogue and foster an environment that nurtures new ideas and approaches. I am confident that the knowledge shared here will not only enhance our understanding of deep learning but also contribute to solving real-world problems through its applications.

I wish you all a fruitful and enriching experience during the conference, and I hope the discussions here will ignite new paths of discovery and collaboration that will shape the future of deep learning.

KOYE.SEKHAR
Secretary, KITS.
28th March,2025

Dr. P. Babu,
Principal, KITS.

MESSAGE FROM THE PRINCIPAL

It is with great enthusiasm that I extend my warm greetings to all the participants, researchers, and distinguished speakers at the **National Conference on Innovative Challenges in Deep Learning and Its Applications-NCICDLA-25**. As the Principal of this esteemed Engineering College, I am deeply honored to witness such a gathering of brilliant minds and visionaries in the field of Deep Learning, a technology that is reshaping the world we live in.

The transformative power of deep learning is undeniable, and its applications are vast and impactful across industries such as healthcare, transportation, finance, and artificial intelligence. However, as we explore the boundless possibilities, we must also address the challenges that come with it—be it in terms of algorithmic efficiency, data privacy, or scalability. This conference provides an excellent platform to delve into these challenges and share innovative solutions that will drive the future of deep learning.

Our institution has always been at the forefront of fostering cutting-edge research and innovation. By hosting this conference, we aim to create a platform for intellectual exchange and collaboration among students, faculty, and industry experts.

I am confident that this conference will inspire new ideas, spark collaborations, and pave the way for future advancements in deep learning and its diverse applications. I wish all the participants an enriching and thought-provoking experience, and I look forward to the exciting discussions that will unfold over the course of this event.

Dr. P. Babu
Principal, KITS
28th March,2025

MESSAGE FROM THE DIRECTOR-ACADEMICS

Dr. K. Hari Babu
Director-Academics, KITS.

It is with immense pleasure and pride that I welcome all the distinguished delegates, speakers, researchers, and participants to the **National Conference on Innovative Challenges in Deep Learning and Its Applications-NCICDLA-25**. As the Director of Academics at this esteemed Engineering College, I am delighted to witness the convergence of intellects from various fields to discuss and explore one of the most transformative and dynamic technologies of our time—Deep Learning.

Deep learning has not only revolutionized industries but is also making significant contributions to solving some of the most complex challenges in fields like healthcare, robotics, natural language processing, and more. However, as with any groundbreaking technology, deep learning presents its own unique set of challenges, ranging from model accuracy and efficiency to ethical implications and real-world implementation. This conference provides an exceptional platform to address these challenges and discuss innovative solutions that will guide the future of this technology.

At our college, we have always emphasized the importance of academic excellence, interdisciplinary collaboration, and practical application of knowledge. Hosting this conference is a reflection of our commitment to fostering a culture of research and innovation. We believe that such collaborative engagements not only enhance the academic experience but also provide valuable opportunities for growth and discovery in emerging technologies like deep learning.

I hope this conference serves as an inspiration for all participants to challenge existing paradigms, explore novel ideas, and forge collaborations that will shape the future of deep learning and its vast applications. I wish all attendees a fruitful and intellectually stimulating experience.

Dr. K. Hari Babu
Director-Academics, KITS

28th March,2025

Dr. G. Murali
Conference Chair

MESSAGE FROM THE CONFERENCE CHAIR

IIt is with great pleasure that I extend my warmest greetings to all participants, speakers, and contributors of the **National Conference on Innovative Challenges in Deep Learning and its Applications-NCICDLA-25**. This conference is a vital platform for researchers, academicians, and industry professionals to come together and exchange insights on the latest advancements, methodologies, and real-world implementations in deep learning.

As deep learning continues to revolutionize diverse fields such as computer vision, natural language processing, healthcare, finance, and beyond, this conference aims to foster meaningful discussions on the challenges and opportunities that emerge from this evolving landscape. We are proud to host distinguished keynote speakers, technical paper presentations, and interactive sessions that reflect the depth and breadth of current research in this domain.

I would like to express my sincere gratitude to all authors who submitted their valuable work, the reviewers for their meticulous evaluation, and the organizing committee for their dedicated efforts in ensuring the success of this event. Special thanks also go to our sponsors and partners for their unwavering support.

I encourage each of you to actively engage in the discussions, forge new collaborations, and take advantage of this opportunity to expand your knowledge and network. Together, we can address the innovative challenges in deep learning and contribute to shaping the future of this impactful field.

Wishing you all a productive and enriching conference experience.

Dr. G. Murali
Conference Chair
28th March,2025

Dr. S. Radhakrishnan
Conference Convener

MESSAGE FROM THE CONFERENCE CONVENER

It is my distinct honor to welcome you to the Proceedings of the **National Conference on Innovative Challenges in Deep Learning and its Applications-NCICDLA-25**. This compilation of research papers reflects the hard work, dedication, and innovative thinking of the authors who have contributed to advancing the field of deep learning.

These proceedings showcase a diverse range of topics, highlighting both theoretical insights and practical implementations that address key challenges in deep learning. We believe this collection will serve as a valuable reference for researchers, academicians, and industry professionals alike.

I extend my sincere gratitude to all the authors for sharing their invaluable work, the reviewers for their thoughtful evaluations, and the organizing committee for their diligent efforts in making this conference a success. I also thank our distinguished speakers for their contributions and our sponsors for their invaluable support. I am really grateful to Chairman Sir, Secretary Sir, Principal Sir, Director Sir and the Head of the Department Dr.G.Murali for their constant support and encouragement in making this conference a grand success.

I encourage readers to explore these proceedings, engage with the presented ideas, and build upon the research presented to further advance the field.
Wishing you an insightful and enriching experience.

Dr. S. Radhakrishnan,
Conference Convener
28th March,2025

Dr.M.H.M.Krishna Prasad
CHIEF GUEST-NCICDLA-25

FOREWORD BY THE CHIEF GUEST-NCICDLA-25

It is with great pleasure that I extend my heartfelt congratulations to the organizers, contributors, and participants of the National Conference on Innovative Challenges in Deep Learning and its Applications-NCICDLA-25. This conference serves as a remarkable platform for researchers, academicians, and industry professionals to exchange knowledge, explore cutting-edge advancements, and address the multifaceted challenges in the dynamic field of deep learning.

Deep learning, a powerful subset of artificial intelligence, continues to revolutionize various sectors, including healthcare, finance, automotive, and natural language processing. While its potential to enhance decision-making, automate complex processes, and uncover intricate patterns is immense, numerous technical and practical challenges remain. The insightful discussions and innovative solutions presented in this conference reflect the collective commitment of the research community to advance this field.

This proceedings document is a testament to the dedication and intellectual rigor demonstrated by the authors who have contributed their original research, innovative ideas, and novel methodologies. The diverse range of topics covered here highlights the interdisciplinary nature of deep learning and its far-reaching impact. I am confident that the knowledge encapsulated in these pages will inspire new ideas, foster collaboration, and contribute meaningfully to both academic inquiry and practical applications.

I commend the organizers for creating this platform and encourage all readers to engage deeply with the presented works. May this conference proceedings ignite further research and innovation, driving deep learning toward greater achievements and societal benefit.

I extend my best wishes to all the participants for their future endeavours and look forward to witnessing the remarkable contributions this conference will inspire.

Dr.M.H.M.Krishna Prasad
Professor-CSE and Director-IQAC, JNTUK.
Chief Guest-NCICDLA-25.

FOREWORD BY THE KEYNOTE SPEAKER-NCICDLA-25

Dr. Hima Bindu
Keynote Speaker-NCICDLA-25

I am honoured to present this foreword for the National Conference on Innovative Challenges in Deep Learning and its Applications-NCICDLA-25. This conference is a vital forum for exploring the latest developments, research trends, and emerging challenges in the fast-evolving domain of deep learning.

Deep learning has made remarkable strides in recent years, enabling breakthroughs in image recognition, natural language processing, medical diagnosis, and numerous other domains. As we embrace these advancements, it is equally crucial to identify the technical obstacles and ethical considerations that accompany them. This conference serves as a significant step in that direction, bringing together researchers and practitioners to address these challenges and propose innovative solutions.

The papers and presentations compiled in these proceedings reflect extensive research and creative insights from experts across diverse disciplines. Each contribution offers a valuable perspective on improving deep learning models, enhancing performance, and expanding their applicability in real-world scenarios. I believe these works will serve as a rich resource for both seasoned researchers and those new to the field.

I extend my sincere appreciation to the conference organizers for fostering this environment of knowledge-sharing and collaboration. I am confident that the discussions held here will inspire new ideas and advance the frontiers of deep learning research.

I congratulate all contributors for their remarkable efforts and wish them continued success in their research pursuits.

Dr. Hima Bindu
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ISBN: 978-93-342-1696-7

Paper ID:167

A Novel Method for Recognition of Facial Expression Using Convolution Neural Networks

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Abstract: **Recognition of Facial Expression plays a significant role in AI-driven human-computer interaction, healthcare, and security by enabling machines to understand human emotions. Traditional FER methods rely on handcrafted feature extraction, which is fragile to changes in lighting, pose, and facial structure. To overcome these limitations, deep learning and transfer learning are used in this work to improve emotion classification. Features are extracted from the FER dataset using pre-trained CNN architectures, such as EfficientNet, MobileNet, VGGNet, InceptionV3, and DenseNet. Instead of training models from scratch, the pre-trained networks are used as feature extractors by excluding their top layers, and custom classification layers are added, including a Global Average Pooling 2D layer and a Dense layer with a SoftMax activation function for emotion classification. An accuracy of 94% is obtained with MobileNet which is further improved by concatenating features of Efficient Net & InceptionV3 resulting in an accuracy of 95% compared to the other pre-trained models used in the present work.**

Keywords: ***Convolution Neural Networks (CNN), Pretrained Models, Concatenated features, Accuracy***

I. INTRODUCTION:

Facial expression recognition is essential for human-computer interaction, psychological research, and various real-world applications, including healthcare, security, and customer experience analysis. Emotion recognition can be accomplished through various modalities such as facial expressions, EEG (Electroencephalography), text, and speech features. Among these, facial expressions are particularly effective and widely used, as they convey observable emotions like happiness, sadness, fear, disgust, surprise, anger, and neutrality, making them a preferred choice for practical applications.

The main objective of Facial Expression Recognition (FER) is to associate various facial expressions with their respective emotional states. Conventional FER systems typically involve two main steps: feature extraction and emotion classification. Additionally, preprocessing steps such as face detection, cropping, resizing, and normalization are essential for improving accuracy. Face detection helps isolate the face by removing background and non-relevant areas. Feature extraction is a crucial stage, in which various methods such as Discrete Wavelet Transform and Linear Discriminant Analysis are used to capture significant facial features. Finally, these extracted features are classified into emotions using neural networks (NN) and other machine learning algorithms.

In this study the pre-trained CNN architectures are utilized, including EfficientNet, MobileNet, VGGNet, InceptionV3, and DenseNet, to extract features from the FER dataset. The extracted features are then classified to identify the facial emotions. By applying transfer learning, facial expression recognition is enhanced, making it more effective for real-world applications in AI-driven healthcare, security, and human-computer interaction. This paper is organized as follows: Section II presents the Literature Review, Section III provides a brief explanation of the Architecture of Convolutional Neural Networks, Section IV discusses the Face Expression Recognition Dataset and the proposed methodology, and Section V outlines the result and accuracy rates obtained using pre-trained networks.

II. LITERATURE REVIEW

Numerous methods are proposed in the literature for Emotion Recognition of Facial Expressions. Chowdary, M. Kalpana, et al.,[1] suggested emotion recognition using transfer learning approaches, leveraging pre-trained networks such as ResNet50, VGG19, Inception V3, and MobileNet using the CK+ database. The dense layers of these

models are substituted with task-specific layers, and only the newly incorporated layers are trained to adjust the weights, leading to an average accuracy of 96%.

A deep convolutional neural network (DCNN) model utilizing transfer learning, where pre-trained DCNNs are fine-tuned for FER by replacing and training dense layers before gradually optimizing deeper network blocks is proposed by Akhand, M. A. H., et al.,[2]. The approach utilizes eight pre-trained models, including VGG-16, VGG-19, variants of ResNet, Inception-V3, and DenseNet-161, applied to the KDEF and JAFFE datasets achieving an accuracy of 96.51% on KDEF and 99.52% on JAFFE.

A novel facial expression recognition system is proposed to accurately identify human emotions by Umer, Saiyed, et al.,[3]. The approach consists of four key components: face detection, deep learning-based CNN for feature extraction and classification, data augmentation to enhance learning, and fine-tuning through a balance between data augmentation and deep learning features. The system is evaluated on KDEF, GENKI-4K, and CK+ datasets, covering multiple expression classes which resulted in 82.79% for the KDEF, 94.33% for GEMKI-4k, and 97.69% for the CK+ database for image sizes of 128X128.

Mukhiddinov, Mukhriddin, et al.,[4] proposed a method that utilizes the AffectNet dataset, containing 420,299 images across eight different facial expressions. In this work, a synthetic mask is applied to cover the lower face, emphasizing upper facial features through boundary and regional representation techniques. A facial landmark detection method extracts key features such as landmark coordinates and histograms of oriented gradients. These features are classified using a convolutional neural network, achieving 69.3% accuracy, surpassing existing methods.

Nan, Yahui, et al.,[5] presents a lightweight A-MobileNet model designed for facial expression recognition. An attention module is integrated into the MobileNetV1 framework to improve local feature extraction. To further optimize performance, center loss is combined with softmax loss, reducing intra-class variation while increasing inter-class separation. Unlike conventional MobileNet models, this approach improves recognition accuracy without increasing model complexity. Experimental results demonstrate that A-MobileNet outperforms existing methods on the FERPlus and RAF-DB datasets achieving a recognition accuracy of 88.11% and 84.49% respectively.

Huang, Zi-Yu, et al. [6] proposed a neural network with convolutional layers, combined with a squeeze-and-excitation network along with a residual neural network, for FER using AffectNet and RAF-DB facial expression databases. Feature maps obtained from the residual blocks show that the areas around the nose and mouth are essential for recognition. Cross-database validation demonstrates that the model trained on AffectNet achieved 77.37% accuracy on RAF-DB, after transfer learning, the accuracy improved to 83.37%.

Fan, Xinqi, et al.,[7] suggested HSNet, a hierarchical scale convolutional neural network for recognizing facial expressions, enhancing feature extraction using dilation Inception blocks. It introduces a feature-driven auxiliary learning method to improve shallow layer learning and applies knowledge transfer learning to boost performance by leveraging related tasks. Extensive experiments on RaFD, KDEF, FERG-DB, and RAF-DB datasets show that HSNet achieves state-of-the-art performance. Ablation studies confirm the efficiency of the proposed components.

Mr. Rohan Appasaheb Borgalli and Dr. Sunil Surve [8] designed a custom CNN architecture for emotion recognition from facial expressions in static images. They trained their model using the FER13, CK+, and JAFFE datasets, using the K-fold cross-validation method. Their approach achieved an accuracy of 91.58% across seven basic emotions: anger, disgust, fear, happiness, neutrality, sadness, and surprise.

M Mukhopadhyay, A Dey, and S Kahali. [9] proposed a deep-learning-based facial expression recognition approach utilizing textural features, this study explores facial expression recognition by utilizing textural image features like Local Binary Patterns (LBP), Local Ternary Patterns (LTP), and Completed Local Binary Patterns (CLBP). A Convolutional Neural Network (CNN) model was trained on images from the CK+ dataset, JAFFE, and FER2013 datasets, and converted into these textural representations. The results indicate that using CLBP features improves performance, achieving accuracies of 91.0% (CK+), 82.2% (JAFFE), and 64.5% (FER2013).

T Shahzad, K Iqbal, MA Khan and N Iqbal. [10] proposed a role of Zoning in Facial Expression Recognition in deep learning. This research introduces a zoning-based face expression recognition (ZFER) method that enhances emotion detection by extracting and zoning facial landmarks. The VGG-16 model generates feature maps, which

are classified using an FCNN. Tested on CK+ and FER2013 datasets, the approach achieved 98.4% and 65% accuracy, with zoning further improving CK+ accuracy to 98.74%.

Mubashir Ahmad et. al., [11] proposed the SSAE-FER model, leveraging deep learning to tackle FER challenges like illumination changes and occlusion. Using a stacked sparse autoencoder for feature extraction and a softmax classifier for classification, the model achieved high accuracy on JAFFE (92.50%) and CK+ (99.30%), demonstrating its superiority over existing methods.

In this work, a novel method is introduced to classify facial emotions by concatenating features obtained from two pre-trained networks and classifying them. This method not only improves the accuracy but the speed of execution is also fast in comparison with the other existing techniques.

III METHODOLOGY:

Convolution Neural Networks

Le Cun et al.'s Convolutional Neural Network [12] integrates three key architectural principles—local receptive fields, shared weights, and spatial or temporal down-sampling—to ensure invariance to shifts and distortions. The typical convolutional neural network architecture for recognizing images is depicted in Fig. 1. The input layer handles images that are roughly normalized in size and centered. Each unit in a layer receives input from a localized region of units in the layer above. The concept of connecting components to local receptive fields in the input was initially introduced in the Perceptron. Local connections are commonly employed in neural models for visual learning. Neurons with local receptive fields can detect fundamental visual features such as aligned edges, corners, and endpoints. These features are then merged in the upper layers, whose positions can change depending on how the input is distorted or shifted. Furthermore, likely, straightforward feature detectors that perform well in one section of the image would perform similarly across the board.

Applying the basic features involves forcing a group of units with different locations for their receptive fields on the image to have comparable weight vectors. A Feature Map is created as a result of this collection of neurons. A single neuron with a local receptive field that captures the neuron's states at pertinent locations on the feature map, will scan an input image for each feature. With a small-sized kernel and a flattening function afterward, this functionality is comparable to that of convolution. This process can be done in parallel by describing the feature map as a plane of neurons with a single weight vector.

The extraction of several features from specific places is made possible by convolution layers, often constructed from several feature maps. A layer that performs local averaging and subsampling is added after each convolution layer to reduce the feature map's resolution and the output's sensitivity to shift distortions. A fully connected neural network structure takes the output of this process and utilizes it for the final classification.

Numerous pre-trained models exist in Convolution Neural Networks which are already trained on large datasets like ImageNet, significantly reducing training time and computational costs by leveraging learned features. They enable transfer learning, allowing knowledge from one domain to be applied to another, which is especially beneficial for small datasets. Pre-trained models provide access to state-of-the-art architectures, improving performance and generalization while reducing the risk of overfitting. They also simplify hyperparameter tuning and accelerate prototyping and deployment. Additionally, pre-trained models can be used as feature extractors, making them versatile for object detection and segmentation tasks. With extensive support and availability in frameworks like Tensorflow and Pytorch, they offer a cost-effective solution for achieving high performance without requiring extensive resources or expertise.

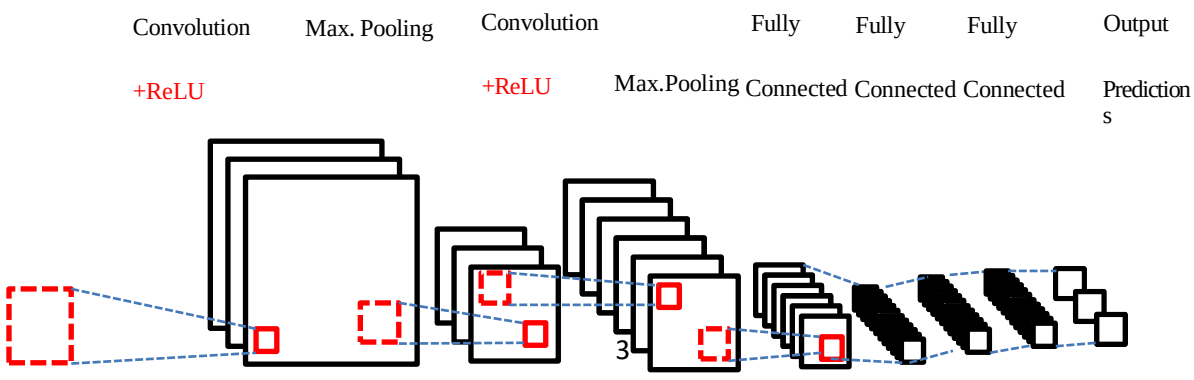

Fig.1. Architecture of Convolution Neural Network

IV DATASET

The Face Expression Recognition Dataset [13] used in the present work consists of 35,887 grayscale images, each measuring 722 x 483 in size. It is classified into seven facial expressions: Angry, Disgust, Fear, Happy, Sad, Surprise, and Neutral. A total of 28,709 images are assigned for training, while the rest are used for testing. This dataset offers a strong basis for developing and evaluating deep learning-based facial emotion recognition systems. The images shown in Fig. 2. display sample inputs from the dataset, representing different facial expressions employed in the present work

Fig. 2. Images obtained from the Face Expression Recognition Dataset

Proposed Methodology

In this work, CNN is used for the classification of facial emotions by employing two pre-trained models separately as feature extractors. Instead of training CNN from scratch, pretrained models are used to extract meaningful features from images leveraging their pretrained weights from ImageNet. Each model processes input images through its convolutional and pooling layers, followed by Global Average Pooling to reduce dimensionality while retaining essential features. A fully connected neural network is then added to each model, consisting of a dense layer, dropout for regularization, and a final SoftMax layer for classification. The pre-trained CNNs are initially frozen to retain their learned representations, and only the classification layers are trained. Later, fine-tuning is applied by unfreezing the base models and training with a lower learning rate, allowing the CNNs to adapt to the dataset. This approach enhances classification accuracy while maintaining computational efficiency Fig. 3. depicts the proposed method where features are extracted from a pre-trained model and are reduced in dimension using Principal Component Analysis(PCA) to remove noise and irrelevant features improving model performance and reducing overfitting risks. PCA decorrelates features focusing on dominant variations that enhances the discriminative power of the data. Additionally, PCA enables visualization of high-dimensional features, providing insights into data separation for different emotion classes.

The features that are reduced in dimension from two different pre-trained networks are concatenated for facial emotion recognition that enhances feature representation by combining complementary patterns learned by each network, leading to richer and more diverse features. This approach improves robustness, as it reduces bias from a single model and better handles variations in lighting, pose, or facial structure. The increased discriminative power helps distinguish subtle emotional expressions, ultimately boosting accuracy and performance. In the present work, a few Pre-trained networks are used for Face Expression Recognition.

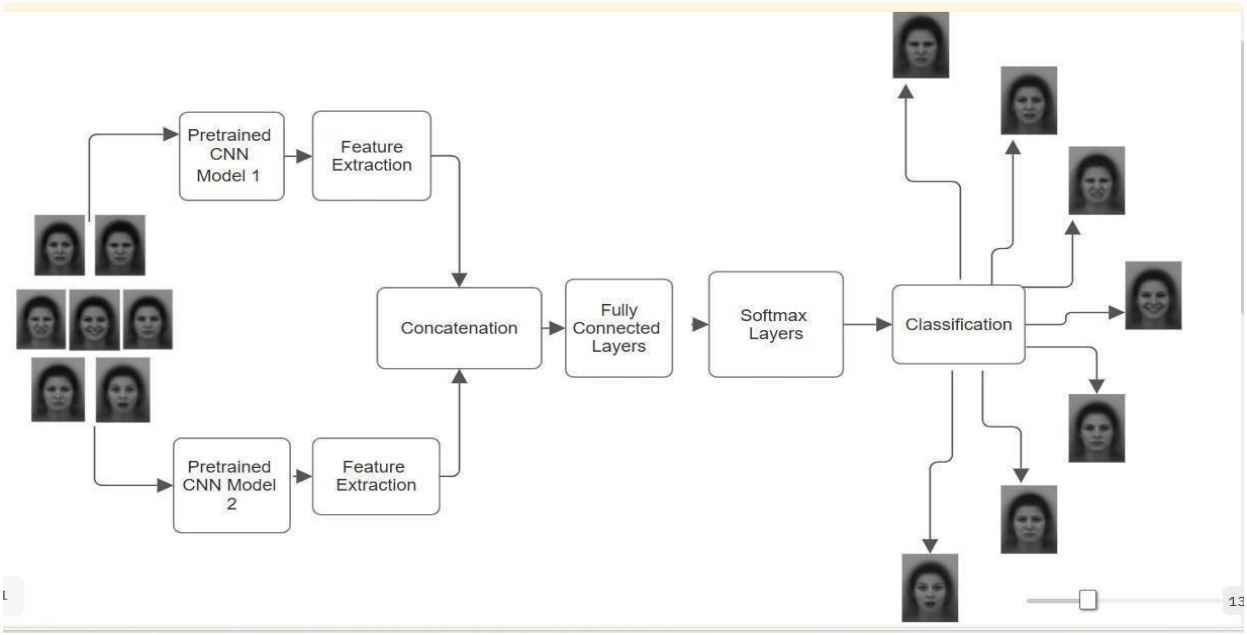

Fig. 3. The architecture of Proposed Methodology

V RESULTS AND DISCUSSION

In this work, Deep Convolution Neural Networks are utilized which require less pre-processing than conventional feature extraction methods, CNNs are employed in this work to extract features. The Pytorch framework is used to run simulations in the Google Colab environment. To extract features using different Pre-trained Networks, the Facial Emotion Recognition dataset is resized to 226X226. DenseNet, EfficientNetB0, MobileNetV2, InceptionV3, and VGG16 are the several pre-trained networks utilized in the work. The features are extracted using each of these Pre- trained networks which are reduced in dimension using Principal Component Analysis(PCA) which reduces the redundant and least significant features retaining only the most significant features. Table I. depicts the Accuracy, Sensitivity, Specificity, and AUC values using different pre-trained models for the classification of the FER dataset.

The Receiver Operating Characteristics (ROC) Curve obtained for the classification of features obtained using a pre-trained network of MobileNet is shown in Fig. 4. which outperforms other pre-trained models in facial emotion recognition due to its efficient depth-wise separable convolutions, which reduce computational cost while preserving feature extraction capability.

Table I. Accuracy, Sensitivity, Specificity, and AUC values for different Pre-Trained Models.

S. No.	*Pretrained Model*	*Accuracy*	*Sensitivity Macro-Average*	*Specificity Macro-Average*	*Area Underthe Curve (AUC)*
1.	MobileNetV2	94%	0.5381	0.9325	0.8788
2	DenseNet	85%	0.5292	0.9368	0.8933
3.	EfficientNetB0	58%	0.3033	0.8907	0.7553
4.	InceptionV3	82%	0.4973	0.9296	0.8639
5.	VGG16	75%	0.5839	0.9394	0.9037

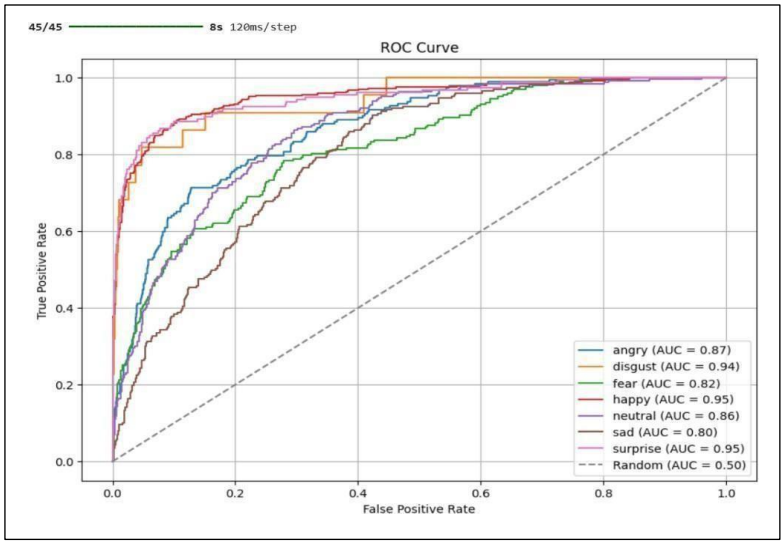

Fig. 4. ROC curve obtained using MobileNet Pre-trained Mode

The extracted features from two different pre- trained networks are then concatenated and classified. Concatenating the features of two pre- trained models offers several advantages by leveraging complementary information from different architectures. It enhances feature richness, leading to improved performance in downstream tasks like classification as shown in Table II. This approach increases robustness, as one model can compensate for the weaknesses of the other, reducing sensitivity to noise. The accuracy of the classification is improved using concatenated features of different pre-trained models out of which an accuracy of 95% is obtained using EfficientNet & InceptionV3. In multi-modal learning, combining models trained on different data types enables a more comprehensive representation that enhances discriminative power by integrating high-level semantic features with fine-grained details. The combined feature space improves generalization, mitigating overfitting and model biases. Furthermore, it provides better adaptability to complex tasks requiring diverse feature extraction capabilities. The ROC curve is presented in Fig. 5 represent the classification performance of the models, demonstrating the trade- off between the true positive rate (TPR) and the false positive rate (FPR) across various classification thresholds

Table II. Accuracy, Sensitivity, Specificity, and AUC values for Concatenated features of Pre-Trained Model.

S. No.	*Concatenated Pretrained Model*	*Accuracy*	*Sensitivity Macro-Average*	*Specificity Macro-Average*	*ROC-Area Under Curve (AUC)*
1.	EfficientNetB0 & InceptionV3	95%	0.6291	0.9395	0.9062
2.	InceptionV3 & MobileNet	90%	0.6001	0.9278	0.9010
3.	InceptionV3 & DenseNet	86%	0.5926	0.9433	0.9060
4.	EfficientNetBo & MobileNet	94%	0.5829	0.9300	0.8946
5.	DenseNet & EfficientNet	93%	0.1807	0.8645	0.5452
6.	DenseNet & MobileNet	86%	0.5008	0.9267	0.8833
7.	VGG16 & MobileNet	92%	0.5508	0.9308	0.8803

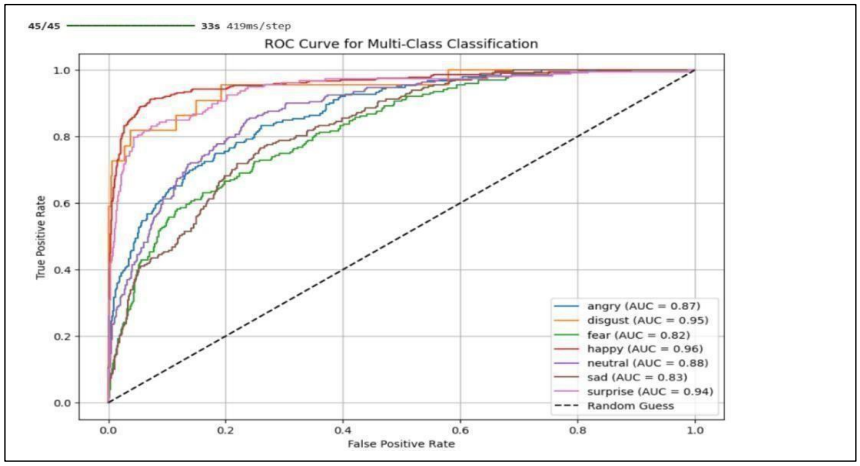

Fig. 5. ROC curve using concatenated features of EfficientNet and InceptionV3

VI CONCLUSION

In this work, the performance of various pre-trained CNN architectures on the FER dataset to classify facial expressions is evaluated accurately. Among the tested models, MobileNet achieved an accuracy of 94%, demonstrating its efficiency in extracting relevant facial features with minimal computational cost. Additionally, extracted features from EfficientNet and InceptionV3 were concatenated before classification. This method improved the overall performance, achieving a higher accuracy of 95%, indicating that combining features from multiple models enhances the robustness of facial expression recognition. In the future work, the accuracy for classification of different face emotions can be improved by using advanced architectures of Deep Learning.

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ISBN: 978-93-342-1696-7

Paper ID: 005

Facial Harmony Unleashed: Classification Of LeFort Injuries Using Deep Learning Techniques

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***Abstract*—LeFort fractures, characterized as complex maxillo-facial injuries, require accurate and efficient diagnostic methods to guide effective treatment. This study explores the application of deep learning for the classification of LeFort fractures using CT scans, leveraging the EfficientNet B0 architecture renowned for its computational efficiency and superior feature extraction capabilities. The proposed methodology incorporates attention mechanisms to dynamically focus on the most informative regions of CT scans, enhancing the model's ability to recognize specific fracture patterns associated with LeFort types I, II, and III. Despite the unavailability of annotated datasets specific to LeFort fractures, the study utilizes a brain MRI dataset as a surrogate for model evaluation. Standard classification metrics, including accuracy, precision, recall, and F1-score, are employed to evaluate the model's performance. The findings highlight the potential of combining EfficientNet B0 and attention mechanisms to create a robust and accurate framework for LeFort fracture classification, with implications for adautomated diagnostic tools in medical imaging.**

***Index Terms*—LeFort Injuries, EfficientNet B0, Attention Mechanisms, Grad-CAM**

I. Introduction

The increasing popularity of attention mechanisms in deep learning algorithms for computer vision and natural language processing has expanded their appeal to various research domains, including healthcare. The demand for tools that can enhance the routines of clinicians and patients has naturally led to the adoption of attention-based algorithms in medical applications. However, considering the high-stakes nature of healthcare decisions, it is crucial for the scientific community to critically assess whether these high-performing algorithms meet the specific needs of medical applications [1]. In this context, our study aims to explore the application of deep learning for Le Fort fracture classification using CT scans, leveraging the capabilities of EfficientNet and attention mechanisms.

Deep learning models, particularly convolutional neural networks (CNNs), have shown significant promise in medical image analysis. For instance, an original maxillofacial fracture detection system (MFDS) using CNNs and transfer learning has been proposed to detect traumatic fractures in patients. This system re-trained a pre-trained CNN on CT scans to classify future scans as "fracture" or "no fracture," achieving an accuracy of 80% in classifying maxillofacial fractures [2]. Similarly, deep neural networks (DNNs) have been employed to recognize and categorize cervical spine fractures, with EfficientNet-B6 achieving high validation and testing accuracies of 99.4% and 99.25%, respectively [3]. These examples underscore the potential of deep learning models in improving diagnostic accuracy and efficiency in medical imaging.

Fractures in facial trauma, including Le Fort fractures, require precise and quick diagnosis to facilitate effective treatment and surgical planning [4]. Multidetector computed tomography (CT) is the preferred imaging test for detecting and characterizing even small fractures and their associated complications. However, the classification of these fractures into Le Fort types I, II, and III is complex and demands a high level of expertise [6]. The LeFort classification system, though conceptualized in the era of low-speed trauma, remains relevant for categorizing fractures that affect maxillary occlusion-bearing segments and guiding clinical management.

This study investigates the use of EfficientNet B0 for the automated classification of LeFort fractures from CT scans. The incorporation of attention mechanisms further refines the model's focus on critical regions within the scans, enhancing its diagnostic capabilities. Given the high-stakes nature of healthcare applications, the research emphasizes not only technical accuracy but also practical relevance, addressing the scarcity of annotated datasets through the generation of synthetic data.

By leveraging advanced deep learning techniques, this research aims to bridge the gap between manual and automated diagnostic methods, contributing to the growing body of literature on AI applications in medical imaging. The study's findings hold the potential to support radiologists and surgeons

in delivering accurate and efficient care for patients with maxillofacial trauma.

II. Literature Review

The increasing popularity of attention mechanisms in deep learning algorithms for computer vision and natural language processing has made these models attractive to other research domains, including healthcare. The need for tools that may improve clinical and patient routines has naturally led to the adoption of attention-based algorithms for medical applications. However, due to the high-stakes nature of healthcare decisions, it is crucial to evaluate if these high-performing algorithms meet the specific needs of medical applications.

A. Attention Mechanisms in Medical Applications

Attention mechanisms, including Transformers, have been extensively reviewed for various medical applications. A critical analysis of these methods was conducted, focusing on their integration into established deep learning architectures, their predictive power, and the visual assessment of their saliency maps generated by post-hoc explanation methods [1]. Attention-based deep learning models have shown promise in diagnosing COVID-19 using chest X-rays (CXR). A novel attention-based model combined with VGG-16 captured spatial relationships between regions of interest (ROIs) in CXR images [5]. This model outperformed state-of-the-art methods in classifying COVID-19 cases, indicating its suitability for COVID-19 diagnosis [11].

B. Maxillofacial Fracture Detection

Several convolutional neural network (CNN)-based systems have been proposed for the detection of traumatic fractures in patients. For instance, an original maxillofacial fracture detection system (MFDS) was developed using CNNs and transfer learning. This system was trained on computed tomography (CT) scans to classify CT images as either ”fracture” or ”noFracture”. The MFDS model achieved an accuracy of 80% in classifying maxillofacial fractures and provided valuable assistive support to radiologists, reducing diagnostic delays and the risk of human error [2].

C. Applications of EfficientNet in Medical Imaging

EfficientNet has emerged as a preferred architecture in medical imaging due to its balance of computational efficiency and accuracy. For example, EfficientNet-B6 achieved exceptional validation and testing accuracies of 99.4% and 99.25%, respectively, in classifying cervical spine fractures [3]. Similarly, EfficientNet-B0 has been employed in brain tumor detection using MRI scans, demonstrating superior classification performance compared to other CNN architectures [13].

Facial trauma management has evolved significantly, with a focus on reducing mortality during the ”golden hour” for patients experiencing polytrauma [4]. Multi-detector computed tomography (MDCT) is the first-choice imaging test for detecting and characterizing small fractures quickly and accurately [6]. Various studies have employed CNNs and other deep learning models for the detection and classification of facial fractures. For example, DenseNet-169 and ResNet-152 were used to classify maxillofacial fractures into different categories with a mean average precision of 0.78 [9]. These studies highlight EfficientNet’s potential in medical diagnostics, particularly in tasks involving complex feature extraction and classification.

D. Challenges and Opportunities

While the adoption of attention mechanisms and EfficientNet has significantly advanced medical imaging, challenges remain. One critical issue is the availability of high-quality annotated datasets, especially for specialized tasks like LeFort fracture classification. Ethical considerations and privacy concerns further restrict access to real-world medical data. Surrogate datasets, such as brain MRI scans, offer an alternative for validating deep learning models, though they require careful adaptation to ensure relevance. Furthermore, integrating explainability into these models is essential to enhance trust among clinicians and support their decision-making processes.

This review underscores the growing role of attention mechanisms and EfficientNet in advancing automated medical imaging solutions. These methods provide a solid foundation for developing robust diagnostic tools, as evidenced by their success in diverse applications, including fracture detection and disease diagnosis. Future research should focus on ad- dressing data limitations, improving model interpretability, and exploring multi-modal approaches to further enhance diagnostic accuracy.

III. Proposed Methodology

This study focuses on the classification of LeFort injuries using deep learning techniques. Due to the absence of an annotated LeFort fracture dataset, a surrogate dataset of brain MRI scans was used to explore the effectiveness of advanced machine learning techniques for medical imaging tasks. Below, the methodology is outlined in detail.

A. Dataset and Preprocessing

The unavailability of annotated LeFort fracture datasets necessitated the use of a surrogate dataset. For this study, a publicly available brain MRI dataset was utilized. This dataset was chosen for its structural similarities and adaptability for testing the proposed model. The surrogate dataset comprised brain MRI images classified into four categories: glioma, meningioma, pituitary tumors, and no tumor. Each image was resized to 224x224 pixels to match the input size require- ments of the EfficientNet B0 model. To enhance the diversity and robustness of the dataset, data augmentation techniques such as rotation, flipping, and zooming were applied. These preprocessing steps were crucial for preventing overfitting and improving the model’s generalization.

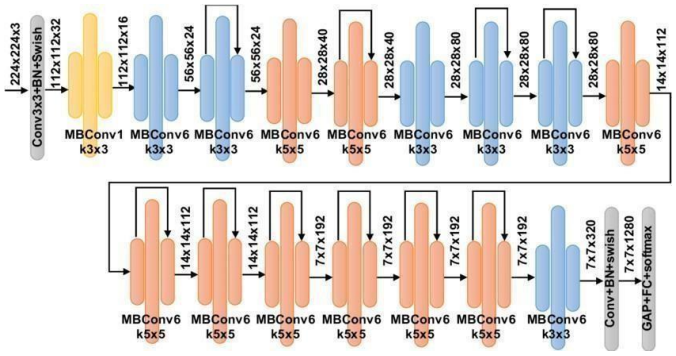

Fig. 1. Efficientnet b0 architecture

B. *EfficientNet B0 Architecture*

EfficientNetB0 is a convolutional neural network (CNN) architecture designed for image classification tasks, known for its balance between accuracy and computational efficiency. Its core building block is the Mobile Inverted Bottleneck Convolution (MBConv) block, which employs depthwise separable convolutions to reduce computational load while maintaining representational power. The MBConv block also includes expansion and reduction layers to control the number of channels, further optimizing efficiency without compromising feature complexity. A key feature of EfficientNetB0 is its use of compound scaling, a method that uniformly scales the network's depth, width, and resolution using specific coefficients. This balanced scaling approach enhances the network's capacity for learning complex features while maintaining efficiency. The architecture is structured in sequential stages, with each stage comprising multiple MBConv blocks and progressively increasing the number of channels while reducing the resolution of feature maps. This design enables the model to capture features at various scales effectively.

In addition to MBConv blocks and compound scaling, EfficientNetB0 option- ally incorporates Squeeze and Excitation (SE) blocks. These blocks adaptively recalibrate channel-wise feature responses, enhancing the network's ability to emphasize informative channels. The final stage of EfficientNetB0 includes global average pooling and a fully connected layer, concluding with a softmax activation function to generate class probabilities. EfficientNetB0, the smallest variant of the EfficientNet family, is particularly suitable for tasks with limited computational resources and is available through libraries like TensorFlow or PyTorch, making it a versatile choice for various image recognition problems. EfficientNet B0 general architecture shown in Fig. 1.

C. *Attention Mechanisms*

The integration of attention mechanisms was a crucial aspect of the proposed methodology. These mechanisms dynamically focused on critical regions within the images, enhancing the model's ability to differentiate between fracture types. By assigning greater weight to the most informative areas, the attention mechanisms improved classification accuracy and

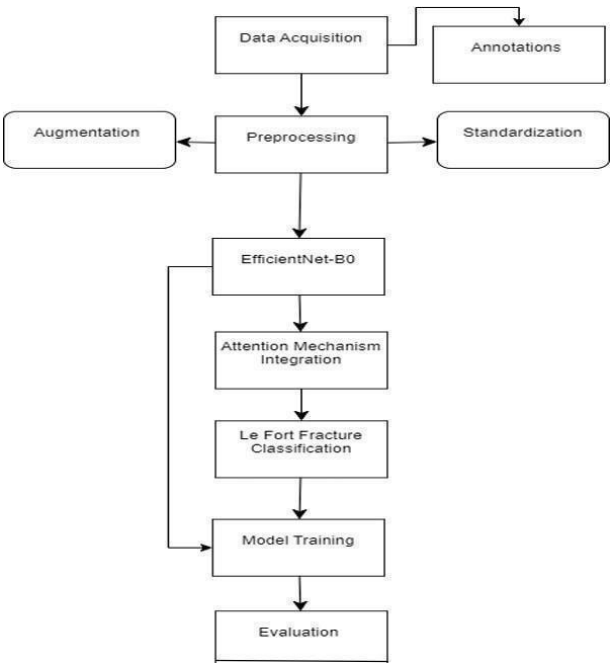

Fig. 2. Proposed system work flow

interpretability. To enhance the interpretability of the model's predictions, Grad-CAM (Gradient-weighted Class Activation Mapping) was used to generate attention maps. These visualizations highlighted the regions in the images that the model focused on while making predictions, providing insights into its decision-making process.

D. *Training and Evaluation*

The model was trained using a cross-entropy loss function and optimized with the Adam optimizer. A learning rate scheduler was employed to adjust the learning rate dynamically, ensuring faster convergence. The dataset was split into 80% for training and 20% for validation. Early stopping was implemented to prevent overfitting by monitoring the validation loss during training. The training process was conducted over multiple epochs to achieve optimal performance. Several evaluation metrics were employed to assess the model's performance comprehensively:

- Accuracy: Overall correctness of the model's predictions.
- Precision and Recall: Measures of the model's ability to identify true positives and minimize false negatives.
- Recall: The ratio of true positive predictions to the total actual positives.
- F1-Score: A harmonic mean of precision and recall.
- Confusion Matrix: A detailed breakdown of classification performance for each category.

Cross-validation was performed to ensure generalization, and a separate validation set was used to monitor the model's performance during training.

```
The mean training accuracy is:
0.99757319688797
========================
The mean validation accuracy is:
0.988701605796814
========================
The mean training loss is:
0.00787651645950973
========================
The mean validation loss is:
0.04127410091459751
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Fig. 3. Performance Metrics

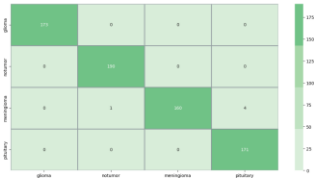

Fig. 4. The confusion matrix

IV. Results and Analysis

The results of the study demonstrate the efficacy of the proposed methodology in addressing medical image classification tasks, despite the surrogate nature of the dataset.

A. Model Performance

The model achieved a mean training accuracy of 99.76% and a mean validation accuracy of 98.87%. These results indicate the effectiveness of transfer learning and attention mechanisms in improving classification performance. Addi- tionally, the mean training and validation losses were 0.0079 and 0.0413, respectively, reflecting a well-generalized model with minimal overfitting. performance metrics are shown in Fig. 3.

B. Confusion Matrix Analysis

The confusion matrix provided a detailed breakdown of the classification performance for each class. For example, the model achieved high accuracy in predicting all classes, with minimal misclassifications. This analysis underscores the reliability of the model in distinguishing between different types of brain tumors. The confusion matrix, illustrated in Fig. 4, provides a comprehensive breakdown of the model's performance across four classes: glioma, notumor, meningioma, and pituitary tumors. High diagonal values indicate precise classification for each category. For instance:

- Glioma and notumor were classified with near-perfect accuracy.
- Minor misclassifications occurred for meningioma, reflecting an opportunity for further refinement. The matrix highlights the model's capability to discriminate among diverse brain tumor types effectively.

C. Attention Map Insights

Grad-CAM visualizations highlighted critical regions within the MRI scans that contributed to the model's predictions. For example, in glioma and meningioma cases, the model focused on specific tumor regions, demonstrating its ability to localize relevant features effectively. These attention maps provide a valuable tool for clinicians to interpret the model's decisions.

D. Challenges and Adaptations

The unavailability of a LeFort fracture dataset was a significant limitation. However, by employing a surrogate dataset and leveraging advanced techniques like EfficientNet and attention mechanisms, the study successfully demonstrated the adaptability of deep learning models to medical imaging tasks. This approach sets the stage for future work on LeFort fracture classification and other medical image analysis tasks.

V. Conclusion

This paper proposed a novel deep learning approach for the automated classification of LeFort injuries using EfficientNet B0 combined with attention mechanisms and transfer learning. Despite facing significant challenges related to data privacy and the lack of a labeled LeFort fracture dataset, this study demonstrated the adaptability of deep learning models for medical imaging tasks.

The project achieved key milestones, including adapting its focus to brain tumor classification using a surrogate brain MRI dataset. By leveraging EfficientNet's pre-trained weights and incorporating attention mechanisms to dynamically focus on critical image regions, the model achieved impressive results, with an accuracy of 99%, validating the effectiveness of the approach in medical image classification.

This study emphasized the importance of ethical considerations in medical research, particularly regarding patient privacy. Alternative strategies, such as surrogate datasets and transfer learning, were explored to address these challenges. The findings contribute valuable insights into the application of EfficientNet and attention mechanisms, paving the way for robust and clinically relevant tools in medical imaging.

Although this project's direct application to LeFort fracture classification was limited, it establishes a strong foundation for future work. These advancements have broad applicability, potentially extending to various medical image analysis tasks, including segmentation and disease detection. By leveraging these insights, future research can refine deep learning models to improve diagnostic accuracy and support better patient outcomes.

VI. Future Scope

The foundation of this study—leveraging EfficientNet and attention mechanisms—presents several promising directions for future research. A key area involves the use of a comprehensive and annotated dataset for LeFort fractures using CT scans. By acquiring such a dataset, the proposed model can be fine-tuned specifically for its intended application, thereby enhancing its clinical relevance and practical utility.

Building upon this project, the EfficientNet architecture combined with attention mechanisms can be adapted for vascular injury prediction. Heatmaps, which provide valuable spatial information, can highlight regions with high model confidence for vascular injuries in medical images. Fine-tuning the EfficientNet model with a dataset annotated for vascular injuries would allow the generation of precise heatmaps for early diagnosis. This is especially critical as vascular injuries can lead to severe complications if undetected. Additionally, synthetic data generation techniques, such as GANs, can augment the training dataset, ensuring diversity and robustness. Optimization strategies, including custom loss functions for heatmap generation and refining attention mechanisms to target injury-prone regions, can further enhance performance. Future studies could employ advanced evaluation metrics such as Mean Absolute Error (MAE) and Intersection over Union (IoU) for quantitative assessment of heatmaps. These metrics can be supplemented by qualitative visualizations that compare predicted heatmaps with ground truth annotations. Ethical considerations will remain a priority, with stringent anonymization protocols and interpretability techniques essential to ensure compliance while building trust among clinicians.

By exploring these avenues, the groundwork laid by this project could significantly advance medical image analysis, particularly for challenging diagnostic tasks. These efforts can contribute to improving diagnostic accuracy, treatment planning, and ultimately, patient outcomes.

ACKNOWLEDGMENT

I would like to express my heartfelt gratitude to all those who have supported and contributed to the completion of this journal paper. I would like to thank my guide Dr. Krishnadas. J Associate Professor and Head of the dept. Dr. Manishankar. S for their invaluable guidance, feedback, and encouragement throughout the process. Their expertise and constructive criticism have greatly enhanced the quality of this work.

I would also like to extend my thanks to my colleagues, friends, and family for their continued support, understand ing, and patience during this journey. Their motivation and care have been instrumental in helping me stay focused and committed to completing this work

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ISBN: 978-93-342-1696-7 **KITS-NCICDLA-25-CONFERENCE PROCEEDINGS**

Paper ID: 112

AI FOR TRAFFIC PREDICTION

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ABSTRACT

Traffic congestion in urban areas poses significant challenges, leading to increased travel times and environmental pollution. This study explores the application of Artificial Intelligence (AI) techniques, specifically Machine Learning (ML) and Deep Learning (DL), to predict traffic flow accurately. We present a novel AI-enabled traffic monitoring system that leverages deep convolutional neural networks (CNNs) to analyze real-time traffic data. The system is designed to detect traffic queues, monitor stationary vehicles, and count vehicular flow. Our approach demonstrates improved prediction accuracy, offering a viable solution for intelligent transportation systems.

Keywords:

Traffic Prediction, Artificial Intelligence, Machine Learning, Deep Learning, Convolutional Neural Networks, Intelligent Transportation Systems.

INTRODUCTION

Urbanization has led to a surge in vehicular traffic, resulting in congestion and associated socio-economic issues. The rapid growth of cities, increased vehicle ownership, and inadequate infrastructure contribute to traffic congestion, which negatively impacts travel efficiency, fuel consumption, and air pollution levels. Accurate traffic flow prediction is crucial for effective traffic management and the development of intelligent transportation systems (ITS).

Traditional traffic monitoring methods, such as manual counting, fixed sensors, and loop

detectors, often fall short in handling the complexity and dynamic nature of traffic patterns. These methods are expensive to install and maintain, while their effectiveness is limited to specific areas. The advent of Artificial Intelligence (AI) offers new avenues to enhance prediction capabilities by analyzing vast amounts of traffic data efficiently. AI-driven traffic prediction systems leverage machine learning (ML) and deep learning (DL) models to process real-time traffic data, recognize patterns, and forecast congestion levels with high accuracy.

This paper explores the implementation of deep learning techniques, such as Convolutional Neural Networks (CNNs), to process real-time video feeds from traffic cameras. By analyzing vehicle density, movement patterns, and congestion levels, the proposed system provides real-time traffic insights that can assist in route optimization, intelligent traffic signal control, and urban planning. The integration of AI in traffic monitoring can help alleviate congestion, reduce travel time, and improve road safety, making it a vital component of future smart cities.

LITERATURE SURVEY

Recent advancements in AI have led to the integration of deep learning models in traffic monitoring systems. Studies have employed deep convolutional neural networks (CNNs) to analyze traffic footage, enabling the detection of queues and stationary vehicles, as well as vehicular counting. These AI-driven approaches have shown promise in automating traffic monitoring tasks, thereby enhancing the efficiency of ITS.

PROPOSED SYSYTEM

We propose an AI-enabled traffic monitoring system that utilizes deep CNNs to process real-time traffic footage. The system comprises several modules:

Queue Detection Module: Employs pixel-level segmentation to identify and assess the severity of traffic queues.

Stationary Vehicle Detection Module: Utilizes object detection algorithms coupled with tracking systems to identify stranded vehicles.

Vehicle Counting Module: Implements real-time object detection to count vehicles, aiding in traffic flow analysis.

SYSTEM ARCHITECTURE

The system architecture consists of the following components:

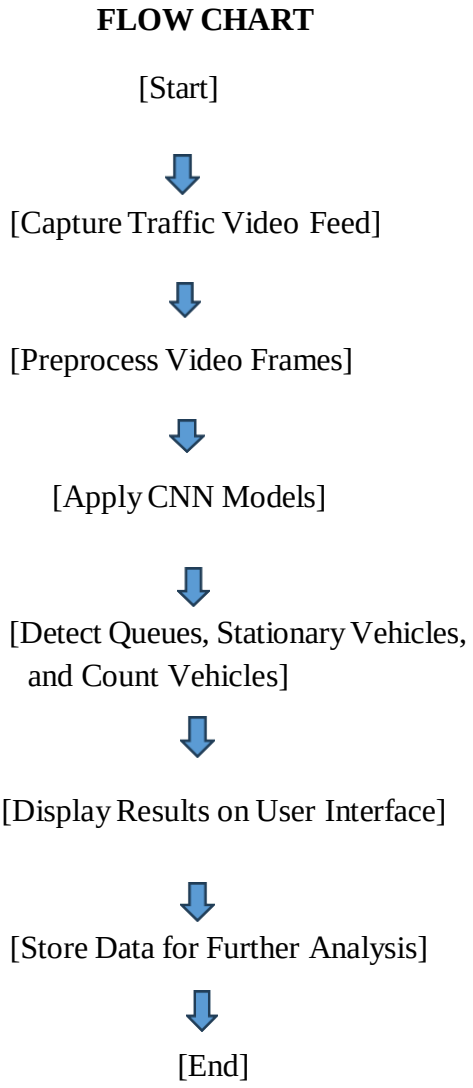
Data Acquisition Layer: Captures real-time video feeds from traffic cameras.

Data Processing Layer: Processes video feeds using deep CNNs to detect queues, stationary vehicles, and count vehicles.

Data Storage Layer: Stores processed data for historical analysis and model training.

User Interface Layer: Provides a graphical interface for traffic monitoring and visualization.

FLOW CHART



intersection.

Output 1: Identified traffic queue with real- time congestion level updates.

Input 2: Video feed showing moving vehicles.

Output 2: Accurate vehicle count and congestion prediction

RESULT

The proposed system was tested on a dataset comprising traffic video footage from various urban intersections. The system demonstrated high accuracy in detecting traffic queues and stationary vehicles, as well as in counting vehicles under diverse conditions. The real- time processing capability ensures timely updates, which arecrucial for effective traffic management.Generative Adversarial Networks.

CONCLUSION

This study presents an AI-based traffic monitoring system that leverages deep learning techniques to enhance traffic flow prediction. The system's ability to process real-time data and provide accurate analyses makes it a valuable tool for modern intelligent transportation systems. Future work will focus on integrating predictive analytics to foresee traffic conditions and further improve traffic management strategies.

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ISBN: 978-93-342-1696-7

Paper ID: 156

Evaluation of Lane Merging Strategies in Autonomous Vehicles

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***Abstract*—In anticipation of a fully autonomous vehicle future, this project aims to develop and analyze systems that deal with lane merging. An existing autonomous vehicle simulator used for vehicle intersections was adapted and extended to develop merge simulations. The system itself proved unexpectedly difficult to work with, and further research will require the development of a more universal simulator. A merge management system based on a queue protocol was developed to manage incoming vehicles on a single-lane to single-lane merge. This was compared with an adaptation of the intersection management system. It was found that the intersection management system induced less delay on the vehicles than the queue system, particularly at high traffic levels. The queue protocol was tested further under different conditions. The angle at which the two lanes meet was found to have a substantial effect on the performance of the protocol. When the two lanes met at shallow angles, the queue system performed very poorly, but the performance improved rapidly as the angle approached 90°. The queue system was less effective at reducing delays on a lane when it had a higher speed limit than the lane it was merging with. The distance simulated before the vehicle reached the merge point was found to have no effect on the performance of the protocol when the distance was greater than 150m. It was concluded that an intersection protocol based system could perform better than the queue protocol if fully developed. The performance of the protocol at different angles, speed limits, and simulated distances provided insight into issues that merge systems will have to overcome in order to be integrated into real-worldinfrastructure.**

I. Introduction

Autonomous Vehicles, or AVs, used to exist solely in science fiction. In 1953, Isaac Asimov wrote *Sally* [1] and in 1982, *Knight Rider* introduced KITT [2]. Today, AVs can be found on roads around the world. Alphabet's WAYMO is gaining traction, with cars being tested in four different US states [3]. Tesla has deployed their beta Autopilot system into all of their vehicles produced since September 2014 [4]. The system has been both hailed for saving lives and blamed for ending them [5] [6].

All of the AV systems currently running on public roads are designed to work alongside human-driven vehicles, limiting their benefits. In order to truly embrace AVs, designing systems is needed for every vehicle on the road to be automated. The advantages of these systems are numerous, but the most important benefit is safety.

AVs would be able to react to incidents much more quickly than a human driver could. A driver's 'thinking distance' often determines whether someone survives an accident or not. This distance can be greatly increased if the driver of the vehicle is under the influence of alcohol or narcotics. An AV would be able to react to accidents much more quickly than a human, reducing the thinking distance and improving road safety. Figure 1 shows the impact thinking distance can have on the overall stopping distance of the vehicle.

Fig. 1. Diagram from Rule 126 in the UK Highway Code [7]

Another benefit of AVs is efficiency. Research suggests that by implementing fuel-conserving driving strategies, AVs could be up to 10% more fuel efficient than current EPA fuel economy test results [8]. Fuel-efficient vehicles are be- coming increasingly important, with landmark climate change deals such as 'The Paris Agreement' introducing limits on greenhouse gas emissions globally [9]. The introduction of electric vehicles into the car market is also an important factor to consider, as the driving range of such vehicles has still not managed to match that of their gasoline counterparts. Introducing efficient driving strategies through AVs could help bring electric vehicle range up to par.

Congestion contributes to fuel waste in quite a large way. In 2014, the US wasted an estimated 3.1 billion gallons (11.7 billion liters) of fuel due to congestion [10]. Automated driving strategies, in situations such as lane changes, could reduce congestion and improve efficiency. Dangerous lane changes don't even have to result in a crash to cause delays. If a car brakes due to a dangerous merge, it can cause a ripple effect, creating congestion. This ripple effect is known as a 'traffic shock' [11].

As well as more quantifiable benefits, AVs could also provide a level of comfort not currently available today. In a world where AVs are commonplace, it is not hard to imagine people working, reading, or relaxing in their car instead of focusing on driving.

However, today, there are still a number of concerns surrounding AVs, one major issue being the reliability of the systems governing the vehicle. Systems need to be responsive and accurate. They cannot afford to fail in such safety-critical environments. Today concerns over Tesla's Autopilot system are impacting the image of the company, and the system isn't

In order to address these concerns safely, simulations that test the reliability of autonomous systems can be created. Researchers at the University of Texas set up the Autonomous Intersection Management (AIM) project, which aims to "create a scalable, safe, and efficient multi-agent framework for managing Autonomous Vehicles at intersections" [13]. The team managed to apply their simulator-tested intersection software in a mixed reality test, using a real-life AV [14]. This demonstrates how vital simulators are when testing safety critical systems.

The motivation for the AIM system was to reduce congestion at intersections. Similarly to intersections, lane merges can be significant sources of congestion. AVs will need to be able to deal with various lane merge situations if they are to become effective alternatives to manual vehicles. This project aims to develop a simulator that can effectively filter traffic through a lane merge. This simulator will be based on the AIM simulator codebase, which will also be considered for future AV projects if it can be adapted effectively. Using this simulator is aimed to compare different merge schemes, particularly looking at the effectiveness of decentralized systems against centralized systems. The paper also aimed to analyze how different merge conditions impact the performance of a merge system.

This project makes a number of assumptions. Firstly, we assume that the sensors resolving the positions of the vehicle and its surrounding obstacles are perfectly accurate. We also assume that all vehicles can reliably communicate with each other and with roadside infrastructure. These assumptions ignore existing areas of research that are not considered in this paper.

Chapter II examines existing work with merging AVs and compares centralized approaches to decentralized approaches. Chapter V takes a deeper look at the issues surrounding lane merges and the different types of lane merges that can be found on the roads today. Chapter X examines different approaches to the merge problem and their advantages and disadvantages. Chapter XIV details some of the problems encountered whilst implementing the merge approaches and the reasons for some of the workarounds implemented. Chapter XXI analyses the performance of the Queue Merge Management system and compares it to a modified AIM implementation.

II. Literature Review

Any autonomous-vehicle system will implement a 'car-following model', which defines actions for a vehicle based on the behavior of its predecessors (the vehicles in front of it). One early car-following model was defined in 1981 by P.G. Gipps [15]. It was designed to mimic real-world driver behavior, calculating a safe traveling speed for a vehicle based on the speed of its predecessor. A safe travel speed is defined as a speed at which the driver can safely stop if the preceding driver stops.

Gipps defined two equations applying constraints on the acceleration and braking profiles of the vehicles. Gipps' model worked well at describing the behavior of traffic. However, translating this work to AVs poses a number of problems.

Firstly, the work is based on the behavior of real-world drivers in instrumented vehicles. This introduces human driver variables into the equations. Gipps' modeled reaction time, which will be far smaller for AVs. The gaps between successive vehicles are also larger than necessary. AVs are more precise than human drivers and can drive closer to their predecessors.

In 2000, Treiber et al. suggested the 'Intelligent Driver Model' (IDM) [16]. Thismodel defines an acceleration profile for a vehicle as a continuous function. This function is based on the vehicle's current velocity, its desired velocity, and the distance from the vehicle to its successor.

The IDM does not attempt to directly mimic human behavior in traffic situations. It models a general acceleration and braking profile for a given vehicle. As such, it is well suited for adaptation by AV models, as seen in Kesting's work [17] in Section IV-B.

Gipps' model and the IDM also both fail to recognize and incorporate the use of vehicle-to-vehicle communication in their models. AVs could communicate with each other to help reduce overall travel time and improve efficiency. In vehicle platoons, such as those analyzed by Kamali in 2016 [18], each vehicle autonomously follows its predecessor, with the lead vehicle controlling the overall pace of the platoon. Platoons make heavy use of vehicle-to-vehicle (V2V) communication to allow vehicles to join and leave, as well as to continuously control vehicle spacing and velocity. The advantage of a platoon is that all vehicles can accelerate and decelerate simultaneously, reducing the effect of traffic shocks [11].

III. Centralised and Decentralised

We can divide approaches to AVs into centralized and decentralized solutions. Centralized solutions rely on an external agent to manage vehicles. Vehicles use vehicle-to-infrastructure (V2I) communication channels to send information and receive instructions from the external agent. Decentralized solutions use vehicle-to-vehicle (V2V) communication to let other vehicles know their state and their intentions and to arrange any complex actions that might affect surrounding vehicles.

A. Centralised Systems

The Autonomous Intersection management system (AIM) described in [19] is an example of a centralized V2I system. The system works by dividing the intersection into a grid of $n \times n$ reservation tiles. Drivers 'call ahead' to the intersection, sending information packets containing

1) The time the vehicle will arrive.
2) The velocity at which the vehicle will arrive
3) The direction the vehicle will be facing when it arrives
4) The vehicle's maximum velocity
5) The vehicle's maximum and minimum acceleration
6) The vehicle's length and width

The intersection infrastructure simulates the journey of the vehicle through the intersection, noting the tiles occupied by the vehicle at each time interval. If any cell is reserved at the same time the intersection rejects the request. The driver

will start decelerating and continue making requests until it obtains a reservation. It will not enter the intersection without a reservation, even if that means coming to a stop at the intersection.

A centralized reservation system works well in high-traffic zones like intersections because it forces all vehicles to communicate with a single entity. This entity has a global view of activity at the junction, allowing the system to make vehicle management decisions more easily. A V2V solution would require more complex communication protocols involving large numbers of vehicles. The volume of messages required for each vehicle to obtain a global view of the intersection would be considerably larger, and as such, most vehicles will never get a complete understanding of the status of the intersection.

This paper forms the foundation for the AMM protocol designed in Section XI.

B. Decentralised Systems

The main arguments against centralized systems generally tend to stem from concerns over feasibility and fault tolerance. A centralized V2I solution relies on one system always being available to manage vehicles. The original implementation of the AIM system works well, but if the system were to fail and no longer provide reservations, then approaching vehicles would simply halt at the intersection. In a worst-case scenario, the system would still give reservations but fail to compare them to reservations already in place, causing major car crashes in the intersection. Having a single point of failure like this is a major concern, particularly when lives are on the line.

A paper by VanMiddlesworth et al. in 2008 [20] defined a decentralized version of the AIM model using V2V communication protocols. In VanMiddlesworth's model, each vehicle can broadcast two different types of messages. These messages are broadcast repeatedly within a specified period.

1) *Claim* This is a message indicating the vehicle's intention to traverse the intersection. It provides the vehicle's VIN, arrival lane, turning direction, arrival time, and exit time. It also provides a message ID, which increments when a new message is broadcast. Finally, the *Claim* message contains a boolean indicating whether the vehicle has stopped at the intersection.
2) *Cancel* This message releases any currently held reservation, it contains the vehicle's VIN and a message id, which acts the same as the message id in *Claim*.

Two *Claim* messages are in conflict if their paths, as determined bytheir lane and turn parameters, are incompatible and their time intervals, as determined bytheir arrival and exit times, overlap. To resolve the conflict, VanMiddlesworth's model determines which *Claim* has dominance. A claim C_1 dominates another claim C_2 if C_1's vehicle is stopped at the intersection and C_2's vehicle is not. If C_1 and C_2 both have the same value for the 'stopped at intersection' boolean, dominance is determined based on priority. Priority is indicated by the following rules, given in order of evaluation:

1) Ifneither vehicle is stopped at theintersection, the *Claim* with the earliest exit time has priority.
2) If both vehicles are stopped, the vehicle whose lane is 'on the right' has priority. This is defined similarly to current US 4-way stop rules.
3) If neither lane can be considered to be on the right, the vehicle that is not making a turn has priority.
4) If no other priority order can be established, the vehicle with the lowest VIN has priority.

The protocol starts with approaching vehicles and receiving messages from existing pending vehicles. An approaching vehicle may not start broadcasting its own messages until it is within 'lurk distance' of the intersection.

Once within lurk distance, the vehicle generates a *Claim* message for the earliest possible time the vehicle might arrive at the intersection. Once the vehicle has a *Claim* broadcasting, it mayneed to change it if it looks like the vehicle might be late to the intersection or if a competing *Claim* dominates it. A vehicle might also change its *Claim* to take advantage of a newlyavailable time slot. In this situation, the vehicle must then send a *Cancel* message and a new *Claim*. The *Cancel* message is sent repeatedly with the same period as the *Claim* message. Once the vehicle reaches the intersection, it must traverse according to its current *Claim*, broadcasting throughout the traversal. At this point, the vehicle's claim cannot be dominated.

The main drive behind the unmanaged AIM intersection was to reduce cost. Adding in new infrastructure to an intersection costs money, and it might not be considered worthwhile for small intersections with only one or two lanes on each side. An unmanaged, decentralized system like that described by Van Middlesworth would drastically reduce the cost to the state in creating automated road networks.

This paper forms the foundation for the decentralized protocol designed in Section XIII.

IV. Making lane changing decisions

Lane changes are a form of lane merging in which the lanes are parallel. Some of the lane merging approaches here could help in designing merge protocols. The approaches could also be applied to multi-lane merges.

There are a number of reasons that a driver would want to change lanes. The most obvious is that the journey the driver wishes to complete requires the vehicle to move into a different lane. In this case, the vehicle *must* change lanes before it reaches a critical position. Beyond this position, the driver will need to change their planned route, most likely extending their journey time.

Another reason a driver might change lanes is in order to increase velocity, with the aim of reducing journey time. In general, a driver will aim to change lanes if their average velocity in their current lane is much less than the velocity it could be achieved in another lane.

A. Lane Changing to hit a target lane

In 2016, Atagoziyev et al. described a centralized system for lane changes [21]. This system uses roadside infrastructure

to help groups of vehicles change lanes before they reach a 'critical position', such as a motorway exit or intersection. The vehicles send their position and velocity information to the roadside infrastructure. The system keeps track of the gaps between vehicles and their relative speeds and then uses a series of equations to determine how to manipulate a vehicle into its desired lane. Each equation is used in a different context based on the relative positions of surrounding vehicles. With the context identified, the system uses a finite state machine to determine the instructions to send to the vehicle.

Atagoziyev's model forces cooperation between vehicles by forcing them to move out of each other's way in order to allow vehicles to reach their target lanes. This is far better than human drivers, who have no requirement to act selflessly during lane changes. However, Atagoziyev's model does suffer from being a centralized system and cannot be applied to situations far from critical positions. As most merges will be at 'critical positions', however, this matters less to our problem. A simple merge system that forces vehicles to take turns and allow others to pass through could work as well as Atagoziyev's model, which proved to be effective in multiple lane change scenarios.

B. *Lane Changing to improve overall velocity*

Work by Kesting et al. in 2007 [17] describes a decentralized model of lane changing that lets vehicles change lanes to increase velocity whilst still ensuring that the overall traffic flow is not disrupted. This helps to avoid traffic shocks and maintains smooth traffic flow. In order to do this, Kesting introduced the MOBIL or 'Minimising Overall Braking Induced by Lane Changes' model.

The model uses two criteria that the vehicle must satisfy. The first gives the vehicle a maximum deceleration value. The second is the 'incentive criterion', the motivation for a driver to change lanes. Whether a driver changes lanes or not is based on the relationship between the utility a driver gets by changing lanes and the utility the vehicle behind the driver in the new lane loses by being pulled out in front of. How willing a driver is to sacrifice another driver's utility for their own is down to the driver's politeness factor *p*. With a *p* value of 0, drivers act selfishly, with no regard for the utility of other drivers. With a *p* value of 1, drivers act altruistically, only changing lanes when the is a net benefit to all drivers involved, at least above a set threshold. A *p* value of 1 caused the maximum lane changing rate to halve. Kesting also discovered that 'altruistic' lane-changing behavior increased the mean speed of both lanes involved in the simulation, improving overall traffic performance.

MOBIL could be used to manage merges with slip lanes, with drivers only merging when it has the least impact. The politeness factor would have to change as the vehicle came closer to the end of the slip lane, however, as eventually the vehicle must merge or suffer a collision.

V. Problem Analysis

Lane merging is not a straightforward problem with a single solution. There are many different types of lane merging scenarios, as well as a number of factors that add more variance to the problem. Section VI analyses some of the different merging scenarios to better define them. Section VII indicates how the success of a merging scheme can be measured, and Section VIII defines some factors that could alter the behavior of a given merge scenario.

VI. Merge Types

In this paper, we focus on merges made at 'critical positions' such as junctions. This is true for all of the merge scenarios analyzed. Figure 2 illustrates some of the merge scenarios described.

A. *Single-to-Single Merge*

A single-to-single merge (S2S merge) describes a situation where a vehicle moves from a single-lane road into another single-lane road. In this situation, we label the lane that vehicles are moving from the 'merge lane' (ML), and we label the lane that vehicles move to the 'target lane' (TL). The vehicles on the TL generally tend to be faster moving. We describe the vehicles that start on the ML as 'merging vehicles' (MVs) and the vehicles that start on the TL as 'TVs' (TVs). We have our critical position where the ML and TL intersect. We call this area the 'merge zone'.

The main issue with an S2S merge stems from the limited options available to vehicles arriving at the critical position. Target vehicles do not have the opportunity to move laterally out of the wayof MVs, and vehicles on both lanes could struggle to reduce their velocity without affecting their successors. Many S2S merges are performed with an attached slip-road. A slip road gives MVs more time to travel parallel to the TL before merging. This makes the merge easier for both MVs and TVs, as MVs don't slow down in front of TVs in order to make the turn into the TL. Figure 2 A shows an S2S Merge with a slip lane.

B. *Single-to-Double Merge*

A single-to-double merge (S2D merge) describes a situation where a vehicle moves from a single-lane road into a double-lane road. In this situation, we have two TLs. The upper lane, which directly links to the merging lane, is called 'target lane 1' (TL1), and the lower lane is called 'target lane 2' (TL2). We still have only one critical position where the merging lane meets TL1.

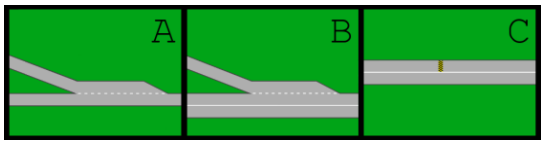

Fig. 2. a) S2S with slip lane, b) S2D with slip lane, c) Lane obstruction

An S2D merge provides more options for vehicles on the target lanes at the critical position. Target vehicles now have the opportunity to move laterally to avoid MVs. Two lanes also allow for more vehicles on the TL, which should give vehicles greater freedom to adjust their velocity without affecting their successors, at least when compared to the same number of vehicles on a single lane.

S2D merges can also take advantage of a slip road. Figure 2 B shows an S2S Merge with a slip lane.Any collisions that do happen should be reported immedi- ately. The system should automatically be considered a failure.

B. Delay

Delay measures the effect that the critical position had on the overall journey of the vehicle. It is the primary metric considered in Dresner et al.'s 2004 paper [19] on AIM.

Dresner et al. provide the following equation for measuring average delay.

C. Lane Obstruction Merge

A lane obstruction merge is where a vehicleneeds to change lanes to avoid an obstacle in its way. It is essentially an

$$\frac{1}{|C|}\Sigma$$

$v_i \in C$

$t(i) - t_0(i)$ (S2S merge although the vehicle moves laterally to avoid the obstacle. In this situation, the critical position is a point shortly before the obstruction.

The obstacle could be a broken-down vehicle or some debris on the road. Because of the unexpected nature of the obstacle, it may sometimes be difficult to have a centralized approach to the problem. However, if the obstacle was a broken-down vehicle, the vehicle might be able to act as the centralized system managing approaching vehicles. Figure 2 C shows a lane obstruction merge scenario.

VII. Measuring Success

In order to evaluate the effectiveness of solutions to the problems, we need to define measurements of success.

Solutions to the merging problems above must satisfy the

C is the set of vehicles that pass through a critical position within a set time frame. Assuming no other vehicles on the road, a vehicle v_i would complete its trip in time $t_0(i)$. Otherwise, v_i would complete its trip in time $t(i)$. We can represent this trip for vehicles in the simulator as the time difference between the vehicle spawning in and the vehicle being removed from the simulator.

To ensure fairness, the mean delay will be measured across each lane.

C. Throughput

By minimizing delay, we should also maximize throughput; the two are closely related. However, we should also collect direct metrics.

$|C|$following conditions:

1) *No collisions* This means avoiding collisions at the critical position between MVs and TVs, as well as$\text{Vehicle throughput} = \frac{}{t}$

comfort distance. This would mimic the IDM model [16]avoiding collisions between vehicles in the same lane.

2) *Minimise delays to both lanes* Vehicles should not suffer large delays to travel time due to the merge. This means measuring the average delay for both the ML and TL to ensure that the system is not starving one lane for the benefit of vehicles on the other.
3) *Maximise throughput* By minimizing delays and velocity loss, we aim to maximize the throughput of the critical position.
4) *Minimise changes in velocity* Though not strictly a performance requirement, the system should minimize changes in vehicle velocity for both passenger comfort and vehicle efficiency.

We need to measure how well solutions meet these condi- tions.

A. Collisions

Preventing collisions is a basic safety requirement for any autonomous vehicle system. We can measure this by compar- ing the positions of vehicles in the system and ensuring that there is no overlap.We should also consider measuring near misses. We can define a minimum spacing between vehicles, perhaps equal to the minimum braking distance of the vehicle plus an additionalHere t is the time it took for all of the vehicles in C to pass through the critical position. We will also need throughput measurements for each lane separately.

D. Velocity Changes Vehicles should aim to reduce velocity changes as much as possible, particularly rapid changes. Ideally, autonomous vehicles should have very smooth acceleration and braking profiles. This both increases passenger comfort and improves fuel efficiency. To measure maximum acceleration and deceleration, we can measure the change in velocity at each time step in the simulator and divide this change by the time-step length.

E. Merge Variance Factors

In each of the scenarios in section VI theroad layout is fixed. More variance can be introduced to the scenarios by altering other factors. Not all of the factors below will be applicable in every merge scenario. Figure 3 shows some of the factors below, applied to an S2S merge.

- *Traffic Level* The traffic level changes the traffic density. It is measured in vehicles per hour per lane (vhl)
- *Target lane speed limit* The maximum speed that vehicles on the target lane can travel.

Merge lane speed limit The maximum speed that vehicles on the merge

- *Target lane lead in distance* The distance between the point at which TVs arrive in the simulation and the point at which the TVs reach the merge zone.
- *Target lane lead out distance* The distance between the end of the merge zone and the end of the target lane (at least the end in the simulator).
- *Merge lane lead in distance* The distance between the point at which MVs arrive in the simulation and the point at which the MVs reach the merge zone.
- *Merging angle* The interior angle θ at the point where the merging lane meets the target lane.
- *Slip-road length* Thelength of the slip-road in a merge that uses a slip-road.

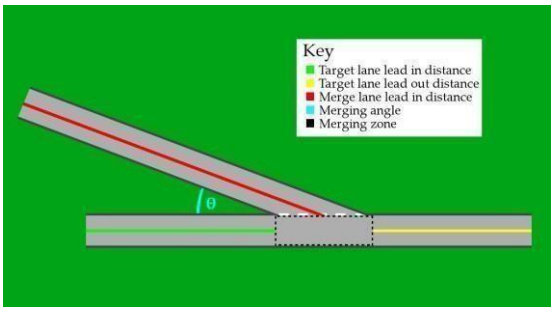

Fig. 3. An S2S merge marked with some of the variance factors

Traffic level has a fairly obvious effect on performance in a particular merge scenario. The more vehicles that try to merge together, the more difficult it will be for the merge to happen. It will likely require vehicles to move more slowly. Increased traffic density also increases the likelihood of traffic shocks, and vehicle maneuverability is impacted.

Altering speed limits could also affect performance. Higher speed limits could put pressure on systems that process the vehicles. Vastly differing speed limits for each lane could impact how easily a vehicle finds it to merge into another lane and adapt to its speed limit.

Lead in distances changes the amount of deliberation time vehicles have before theyreach the junction. It alsochanges the they have to change their velocity in. This means that distances could lead to larger acceleration and values as well as sub-optimal solutions to the vehicle's maximum velocity, length, width, maximum

The merging angle changes not only the heading at which MVs arrive but also the length of the merge zone. This could impact how long it takes a vehicle to traverse the merge zone as well as affect how easily the vehicles adjust to the new lane heading.

IX. Requirements

Using the problem analysis above, we can define the requirements for our final system. This system will not deal with every merge scenario described but will instead set the groundwork for further research. The complete requirements are given in Appendix A. A shortened version with the most important requirements are given here.

A. Functional Requirements

The functional requirements describe the functionality required within the simulator. They are broken into two sets of requirements. User requirements and system requirements. User requirements describe the behavior expected from the simulator from a user perspective. System requirements are all associated with a user requirement. They describe the functionality required bythe system in order to satisfy the user requirement. Table **??** shows some of the functional requirements.

B. Non-functional Requirements

The non-functional requirements describe the expectations of the simulator that are not actions the simulator will perform. Table I shows some of the non-functional requirements for the simulator.

TABLE I
NON-FUNCTIONAL REQUIREMENTS TABLE.

ID	Description
NS.6	All data displayed to the user should be accurate.
NS.7	All data in the results file should be accurate.
NS.9	Code should be written to allow for easy expansion.
NS.11	The simulator should be integrated into the AIM4 simulator without negativelyaffecting the performance of AIM simulations.

X. Design

For the initial development of the simulator I focused on creating a working prototype for S2S merges. The S2S merge is one of the most simple merge scenarios that an AV might encounter. The designshere can then be expanded at a later date to include some of the other scenarios in VI.

XI. Autonomous Merge Management System (AMM)

This centralised system is based on the AIM system [19]. distance Once in range, approaching vehicles send a request message to shorter the system with their vehicle specification and their predicted deceleration arrival time and arrival velocity. A vehicle specification con- merge. tains a acceleration and maximum deceleration.

Upon receiving a request the management system simulates the vehicle's journey through the merge zone, which has been split into a grid. As the vehicle is simulated, the system notes the cells the vehicle moves through and the times at which it occupies each cell. The system then compares these 'space-time' values to its reservation store. The reservation store consists of sets of space-time values indicating where and when vehicles are expected to be in the merge zone. If the requesting vehicle does not clash with any of these reservations then the request is granted and the reservation store is updated. If not, the system rejects the request. The requesting vehicle will have to tryand make a new reservation. They cannot enter the merge zone until theyobtain a reservation.

Vehicles with a reservation continue towards the merge zone at the speed that allows them to enter at their scheduled arrival time. If a vehicle cannot maintain its reservation for any reason, it is its responsibility to alert the management system, at which point its reserved space-time values will be released, and the vehicle will have to make a new reservation. Once a vehicle has successfully traversed the merge zone, it will need to send a message to the management system to alert the system that they are leaving its zone of control.

This system makes good use of space-time, allowing multiple vehicles into the merge zone at the same time. However, the system does have a number of issues. The primary one is that the leading vehicles in both lanes, that is, the ones before the merge zone, will always be the only two with reservations. Lead vehicles are the only vehicles that can accurately predict their arrival time, as they don't have to consider the braking behavior of any predecessors. A consequence of this is that successor vehicles very close behind the lead vehicle are forced to make reservations very close to the merge zone. These vehicles have to slow down to avoid entering the merge without a reservation, and they become more delayed.

Another problem is that the system does not guarantee that one lane will not experience large delays at the expense of another. If a vehicle on the target lane arrives first and makes a reservation, then a vehicle on the merge lane arrives and has to wait, there is nothing to say that twenty more target lane vehicles will pass through before the merge vehicle ever manages to make a reservation. A queued merge management system might be able to counteract this, as seen in section XII.

XII. Queue Merge Management System (QMM)

The queue merge management system is another approach to centralized vehicle control. Unlike a reservation-based system, where vehicles enter the merge at a pre-arranged time, a queued merge management system controls vehicles with a simple go/no-go system. Vehicles are sent messages telling them to enter the merge zone without knowing exactly when that might be.

As a vehicle approaches the merge, it sends a request to the management system. This request contains the vehicle's ID, the ID of the vehicle's predecessor and the vehicle's distance to the merge zone. The predecessor ID and distance measurements are assumed to be accurate. In a real-world scenario, a vehicle could lie about these parameters, but as these parameters could be verified or collected by the management system instead, we assume them to be accurate. An approaching vehicle has to be within a set distance of the merge zone in order to be added to the queue of vehicles being processed through the merge. This is to mitigate the effect of veryfast vehicles being forced to slow down in order to allow slower vehicles earlier in the queue to pass through the merge zone. Anyrequest from a vehicle further away from themerge zone that this distance is rejected.

If the vehicle's request is from within an acceptable distance, then the queue system checks to see if the vehicle's predecessor has been added to the queue. There is a possibility that the predecessor has not managed to make a request yet. This check ensures that the vehicle's predecessor is added to the queue in a position before the vehicle. If the vehicle's predecessor has not yet been added, then the vehicle's request is rejected. Otherwise, the vehicle's request is accepted with a confirmation message, and the vehicle's ID is added to the queue.

The vehicle is now awaiting a go message from the queue system. During this time, it cannot enter the merge zone and must stop before it enters. The queue system sends go messages to vehicles in the queue as the previous vehicle that was sent a go message leaves the merge zone. This ensures that only one vehicle is in the merge zone at any time. Once a vehicle receives the go signal, it must make its way towards the merge zone and traverse it. Once the vehicle leaves the merge zone, it sends a message to the queue system confirming that it has safely traversed the merge and that it can let the next vehicle through.

This system sacrifices space efficiency for simplicity and a focus on fair access across both lanes. The system cannot have more than two vehicles in the merge zone at the same time, as the AIM-based system can. The system also fails to guarantee a vehicle a time at which it can move through the merge zone. The time a vehicle spends in the queue depends on the speed of the vehicles ahead of it.

XIII. Decentralised Merge Management System

Thedecentralized merge management system is based heavily on the work by VanMiddlesworth et al. in citeVanMiddlesworth2008 [20]. This system is based on two message types, which each vehicle broadcasts to every other vehicle within range. The first message type is a *Claim*. This message is used to try and reserve access to the merge zone. It contains the vehicle's ID, lane, estimated arrival time, estimated exit time, and a boolean indicating whether or not it has stopped at the merge. The second message type is a *Cancel*, used to release any reservations held by a vehicle. *Cancel* messages contain a vehicle's id. All message types also contain a message ID, which monotonically increments with each newmessage sent bythe vehicle. Vehicles broadcast both message types repeatedlywith a constant period toensure that the messages are received by all other vehicles.

Again, we assume all of the values provided by the vehicles are accurate. VanMiddlesworth [20] goes into further detail about dealing with selfish and malicious agents; however, in this scenario, we are assuming all vehicles are forced to provide accurate information.

Claims can compete with each other, in which case Claim dominance must be established. A claim C_1 dominates another claim C_2 if C_1's vehicle is stopped at the merge and C_2's vehicle is not. If C_1 and C_2 are either both stopped at the merge or both not stopped at the merge, dominance is determined based on priority. Priority is indicated by the following rules, given in order of evaluation:

1) *If neither vehicle is stopped at the merge* The *Claim* with the earliest exit time has priority.

2) *If both vehicles are stopped at the merge* The *Claim* on the target lane has priority. This is because, in real-world scenarios, maintaining traffic flow generally means giving way to the target lane.

3) *Otherwise* The vehicle with the lowest ID has priority

As a vehicle approaches the merge, it will receive messages from other agents. Before acting, the vehicle 'lurks' long enough to be reasonablysure of everypending *Claim* message. The vehicle then generates its own *Claim* message based on the earliest possible arrival and exit time of the vehicle. Once a vehicle has a *Claim* they will continue broadcasting until they either complete the merge or have to change it. Once in the merge, the vehicle traverses in the manner their *Claim* indicates. They continue broadcasting their *Claim* during this time, but it cannot be dominated.

If the vehicle's arrival estimation changes (due to a preceding vehicle braking or something similar) the vehicle generates a new *Claim*. If another vehicle arrives at the merge before they do, the vehicle broadcasts *Cancel* repeatedly with the same period as *Claim*. This helps to deal with the 'lead vehicle only problem' found in the AMM system. Once cancelled, the vehicle then attempts to make a new *Claim*.

This system has the advantage of being completely decentralized, requiring no extra infrastructure to handle requests. However, the complexity of this system is far higher, requiring multiple agents to perform complex simulations and attempt to maintain a global picture of the system. In a centralized system, these activities are far easier to organize.

XIV. Implementation

The final implementation was done in Java, and was built on top of the AIM simulator codebase.

XV. Generalising the Codebase

The use of the AIM codebase was a project restriction imposed for research purposes. By working with the AIM simulator codebase I could learn how easy it is to work with, and analyse whether or not it would be a good codebase to continue expanding upon for future AV projects. Each simulator built for this project works alongside the AIM simulators whilst being completely independent. The project: citeMilligan2017 [22], also required simulators to be built using AIM. In addition, both projects had to work alongside each other using the same codebase. To make sure that code coupling was reduced as much as possible, I worked closely with their project lead to generalize the codebase, breaking out useful shared features so that all simulator types could access them. [23]. Breaking out the code like this satisfied requirements *NS.11* and *NS.12*.

Appendix B provides detailed coverage of the changes made to the AIM codebase.

XVI. Merge Schemes

The AMM protocol implementation was developed by examining the original AIM code and creating a modified version applicable to merges. Because the two systems are so similar, much of the code was duplicated. This could be refactored at a later date, but during development, having full control over the actions taken by a vehicle without having to compromise to allow AIM to work correctly was very useful. Despite this approach, there were significant issues with the system. Even using very similar approaches to AIM, almost identical in areas, vehicles would continue to arrive early to their reserved times and vehicles would collide consistently at intersections. The reasons for these errors are described in more detail in Section XVII.

To correctly implement the AMM system, much of the fundamental generalized code that the system was built upon would have had to be replicated or rewritten to ensure that the system was working accurately. Because of this, and due to time constraints, a full version of the AMM system was not implemented. As such, requirement *FS.81* was not satisfied. As an alternative, a modified version of the AIM simulator was developed. In this version the AIM simulator was restricted to onlyspawn vehicles from the south and west roads, with each vehicle's destination set to the east road. This effectively mimicked an AMM system with a 90° merge angle.

The QMM system was implemented as a replacement for a fully implemented AMM system. The system was expected to have good performance, possibly rivalling that of the AMM system. The system was also simpler to implement than the AMM system, and despite issues surrounding some of the generalized methods, the system was fully implemented. With QMM implemented, we now had a system that could be used to analyze how the merge variance factors, such as merge angle, speed limit, and lead in the distance, affect a system. We can also compare the performance of the AMM and QMM protocols.

The QMM system was implemented with a request distance limit of 150m. Vehicles further from the merge than this distance cannot be added to the queue.

The original plan was to compare a centralized system with a decentralized solution, based on the work from VanMiddlesworth [20]. However, this was never implemented due to the difficulties with the system, and time constraints. As such, requirement *FS.91* was not satisfied.

XVII. Simulation

Each simulation consists of multiple interacting agents, which makes it a difficult problem to implement. Using some of the generalized AIM classes helped to reduce the amount of time it took to implement these components. However, using AIM did introduce some complications, and parts of the core code had to be rewritten to adjust for this.

A. Drivers

Driver agents are responsible for manipulating the vehicles in the simulation. They make requests to centralized merge managers and act upon the responses they are given. Each driver acts as a finite state machine, performing specific sets of actions for each state. Vehicles and Drivers both extend from generalized Vehicle and Driver classes, which contain

useful functions for following lanes, turning, and determining distances. However, some of these methods proved to be flawed.

One of the main issues was the assumption that lanes and roads would always meet at 90 degrees. This caused a number of small issues throughout development, but one key problem was turning. A turn through an intersection in the AIM simulator is done by forcing the vehicle to point to a coordinate further down the lane the vehicle is following. This point is always exactly the same distance away from the vehicle, such that when the vehicle reaches a corner, and the lane it's following changes, the vehicle will turn towards that point gradually. This distance proved too much for some merges and resulted in the vehicle making turns too gradually. This was fixed by setting the turn distance to always be the distance from the point at which the vehicle enters the merge zone to themerge zone exit. The target point would also always lie in the center of the target lane. This caused merging vehicles to turn tightly, freeing up the lane for more vehicles. Figure 4 shows how these turns work.

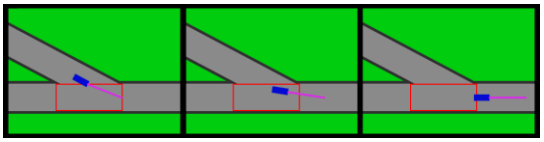

Fig. 4. A diagram indicating how turning works through a merge.

Another problem came about due to collisions. AIM had provided a method called *dontHitCarInFront*, which calculates the distance from the vehicle to the vehicle in front and then takes action to avoid a collision, slowing down if necessary. This method turns out not to be completely effective, particularly at high speeds. Even within the original AIM simulations, vehicles collide. Due to time constraints, collision detection was removed from the project, as fixing the issue would have required an in-depth analysis of core methods. As such, requirement *FS.162* was not fulfilled. As far as I can tell, no collisions take place within the QMM merge zone, as it should be almost impossible by the nature of the protocol. However, without having a check in place this cannot be said for certain. The AIM protocol also avoids collisions in the merge zone by switching to 'acceleration profiles' instead of using the *dontHitVehicleInFront* method.

B. Merge Managers

The role of a merge manager is to take requests from drivers and provide responses, controlling the flow of traffic through the merge zone. They were heavily influenced by the approaches taken by AIM. The AMM merge manager replicated much of the intersection manager code introduced by AIM. At a later date, this could be refactored to reduce duplication, but this would most likely also require changes to Driver and Vehicle, as each type of merge manager is built to deal with different types of vehicles and drivers.

The final implementation of a merge manager, the *QueueV2IManager*, is designed similarly to AIM's *V2IIntersectionManager*, however much of the code is original and far simpler. The AIM system is more complex, requiring the merge manager to monitor reservations and time the arrival of vehicles. The AIM system relies very heavily on each vehicle arriving at its stated time and fails to handle vehicles well if they miss their reservation or arrive too early.

C. Map

The simulation map stores all of the spawn points, lanes, and merge managers for the simulation.

By using some of the generalised components for calculating distances, creating the map was relatively straightforward, however, there were some components that failed to work as intended. The original AIM system assumes that every road meets at 90°, and as such, some methods were inappropriate for when lanes meet at other angles. One example of this is the no-vehicle zone at the beginning of each lane. This zone stops multiple vehicles from spawning on top of each other. The original implementation calculated a *Rectangle2D* at the beginning of each lane, which works fine when lanes are at 90°. For my no-vehicle zones, I had to define a path around the start of each merge lane and create the zone shape from that. This more complicated approach was necessary due to the angles at which the merge lane can meet the target lane.

The map also controls the spawn points creating the vehicles. Most spawning behaviors were based on the AIM spawn points. However, to enable consistent testing, we wanted to be able to repeat the experiment with the same vehicles over and over again. To do this, I created a new vehicle spawn type that uses a JSON file to spawn vehicles. The file contains an array of pairs of vehicle specifications and spawn times. The spawn point reads this data in and spawns a vehicle with the given specification at the indicated time. I also implemented this type of spawner into the AIM system. This means that direct comparisons between the performance of AIM and QMM are now possible.

D. Simulation Control

The simulator itself is responsible for triggering and monitoring the actions of each component of the simulation. It delivers messages between merge managers and vehicles and moves vehicles through the simulation according to their specified velocities and headings. The simulator controller satisfies requirements *FS.12*, *FS.13*, *FS.22*, *FS.32*, *FS.42*, *FS.71*, *FS.73*, *NS.3*, *NS.4* and *NS.8* by managing all of the components in the simulation and producing results.

XVIII. Results Production

In order to provide results Vehicle objects were provided with fields to store their statistics. These fields were:

- Delay
- Final Velocity
- Maximum Velocity
- Minimum Velocity
- Final X Position
- Final Y Position

- Start Time
- Finish Time
- Starting Road

These fields were implemented in both AIM and Merge vehicles. To calculate the delay the simulator first simulates each vehicle specification for both the merge and target roads. The completion times for each specification are recorded and then used to calculate the effect the merge protocol had on each vehicle. The start time and starting roads are initialised in each vehicle when they are created by their spawn point. The maximum and minimum velocities are dealt with after the *moveVehicles* method in thesimulator. The simulator compares the current velocity of the vehicle to its stored maximum and minimum velocity and updates as necessary. The finishing variables are dealt with when the simulator removes them from the simulation and adds them to the completed vehicle store. Maximum acceleration and deceleration measurements were not implemented, as such requirements *FS.6a*, *FS.6b*, *FS.6d* and *FS.6e* were not satisfied. All other requirements connected to *FU.6* and *NS.7* were satisfied. The current design of the AIM simulator uses the maximum deceleration for each vehicle as they approach the merge zone, braking at the last moment as aggressively as the vehicle's specification allows. This obviouslymakes maximum acceleration and deceleration measurements pointless. In real life braking profiles like this won't provide the most comfortable ride to passengers, and it also means that vehicles cannot pre-emptively slow down to maintain momentum whilst other vehicles to move through the merge. Further work could be done to expand both the AIM and Queue protocols to allow for pre-emptive acceleration profiles like these.

The results can be saved to a CSV file containing the throughput, maximum delay, mean delay and minimum delay of the system. There are also results for each vehicle. In addition to the list above, each result contains the vehicle's

- VIN
- Starting Road
- Vehicle Specification Name

XIX. GUI

The GUI for the project was built using Java Swing, extending the existing GUI. New simulator types are given a separate tab in the application with their own simulator setup and a display screen. The display screen can be modified for each simulation type, showing the relevant information for that simulation. We moved away from the AIM graphical implementation to a *StatScreen* implementation which shows information in text format instead. The S2S simulations display the current simulation time, number of completed vehicles and throughput. They also display two tables, one containing information about the vehicles currently in the simulation, and another for vehicles that have left the simulation.

Functional requirements *FS.82* and *FS.92* were not fully implemented as the AIM-like simulations and Decentralised simulations were never implemented in a fully working form. *FS.161* was also never implemented due to the removal of collision detection from simulations. All other GUI requirements were completed.

In order to enable repeat experiments with the same vehicles spawning at the same time, the GUI needed to support the input of merge schedule JSON files to the spawn points. This was implemented using *JFileChooser*. I also added an extra feature to the merge setup panel which allows users to generate spawn schedule files for a specific time period at a specified traffic level. This enables users to generate schedules without having access to the codebase.

XX. Maintainability and Testing

A. Maintainability

The separability imposed between the AIM, Merge and Generalised classes allows developers to create new simulations quickly, without having concerns over the effect they'll have on existing work. In general, as long as the developers extend and modify certain key classes they can create without worry. For example, new developers will have to create a new *SimSetupPanel* and *SimViewer* panel in order for their simulation to appear in the GUI. The separability isn't perfect, there are some instances where AIM specific classes are used by Merge (mainly in the implementation of AMM), but in general most of the classes are broken out correctly, satisfying requirement *NS.9*.

In terms of maintaining existing code, the prospects are quite good. The majority of the complex code is documented using JavaDocs and comments, satisfying requirement *NS.10*. Once familiar with the codebase, it is relatively easy to find the files you are aiming to change. Some sections are quite complex however. Many AIM components are tightly coupled, particularly surrounding the I2V managers and reservation classes. These areas use callback interfaces that result in confusion over the role of each class. Refactoring this out would be hard, as there isn't really a perfect solution, but it could be improved with further development time. The separability of the different simulators also comes at a cost in terms of class structure complexity. The changes made to the vehicle and driver classes in Appendix B should indicate how complex some of the class structures have become.

The main problem with the codebase surrounds the core generalised code. Because the system is based on AIM, attempting to develop something beyond the original specification, such as using lanes that don't meet at 90°, can be problematic. These problems have already been described in Section XVII.

B. Unit Testing

Unit tests were mostly used to ensure getter and setter methods worked as expected. However, some unit tests were used to verify the behaviour of classes. To do this I used Mockito [24] to mock the behaviour of objects used by the test class so that I could prompt the test class into producing the expected results. Mockito was particularly useful in dealing with the components with high coupling.

C. Integration Tests

Integration tests were the most useful tests I used. They allowed me to find and remove problems with the simulators by observing how the map, vehicles, drivers and simulator objects interacted together, as this was usually where most of the errors were occurring. These tests also allowed me to identify key errors with the AIM simulator's approach that were causing problems with AMM.

XXI. Results

The simulator was designed to allow for variance in merge angles, lead in distances, speed limits, and traffic levels. This means that we can experiment to see what effect each of these variables has on the effectiveness of the QMM protocol. We can also compare the QMM protocol to the AIM protocol, using the modified version of the AIM simulator described in Section XVI.

XXII. Experimental Procedure

All experiments were done using pre-generated spawn schedules. In each experiment I used 20 pairs of schedules (1 schedule per lane). Schedule pairs are identical for tests with the same speed limit and traffic rate. Vehicles spawned for 1000 simulated seconds, and all vehicles were allowed to complete. The spawn schedules would only fail to spawn a vehicle if the spawning area was occupied by another vehicle. This caused reduced numbers of completed vehicles if the system became congested enough to cause queues up to the spawning area.

XXIII. Comparing AIM and QMM

By using the modified AIM simulator described in section XVI, I obtained approximations for how well an AMM implementation would handle merges.

The AIM simulator has a lead in and lead out distance for each lane of 150 metres and is limited to 90°merges. These settings were duplicated for QMM. All of the lanes were set to have a speed limit of $20ms^{-1}$ (44.7mph or 72kph). The traffic rate (vehicles/hour/lane (vhl)) was altered to see how well the systems adjust to increasing levels of traffic.

In terms of reducing mean delay, both systems performed well at low traffic rates. From 500 to 1500vhl both systems kept mean delay below 2 seconds. AIM performed slightly better, hitting a mean delay of 0.97s with a standard deviation of 1.35s, QMM achieved a mean delay of 1.84s with a standard deviation of 2.22s. As the traffic rates increased however, the performance of QMM degraded massively in comparison to AIM. At 2500vhl QMM hit a mean delay of 45.78s with a standard deviation of 18.13s. In comparison, AIM hit a mean delay of 5.43s and a standard deviation of 6.25s. Even with a comparatively high standard deviation like this, it's clear that AIM outperforms QMM in this respect. Figure 5 shows how the average delay increases over time for both systems.

In terms of balancing mean delay over both lanes, QMM also fails to perform as well as AIM. At 500vhl the mean target lane delay for QMM is 0.06s, with a standard deviation

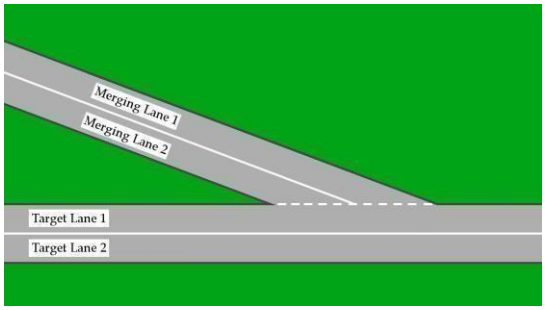

Fig. 5. QMM and AIM mean dealy by merge management system.

of 0.25s. For the merge lane, the delayis 1.36s, with a standard deviation of 0.95s. Comparatively AIM has a mean delay of 0.37s, with a standard deviation of 0.79s, for the target lane, and 0.16s, with a standard deviation of 0.47s, for the merge lane.

At higher traffic rates, the gap between the AIM lanes increases. At 2500vhl AIM has a mean delay of 1.75s, with a standard deviation of 1.54s, for the target lane, and 9.11s, with a standard deviation of 6.79s, for the merge lane. These times are still far better than the mean delays in QMM. Figure 6 shows the delay for each lane under each system.

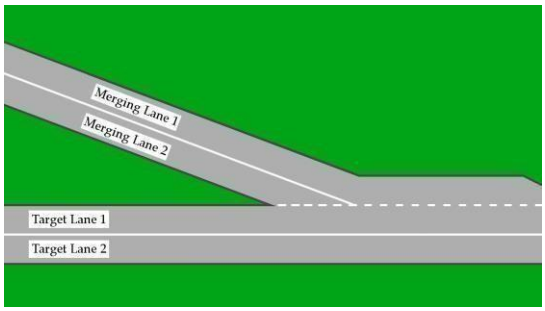

Fig. 6. Mean delay by lane for QMM and AIM

Both systems manage to maintain similar throughputs until the traffic rate increases past 1500vhl. By 2500vhl, AIM can deal with an extra 366 vehicles per hour compared to QMM. Figure 7 shows the throughputs for each system.

These trends clearlydemonstrate that AIM performs far more effectively at high traffic rates than QMM. AIM makes better use of space-time, so when the roads begin getting more congested, this pays off in AIMs favour. QMM ends up causing problems at these high traffic rates as it only allows one vehicle into the merge zone at any one time. QMM would work well for controlling roads with lower traffic rates, however, if the roads are expected to deal with congestion or high volume fast flowing traffic, the AIM system becomes the onlyviable option.

This test makes a good case for continuing attempts to develop an AMM system. This system would need to be able to work for other merge angles, as noresearch was conducted into the effectiveness of AIM at shallower angles. Further development would also need to done using a simulator which

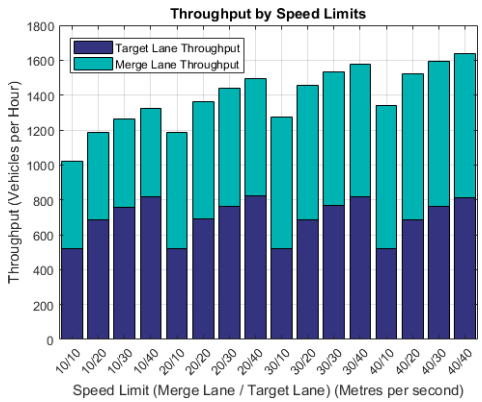

Fig. 7. Throughputs for QMM and AIM

deals with some of the implementation problems found in the AIM simulator.

XXIV. The Effect of the Merge Angle

The merge angle affects both the length of the merge zone and the angle at which vehicles join the target lane. For QMM to be effective, it should be able to deal with a range of merge angles.

For each test, the speed limit for both lanes was 20ms^{-1} (44.7mph or 72kph) and each lane had a lead in distance of 150m. The traffic rate was set to 1000vhl.

At shallow angles QMM performed very poorly. Figure 8 shows how the shallow angle performance compares to steeper angles. At the shallowest angle tested, 5°, the system had a mean delay of 138.98s with a standard deviation of 46.96s. After the merge angle increases to around 30°, performance improves greatly with the mean delay reaching 13.12s with a standard deviation of 9.35s. By the time the merge zone has reached it's minimum length, the mean delay has decreased to 1.24s with a standard deviation of 1.55s. The delay is actually smaller at 85°at 1.23s but this is well within range of the standard deviation for 90°. The delayof both the target lane and merge lane follow very similar trends.

Fig. 8. Mean delay by merge angle

In general throughput increases dramatically with themerge angle until around 35°where it levels off dramatically. The data does show a dip in the merge lane throughput measurements from 40°to 60°. Investigation showed that this was an error with vehicle spawn system which dropped vehicles after detecting that there was still another vehicle in the spawn area. These were false detections due to the change in angle. A solution to the problem would have required separate spawn schedules for each angle which reduces the comparability of the results. These results are considered to be outliers. Figure 9 shows how the throughput improves as the angle increases.

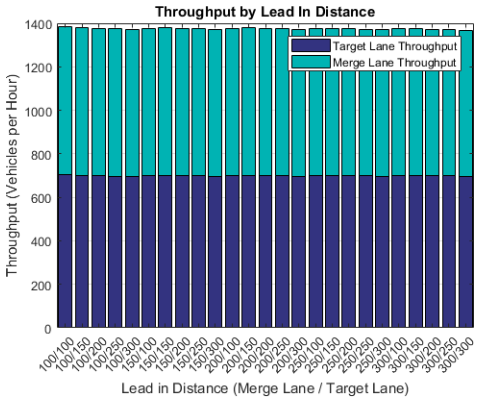

Fig. 9. Throughput by merge angle

Shallow merge angles have such a drastic effect on performance because as the merge angle becomes shallower the merge zone gets longer. This means that the space time inefficiency of QMM has a huge effect on performance as vehicles have to wait for longer before they can enter the merge. One approach for dealing with shallow merges is to introduce a slip road instead of a merge zone. This would require a different system, as queuing wouldn't be appropriate in that situation.

XXV. The Effect of Lead in Distances

The lead in distance had very little effect on the overall success of the simulation. Below 100m there was some increase in delay due to the 150m distance limit before vehicles are added to the queue. Appendix G discusses these results in more detail.

XXVI. The Effect of Differing Speed Limits

The speed limits of each lane and their differences impact how well a vehicle can move into another lane and adjust to its velocity. Many merges will be movements from lanes of differing speed, so its important that QMM can handles these merges.

The traffic rate was set to 1000vhl, the merge angle was 45°, and the lead in distances were both set to 150m. Pairs of speeds were compared. The speed limits used were 10ms^{-1}, 20ms^{-1}, 30ms^{-1}, and 40ms^{-1} (22.4mph, 44.7mph, 67.1 mph, and 89.5mph or 36kph, 72kph, 108kph, and 144kph respectively). These speeds, excluding 40ms^{-1}, are very close to realistic speed limits and should provide insight into the real world applicability of the system.

The target lane suffers the most interference from the merge lane whenever the target lane's speed limit is larger than the merge lane's speed limit. This can be seen well in the

relationship between a target lane speed limit of $30ms^{-1}$ and a merge lane speed limit of $10ms^{-1}$. The mean delay on the target lane is 13.92s with a standard deviation of 3.56s. Comparatively the merge lane had a mean delay of 4.01s with a standard deviation of 2.87s.

Switching the lane speeds shows that the merge lane also experiences larger delays when the merge lane speed limit is larger than the target lane. When the target lane has a speed limit of $10ms^{-1}$ and the merge lane has a speed limit of $30ms^{-1}$, the merge lane has a mean delay of 12.00s with a standard deviation of 3.00s. In this case the target lanehas a mean delay of 0.34s with a standard deviation of 0.95s.

It should be noted that when the speed gaps are smaller the effect on the lanes is reduced. Most of the speed limits containing a $40ms^{-1}$ lane also performed poorly. The velocity causes vehicles to accumulate too quickly for QMM to be able to sort them out effectively. Figure 10 shows how the mean delay is affected by different speed limit pairs.

The number of vehicles that complete for each lane is solely affected by the speed limit of the lane, the difference between the lane speed limits has very little effect. The throughput is likewise only affected by the speed limits of each lane independently.

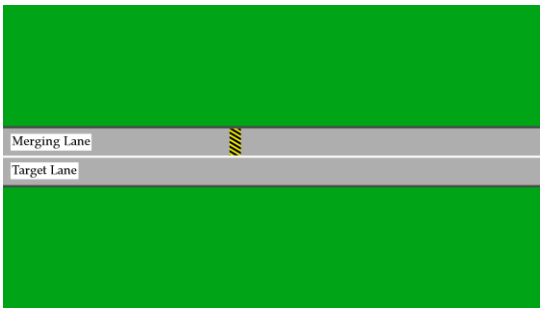

Fig. 10. Mean delay by speed limit pair

These results show that QMM struggles to handle differences in velocity well, with the faster lane being impacted more heavily than the slower lane. This is because the faster lane is forced to slow down to accommodate the slower lane. There will always be delay on the faster lane due to this reason. The aim for a good merge system is to minimise the effect of the speed limit gap as much as possible.

XXVII. Conclusion

This project had three main aims.

1) Design and simulate different AV approaches to a merge scenario, particularly surrounding centralised and decentralised approaches, and analyse their effectiveness.
2) Examine how the performance of merge management systems is affected by changing the conditions surrounding the merge.
3) Determine how well suited the AIM simulator codebase is for simulating other AV problems.

I successfully implemented a centralised approach to an S2S merge scenario using the QMM system. I also adapted the AIM system to emulate the expected behaviour of the AMM system at 90°. The results showed that the AIM system was more effective than the QMM system, particularly at high traffic rates when the QMM system failed to process vehicles efficiently. AIM's efficient use of space-time makes it much better suited for such high volume scenarios. This project has helped to show that developing an AMM system fully is worth investing research time into. A decentralised approach to the merge scenario could not be implemented due to time constraints, but a design based on the work of [20] was defined in Section XIII.

The QMM system also tested under various merge conditions. The merge angle was found to have a very significant effect on the delay and throughput of the QMM system. At shallow angles the system performed extremely poorly to the large merge zone length. The differences in speed limit also had a large effect, impacting the faster lane's delay time quite heavily. The lead in distances had an almost negligible effect beyond very short distances. Even though the QMM system may not be developed further as a solution to the S2S merge problem, it did help to identify some of the issues that AV merge approaches will need to resolve.

Development with the AIM simulator codebase proved to be more difficult that initially anticipated. Implementation originally seemed to be straightforward after breaking out the project into generalised and specific classes. The system had already provided a number of useful functions for driver and vehicle agents. However, as some of these proved to be ineffectual or not applicable to my project, many of them had to be rewritten or adapted. The ineffective collision prevention AIM provided and the assumption of 90°roads caused numerous issues making it difficult to develop simulators as rapidly as originally anticipated. My recommendation would be to either strip back the AIM system andreimplement the core methods, with a focus on creating a more general system, or alternatively, create a new system aimed at performing as a universal core for AV simulations.

Overall I feel that the research I've conducted should act as a starting point for further AV simulations. The next stage of development would be to see how effective a fully implemented AMM system would be at dealing with different merge angles, and with different speed limits on each lane. Once implemented, the AMM system could be adapted to other merge scenarios from Section VI, such as the S2D merge.

The Decentralised Merge Management system designed in Section XIII should also be developed into a fully working simulation and compared to the AMM system. The lack of infrastructure costs make decentralised solutions to the merge problem very desirable.

Other merge systems could also be implemented, helping to eliminate some of the foibles of the AIM, QMM and Decentralised systems. Systems developed with smoother braking profiles could help improve fuel efficiency and passenger comfort, and a system that deals with slip roads will have to be developed if road vehicles are ever going to become

completely autonomous.

There are multiple areas of research to be investigated surrounding AV merging, not to mention the countless research possibilities in the AV field as a whole. My hope is that this project has helped to identify some of the key areas of development required to produce an effective merging system. If vehicles are to move to a fully autonomous future, then all of these research areas will need to be investigated to make sure that we are developing safe, efficient and effective solutions.

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ISBN: 978-93-342-1696-7

KITS-NCICDLA-25-CONFERENCE PROCEEDINGS

Paper ID: 100

AUGUMENTING FIGURE EFFICANCY OF LOW-DOSE CT EXAMS USING ADVANCED DEEP LEARNING TECHNIQUES

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Abstract- ***Low-dose computed tomography (CT) is crucial to lessen sufferers' radiation exposure, but it frequently has high noise ranges and poor photo quality. This examine provides a convolutional neural community (CNN)-based approach to improve the best of low-resolution CT pix. The proposed technique is developed to successfully restore and classify structural details in CT pictures. Several experiments display that our CNN model considerably improves picture first-class by way of maintaining critical anatomical information and enhancing diagnostic accuracy compared to conventional techniques.***

Keywords: Deep learning, CT Scans, Enhances images, Convolution Neural Network (CNN).

I. INTRODUCTION

Computed tomography (CT), an critical imaging approach, is broadly utilized in medical prognosis. However, due to the fitness dangers of high radiation exposure from traditional CT scanning, low- dose CT scanning techniques are used. Although these low-dose scans lessen radiation publicity, they often produce noisy pictures, making analysis tough. One of the drawbacks of conventional noise reduction strategies, inclusive of filtered back projection (FBP) and recursive reconstruction, is the alternate-off between noise discount and element upkeep. In latest years, convolutional neural networks, or CNNs, have established sizeable performance in diverse picture processing packages, which include denoising and brilliant-resolution. CNNs can help enhance low- decision CT snap shots because they are able to examine complex mappings from noise to sharp pix. Despite advances in CT hardware era, dose reduction has been similarly hampered by the boom in photo noise whilst the use of traditional reconstruction strategies, alongwith filtered again projection (FBP).

Therefore, many providers have developed numerous kinds of reconstruction (IR) techniques, such as Philips iDose and IMR, Siemens IRIS, SAFIRE and ADMIRE, Canon's AIDR-3-D and FIRST, and GE's ASiR and ASiR-V.Four-6. In trendy, the photo seems more "spotty" whilst the IR depth is high. The assessment of CT pics and the translation of imaging outcomes rely on the speckled and pixelated look of the photograph, that's regularly observed at excessive reconstruction stages. This is a obstacle of IR.7 approaches. It might be ideal if new reconstruction methods could maintain photo first-rate with low radiation. Deep Learning Image Reconstruction (DLIR) become recently posted (True Fidelity, GE Healthcare). This approach simulates the development of steady- dose FBP photographs using deep convolutional neural network-based models in low-dimensional environments. By offering high contrast, decreased banding artifacts, high spatial decision, and low photograph noise, low-contrast lesions may be without problems recognized (Revolution CT User Guide, GE Healthcare). To teach commercially available DLIR, a big set of constant-dose FBP pics acquired from sufferers and phantoms that are certainly artifact- unfastened in some settings is used.8 In addition, extraordinary size and noise reduction requirements may be considered while deciding on among low, medium, and high reconstruction levels. The advantages of DLIR over low-dose chest CT have not yet been decided.

II RELATED WORK

Literature overview is a very important step in the software program improvement method. Before developing a device, it is important to determine thetime issue, value saving and reliability of the enterprise. After these obligations are completed, the subsequent step is to determine which functional system and language may be used to extend the device. Once the programmers start building a device, they need a lot

of outdoor help. This aid can bereceived from experienced programmers, books or web sites. Before designing the system, the above-referred to issues are considered to optimize the proposed device.

The essential aspect of the work development section is to thoroughly examine and keep in mind all the work improvement necessities. For each paintings, literature review is a completely essential step in the

software improvement machine. Before growing the gadgets and the related machine, the time additives, resource requirements, manpower, economics and organizational ability have to be recognized and analyzed. After pleasing those factors and thoroughly thinking about them. The step is to broaden gear and associated capabilities. Although the mild radiation doses utilized in CT imaging can lead to bad picture resolution and misdiagnosis, scientific imaging is of superb importance for scientific diagnosis. In this observe, an unmonitored deep learning version based on a GAN cycle is proposed as a completely unique manner to improve low-dose CT (LDCT) images. The cycle GAN design is suitable for denoising clinical photographs, in which the corresponding excessive-dose CT (HDCT) photos are frequently absent, because it permits picture- to-picture transformation with out the need for linked records. To distinguish between found out and real pix in both domain names, our model includes two mills for LDCT- to-HDCT and HDCT-to-LDCT modifications, as well as two discriminators. Extensive checking out suggests that our approach produces excessive-decision HDCT-like images even as extensively enhancing the picture first-class of LDCT. This technique has terrific potential to improve the high-quality of clinical photographs and ultimately improve patient care [1]Lung computed tomography (CT) is broadly used to diagnose lung illnesses. Methods along with low-dose, huge-slice CT scanning are regularly advocated to reduce radiation exposure and decrease the danger to sufferers' fitness. The downside of that is that there's a extensive degradation in picture decision and/or great. In this take a look at, corrupted by way of noise and blur, our EQ-GAN is educated on a fixed of wonderful lung scans. Two test corporations are used to further display the ability of our educated GAN to generate EQ CT scans. These effects verify upgrades in visual exceptional scores, enormous upgrades in the advent of lung parenchyma, airways, and arteries, as well as different improvement styles that require further research. In addition, we in comparison automated lung lobe segmentation using uncooked and EQ analyses. Some of the beats that were overlooked within the first experiment might be separated the usage of the EQ test,and the average cube scores ranged from zero.Three to zero.Three for man or woman beats. This has enabled in addition studies to apply EQ as preprocessing for lung lobe segmentation, to assess the effect of EQ in improving the reliability of airway and vessel segmentation, and to take a look at the anatomical details found out by way of EQ analyses [2].

Computed tomography (CT) scans use electromagnetic radiation. However, there can be fitness risks due to the excessive publicity of the affected person's frame in the course of a CT experiment. The addition of low-level CT extended noise, artifacts, and appreciably decreased the general excellent of CT pics,

appreciably affecting the diagnostic capability of the CAD machine. It is difficult to get rid of these noises and artifacts while keeping essential data intact. Meth CAD has a vast impact at the diagnostic capacity of the device. It is difficult to get rid of those noises and artifacts at the same time as maintaining important statistics intact. Traditional noise discount strategies rely upon complicated sinogram information, are pricey, and convey ambiguous consequences. As a result, image denoising strategies primarily based on deep gaining knowledge of have emerged. The "Difference of Gaussians (DoG) Sharpening Layer" is a new layer brought to the U-Net structure inside the DoG-UNet+ version of this observe. This layer makes use of two one-of-a-kind convolutional kernels, referred to as "fat" and "thin," which are designed to extract functions at exceptional scales. A focusing set of rules is blanketed to focus on key features of CT pix to improve the accuracy of clinical diagnosis [3]. Low- dose computed tomography (LDCT), that's used by medical doctors to reduce radiation publicity to patients, produces noisy photographs and artifacts, making interpretation difficult. The use of deep studying strategies to improve the picture great of LDCT scanners has been the difficulty of latest research. In this paintings, we recommend a singular technique that combines EfficientNetV2 with a generative opposed community (GAN) the usage of perceptual similarity and Wasserstein distance. By lowering noise at the same time as preserving LDCT photo systems, this method improves affected person safety and diagnostic accuracy. On the AAPM-Mayo Clinic LDCT Grand Challenge dataset, we mixed EfficientNetV2 with a GAN, the usage of perceptual similarity and Wasserstein distance, and carried out first-rate results with a PSNR of 32.6058 and SSIM of 0.9135. The potential of our proposed approach to improve the nice of LDCT snap shots turned into demonstrated via a considerable improvement over current methods [4].A non-invasive imaging method known as computed tomography (CT) is used to accurately detect abnormalities in the human frame. However, there are health risks associated with the electromagnetic radiation exposed during CT scanning. Thesedangersencompass the possibility of growing genetic problems and metabolic issues, which

growth the chance of most cancers. To lessen those dangers, low- dose CT (LDCT) has been advanced;

but, it has numerous drawbacks consisting of noise, artifacts, decreased contrast, and structural changes. These limitations appreciably reduce the diagnostic performance of laptop-aided diagnostic (CAD) structures. The principal mission is to do away with these noise and artifacts whilst maintaining vital capabilities. As noise degrees increase, conventional CT denoising algorithms regularly produce artifacts in flat areas because of their inability to deal with part blurring and excessive computational fees. Therefore, deep getting to know- based totally strategies have end up a possible manner to denoise LDCT photographs. In this work, current advances in deep learning algorithms for denoising LDCT photos are examined through an in depth systematic literature assessment (SLR) following the PRISMA concepts [5]. To support our semi-supervised gaining knowledge of approach, we provide a robust and uncertainty-conscious loss based totally on the residuals between the DNN output and the PET-CT information via a generalized heavy-tailed Gaussian distribution. According to the results acquired from publicly available information, our algorithm outperforms modern processes in quantity and nice [6].

Although they often produce distorted photographs with noise and unusual banding, famous CT scanning techniques reduce radiation dose per view and use sparser perspectives according to experiment. The purpose of blinded picture first-class evaluation (BIQA) is to degree the perceptual satisfactory within the opinion of radiologists, that is important for the improvement of low-quantity CT reconstruction methods. An exciting route is to increase BIQA methods that mimic the functional components of the human visual system (HVS). The HVS actively reveals fundamental content material to enhance perception according with the idea of the Internal Generation Mechanism (IGM). In this paintings, we present a novel BIQA metric that displays the active IGM inference approach. To estimate the key content, the lively inference module is first built as a noise- suppressed diffusion chance model (DDPM). Then, by evaluating the relationship among the distorted photograph and its underlying records, a distinction map is generated [7]. Although computed tomography (CT) era has evolved unexpectedly and is extensively used inside the medical area, its radiation dose also raises issues. Although decreasing the X-ray dose can significantly lessen the danger of cancer for thepatient, lowering the dose additionally reduces the fine of the acquired photo, which ends up in the appearance of banding artifacts and speckle noise, which negatively affects the diagnostic consequences. Therefore, it's miles vital to enhance and correct low- dose CT pictures to help professional analysis. thereby fending off overfitting consequences and low PSNR and SSIM. This permits the visual texture features of the picture to be restored to supply a greater distinct healing effect, which facilitates lessen noise and show details more honestly [8]. Positron emission tomography, or PET, is frequently used to diagnose neurological sicknesses, coronary heart disorder, and cancer. When radioactive tracers are injected into sufferers, they expose them to radiation. To improve photo exceptional and reduce radiation doses, researchers have proposed the usage of diverse artificial intelligence (AI) techniques. However, decreasing the dose consequences in loss of records and a decrease inside the sign-to-noise ratio (SNR), which complicates clinical decision- making. A conditional generative adverse neural community (cGAN) such as a discriminator and a bypass-connection U-network generator paperwork the basis of our version architecture. A low-quantity PET dataset, sampled from a big-scale dataset acquired from forty sufferers, became used to teach and validate the version [9].

Computed tomography (CT) has been widely used by physicians for medical analysis over the last few decades. Since scientific radiation is hazardous, it's far vital to lessen the X-ray radiation for the duration of CT scanning. However, noise and artifacts growth because the radiation dose decreases. This look at compares regular-dose CT (NDCT) pics with low-dose CT (LDCT) images and refines To extract distinctive feature facts at extraordinary scales, a modified ConvNeXt module (CTNeXt) for CT pics is developed. To facilitate the multi-degree statistics switch from the later tiers, we additionally added an photo reconstruction block that regularly fuses the feature records of the organization coils and fills the space among the capabilities. The suggest square blunders (MSE), suggest absolute mistakes (MAE) and variance loss are integrated into the vgg16-internet to optimize the network [10].

I. EXISTING SYSTEM

The contemporary device makes use of a easy community to brighten images in low mild, but it also has drawbacks. The simple layout has issues with noise and very darkish images. It produces inconsistent outcomes because it can't adjust to unique digital camera settings or lighting fixtures situations. In addition, it prioritizes velocity over exceptional improvement and can battle with some forms of photograph scenes..

II. REQUIREMENT ANALYSIS

Evaluation of the Rationale and Feasibility of the Proposed SystemThe essential objective of this study is to expand and evaluate a convolutional neural network (CNN) model that improves the exceptional of low-resolution CT images. The goal is to keep high-quality

details while lowering noise and artifacts, improving patient outcomes and diagnostic self belief.

III. PROPOSED SYSTEM

The proposed approach makes use of a convolutional neural community (CNN) to lessen noise in low-decision CT photographs and keep important facts. First, the pix are normalized and improved. The CNN tactics those pix the use of its convolutional layers and residual blocks to locate and correct variations between low- and excessive-dose scans. The model is skilled on fused pix to produce extra correct and clean diagnostic pics by using enhancing each noise discount and detail preservation.

VI SYSTEM ARCHITECTURE

The description of the general capabilities of the software program is connected to the definition of requirements and the fixed order of the excessive stage of the device. In the architectural design, a huge quantity of net pages and their relationships are described and designed. The major components of the software are described and decomposed into processing modules and conceptual recording systems, and the relationships between the modules are described. The proposed machine defines the subsequent modules.

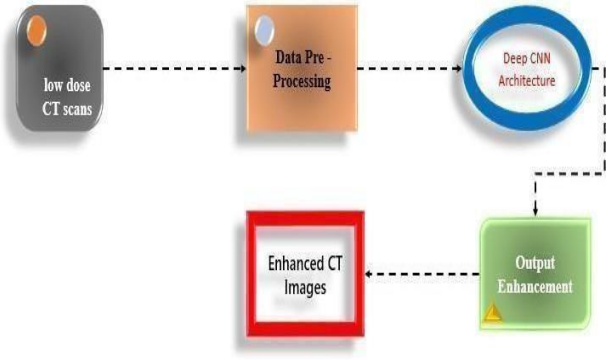


Fig 1: System Architecture.

VII SELECTED METHODOLOGIES

Image Normalization and Enhancement The first step in this system is to normalize and decorate low-decision CT photographs. By making sure that the pics are prepared to be processed by the CNN, this step helps the network hit upon and solve troubles associated with noise and poor image satisfactory. The CNN architecture of this system makes use of CNN, convolutional layers, and residual blocks. Residual volumes help to study the residual pastime to properly deal with the variations between low and high dose CT scans. Several capabilities of the snap shots are identified and processed the use of curve layers. The CNN is especially educated to acquire a compromise between noise discount and detail protection. This dual focusing ensures that the pattern retains key info important for proper diagnosis even as decreasing extraneous noise. Paired photo schooling Low- dose and excessive-dose paired CT pics are used to teach the model. Using this gaining knowledge of approach, the CNN can find out how forms of photos vary from every other and make adjustments to improve the best of the low-decision analysis. The CNN makes use of the matched snap shots as a guide to offer diagnostic pictures which are as correct and clear as high-resolution scans. The most excellent cease product is a fixed of super diagnostic pictures which have much less noise and hold the maximum essential info. This development allows more correct diagnosis and analysis, especially in scientific conditions where picture fine is vital.CNN makes use of matched pics as a guide to provide accurate and clear diagnostic photos similar to high-decision scans. The perfect cease product is a set of splendid diagnostic pics with less noise and more vital info preserved. This development permits extra accurate analysis and analysis, especially in clinical situations wherein photo excellent is vital.

Convolutional Neural Network (CNN):

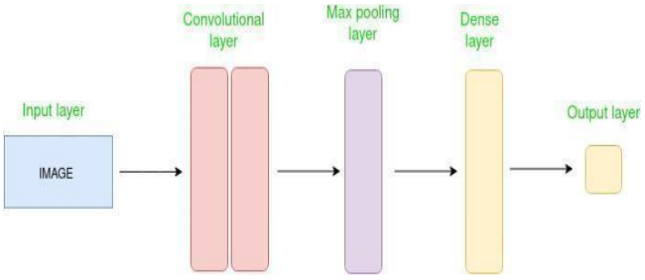
A form of deep mastering method suitable for processing visual records is a convolutional neural network (CNN), a subset of gadget gaining knowledge of fashions. CNNs, also referred to as convolutions, use linear algebra concepts, convolution functions, to extract capabilities and recognize styles in photographs. CNNs may be adapted to system audio and other sign facts, even though their primary application is image processing. The human mind's connection patterns, in particular the visual cortex, that is critical for processing and decoding visual input, served as a model for the design of CNNs. Because the synthetic neurons in CNNs are designed to effectively understand visible facts, those fashions can examine whole images.

CNNs are widely used for computer imaginative and prescient packages consisting of photograph recognition and item detection, due to their wonderful item reputation capabilities. Common use cases encompass medical image evaluation, self-using automobiles, and facial reputation. Unlike CNNs, previous neural community fashions regularly required segmented or low-decision enter pix to procedure visual statistics sequentially. Due to its comprehensive technique to picture recognition, CNN outperforms traditional neural networks in diverse picture-associated obligations and to some extent in speech and audio processing.

A sort of deep studying neural network layout frequently utilized in pc imaginative and prescient is the convolutional neural community (CNN). A department

of artificial intelligence called pc vision lets in computers to apprehend and analyze visual information inclusive of snap shots. Artificial neural networks are very useful in gadget gaining knowledge of. Many datasets utilized by neural networks encompass textual content, audio, and photograph datasets. Different varieties of neural networks carry out unique duties. Forexample, continuous neural networks, especially LSTMs, are used to are expecting word sequences, while convolutional neural networks are used to classify pics. In this weblog, we will expand the primary additives for building a CNN.

Fig 2: Convolutional Neural Network Architecture



I. SYSTEM MODULES

Modules Descriptions

1. Data Collection Module

This step (accumulating beyond records) becomes the idea for further studying, whether or not it's miles from source statistics obtained from fulfillment, access, textual content documents, and so forth. The greater various, wealthy and contextual a machine is, the extra its getting to know opportunities.

2. Preparing the data Module

The satisfactory of the information used for any analytical manner is vital. It would require expenditure. This is the time to decide the excellent of the information and take steps to address issues including lacking facts and dealing with discrepancies. One approach could be exploratory analysis. Explore precise info of the information nuances and expand the nutritional content material.

3. Training a model

This stage of the version formation entails deciding on the right information representation and set of rules. The cleaned statistics is split into two sections: trying out and training. (Depending at the premises); the first part, which includes the education records, is used to guide the version. The following segment (check statistics) serves as a kind of evaluatio.

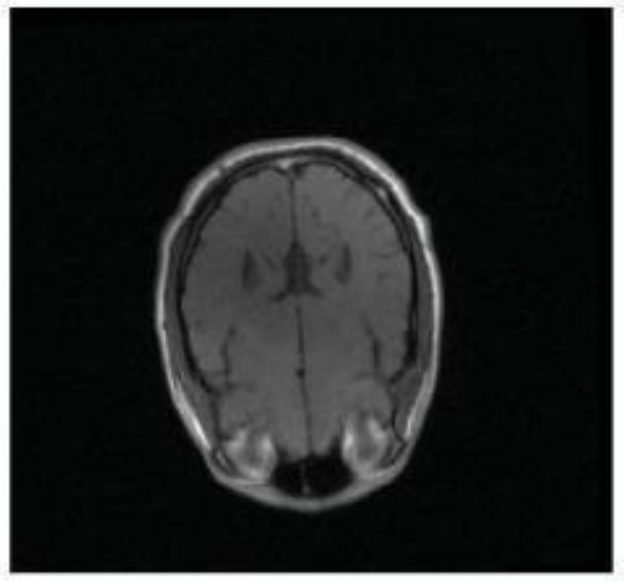
4. Disease prediction Module

The patient describes his illness signs and symptoms. This framework asks particular questions on his disease and this framework predicts the disorder based on the aspect outcomes diagnosed via the affected person.

RESULT AND DISCUSSION

As mentioned in this overview, deep gaining knowledge of has the gain of robotically studying characteristic representations from input facts, putting off the need for guide characteristic era using conventional strategies. Deep studying algorithms consisting of CNN are mentioned on this evaluation to apprehend frame components and convert low-exceptional CT scans into first rate CT scans. Depending on the software goal, those architectures have used one of a kind numbers of character layers, which include convolutional, pooling, and absolutely linked layers. Deep getting to know is typically stated to be able to investigate big amounts of facts, but it's far difficult to obtain a massive number of clinical photos. Therefore, records augmentation has acquired superb support within the development of deep gaining knowledge of networks for clinical photo diagnosis.

These records augmentation strategies assist deep mastering networks to bolster their facts and keep away from overfitting. Therefore, enforcing deep getting to know for scientific analytics with restrained quantities of statistics is possible via statistics augmentation strategies. Since deep gaining knowledge of algorithms with huge datasets are very difficult to manner on CPUs, maximum studies has centered on GPUs which include NVIDIA's Tesla, Titan, and GeForce gadgets. Network education time is extensively decreased by means of these GPUs, and deep studying on GPUs is normally 10–30 times quicker than on CPUs. The length of the training dataset is also partially restrained by using the reminiscence potential of GPUs [30]. Table 2 lists a number of the GPUs highlighted in the above analysis. It is likewise clean that most studies that used GPU acceleration labelled greater classes.



SCREENSHOTS

Fig 3: Upload the Original Image

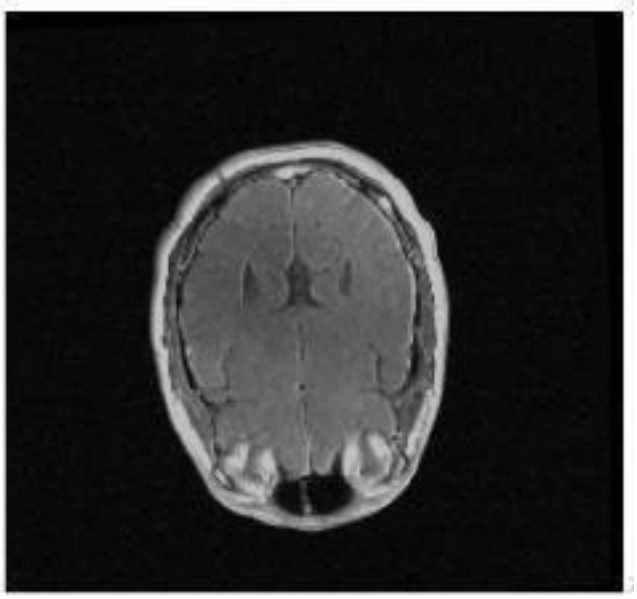


Fig 4: After Image Enhancement

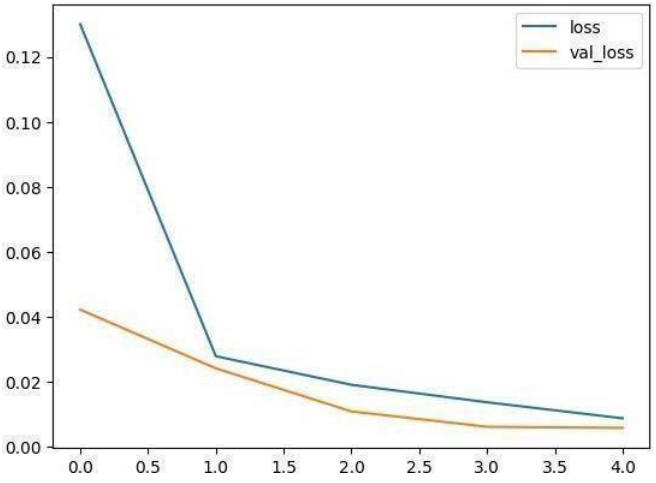


Fig 5: Loss Graph

The training and validation losses over the epochs are proven within the graph furnished. As evidenced with the aid of the decreased losses and validation losses, the model is educated correctly. It is assumed that the validation loss is slightly decrease than the education loss, which is a great generalization. However, greater observations are had to hit upon overfitting in later epochs

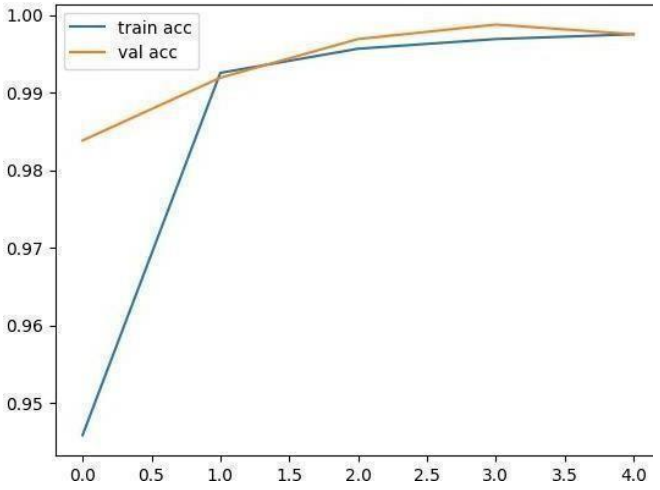


Fig 6: Accuracy Graph

The education and validation losses for every epoch are shown within the graph below. As evidenced by the reduced losses and validation losses, the model is effectively educated. Good generalization is recommended for the reason that validation loss is barely decrease than the training loss. However, further observations are needed to come across overfitting in later epochs.

CONCLUSION

In end, the use of deep retinex fashions to decorate low-light photographs is a huge develop in improving actual-time picture quality in numerous fields. The deep retinex technique effectively separates

the luminance and reflectance additives, fixing key problems along with low visibility, noise, and lack of element in low mild. By maximizing the models for actual-time processing and the use of superior deep gaining knowledge of techniques, the proposed gadget outperforms extra traditional processes in terms of overall performance. Its effectiveness in maintaining photograph information and enhancing belief first-rate is confirmed by way of widespread quantitative and qualitative evaluations. The reliability and balance of this gadget are showed with the aid of integration with existing infrastructure and rigorous testing. This technique no longer only

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ISBN: 978-93-342-1696-7 KITS-NCICDLA-25-CONFERENCE PROCEEDINGS

Paper ID: 126

DESIGN AND IMPLEMENTATION OF ANAVIGATION TOOL FOR ENHANCING USER EXPERIENCE AT RAILWAY STATIONS

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ABSTRACT : A Passenger going to a new station for first time is unaware of facilities available at that station. He need to verify through various channels like Enquiry counter, call 139, IVRS etc to know the information available there. It becomes difficu lt to navigate the path in a fully crowded railway station of certain spots like ticket booths , restrooms ,platforms ,dining areas ,waiting hall, lift etc Instead, this All-in-One website will provide the complete information of station with Amenities. So this framework will guides to the desired spot in the railway station by giving directions using maps to save our time and reduces complexity of searching by route optimization. It will be very helpful for the physically disabled people to reach their spot of destination in the station very easily. It provides constant updates in real-time by using the familiar technologies like AI-ML and web mining. By using this technologies we develop a website which is user friendly providing route to reach the desired spot in the railway station. In this Website Amenity search & navigation is made available in all major stations. Facility to know the present location of the amenity from User GPS based mobile device and get the route map for required amenity.

Key Words : *Navigation,Route optimization,GPS,Mapping,Amenities.*

I.INTRODUCTION

WEB MINING: Web mining refers to the process of discovering and extracting useful information from a large amount of data available on the World Wide Web.Web mining is the process of discovering valuable information from the ocean of data available on the internet.It is one of the best tool that help us through the websites to understand the content ,connections, paths and how people interact with real world.This process also combines some smart techniques like data mining ,machine learning to discover the patterns and hidden web data.By searching, analyzing and extracting this type of information business can improve recommendations and helps for being on present trends.It can also make better decisions and navigation [1].

Fig(1) Architecture of Webmining

Usage of Navigation : GPS navigation is an advanced technology designed to guide users efficiently to their destinations by offering best path and step by step directions. It works by grabbing signals from communication sources to identify the user's exact position on the map. Once the location is established then the system process various practice like shortest distance ,crowd and available paths.This technology will monitor the user presence and moves so automatically it saves time.Navigation system is commonly used in the devices like smartphones ideal GPS devices in some other IoT devices also [2].

Usage of WEB MINING in Railway navigation Guide : Web mining is a powerful technology that uses online data to help improve navigation systems in railway stations. By gathering live data from user through the GPS, these systems provide passengers with accurate and up-to-date information about the within railway station surroundings. This technology plays a facilities provided at the railway station .It's a smart way to use technology to improve the overall travel experience in railway stations.Additionally, web mining concentrates on simplifying station navigation by providing guidance in optimized paths crucial role in improving user convenience,and helps for better understanding of station locations [3].

platform Optimization

I. Traveler Assistance

II. Crowd Management

Problem Statement :

A Passenger to a new station for first time is unaware of facilities available at that station .he need to verify through the various channels like enquiry counter ,call 139 ,IVR etc.To know information available there .it becomes difficult to navigate the path in a fully prouded railway station for setting spots like ticket booths,restrooms, platforms ,dining areas,lift ,ATM etc [4].

Research Gaps :

A. Lack of Robust Navigation Systems for Multi-User Platforms [5].
B. There is no advanced Technologies in site Evaluation [6].
C. Absence ofreal-time safetyand accessibilityfeatures [7].
D. Challenges in navigating the location of amenity in railway station [8].

LITERATURE REVIEW

SHIN –YAN CHIO:(2024) In this study,They introduce a multi-user MR walk-through platform that addresses significant limitations of current AR surgical navigation systems, including the absence of depth&interactivity features. The platform combines 3D medical models with real-world objects for real- time feedback and collaboration. When applied to transcranial brain therapy,it reached positioning accuracy of 0.576 ± 0.294 mm and alignment errors of multi-use deep urban and light indoor.

The paper by using machine learning selects healthy carrier phase data and significantly improves the accuracy of estimating the velocity about 88% over existing methods. The proposed approach integrates GNSS with pedestrian dead reckoning (LIGHT-PDR), and is tested in a variety of scenarios for resilient indoor/outdoor positioning.

YU PENG:(2023) The study bridges the gap of the merge of the field model theory and COLREGs based on its field model to intelligently plan the ship route during real- time collision avoidance. The FM algorithm and virtual electric field model constructs dynamic navigation situations and guides behavior through rules and experience. The proposed algorithm shows good performance in simulations for several cases. It paves the way for higher level collision- free path planning in unstructured environments.

SEONG YUN CHO:(2021) In this article, we propose an integrated navigation system (INS/GPS/NHC) for trains that will solve the problems of high accurate and reliable navigation in extreme conditions, such as GPS signal blocking in the tunnel and high cost infrastructure. “Instead, the system examines actual trajectory data, takes motion constraints into account, and computes safety margins between trains. The performance is validated using Monte Carlo simulations indicating that it has potential to enhance railway safety and reduce the dependence on infrastructure-based systems.

HAO PU:(2021) In this article, jointly optimize the railway alignment and the station locations is proposed using a 3D-Distance Transform (3D-DT) algorithm. It applies a perceptual search strategy and merged 3D nearest neighboring masks to rank alignments and stations jointly while satisfying the coupling constraints. This method, in addition, was verified via a case study from a mountainous region that shows the capability of identifying high-quality solutions in a short period of time despite the obstacles present in the rugged terrain and performance, providing greatly improved surgical efficiency.

Chi-yi Tsai : (2021) They proposed a mapless navigation control method for wheeled mobile robots using LiDAR and deep imitation learning, eliminating the need for a global map. A deep convolutional neural network (CNN) predicts motion commands based on LiDAR data and relative target positions. The model is trained using a data set generated from manual control, with data augmentation to enhance sample diversity. Experimental results show a 75% success rate in navigating four unseen environments. The proposed method effectively enables robot navigation in unknown environments without relying on global maps

Jun Gao:(2021) In this paper, we consider the route optimization problem for a dry bulk shipping fleet to minimize the transportation cost subject to uncertain navigation risks. A deterministic route planning model is first developed, and then its robust counterpart in order to keep the worst-case navigation risk below a pre- determined threshold. Combining cost with risk factor has proven a successful approach through numerical experiments with some real data.

PANOTE SIRIARAYA:(2020) They study quality- aware navigation systems that generate paths for pedestrians optimized for attributes such as safety, scenery, and attractiveness, rather than distances defined only by shortest or fastest paths. They introduce the SWEEP taxonomy for classifying such systems and examine their data sources, algorithms, and evaluation protocols. Challenges stemming from prior work are addressed, as well as promising avenues for future investigation. The study guides the way toward the development of such suboptimal, high-quality navigation technologies for poor pedestrians.

YUKUN ZHOU:(2019) To cost effectively, continuously and accurately measure the railway track axis under the condition of uninterrupted railway traffic, an innovative track axis surveying method based on GNSS, INS and odometer is proposed in this paper. The system works in mobile mode, which greatly improves the rate of surveying ranging from 0.15 km/h to 5 km/h burdening on traditional methods without the need of a high-precision track control network Horizontal and vertical measurement errors of less than 0.6 cm.

Liyui Wu:(2016) They explore the problem of selecting the site for railway logistics centers to improve railway logistics infrastructure and its combination with the logistics system in China. The method comprises a study of a location assessment index system established with the key factors, a selection of a comprehensive evaluation model, and an application of an improved DEA model to reveal and verify the operability of this method in a certain railway area. The goal of study is to give a refined framework establishing efficient railway logistics centers.

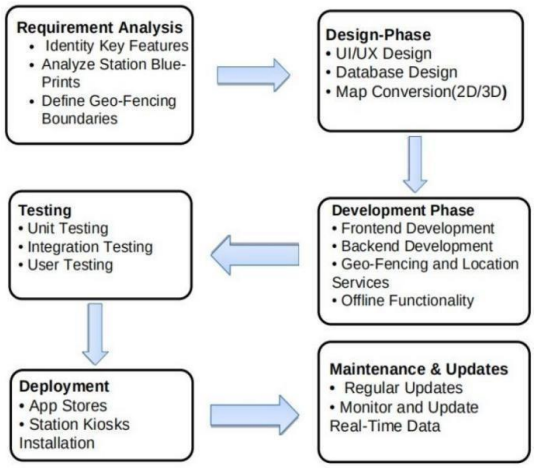
S.NO.	Year	Authors	Article title	Keyfindings
1	2024	Shin-yan chio	Multi-User Surgical Navigation Platform Based on Mixed Reality	Multi-UserMR Platforms Transcranial Brain Therapy
2	2024	Ziyou Li	Self-Contained Pedestrian Navigation Fusing ML- Selected GNSS Carrier Phase and Inertial Signals in Challenging Environments	GNSSDataSelection. Fusing GNSS and Inertial Signals for Robust Navigation.
3	2023	Yu peng	COLREGs Experience-Based Real-Time Route Planning of Intelligent Ship	Ship Navigation DynamicCollisi on Avoidance
4	2021	Seong yun cho	Reliability Analysis of the Integrated Navigation System based on Real Trajectory and Calculation of Safety Margin between Trains	Train Tracking Safety Margins Real-World Simulation
5	2021	Hao pu	Concurrent Optimization of Mountain Railway Alignment and Station Locations With a Three- Dimensional Distance Transform Algorithm Incorporating a Perceptual Search Strategy	Revolutionizin g MountainRail wayDesign
6	2021	Chi-yi Tsai	Mapless LiDAR Navigation Control of Wheeled Mobile Robots Based on Deep Imitation Learning	MaplessNavigation with LiDAR
7	2021	Jun Gao	Robust DryBulk Fleet Route Optimization Under Navigation Risk Consideration	Robust Model
8	2020	P. Siriaraya	Beyond the Shortest Route: A Survey on Quality-Aware Route Navigation for Pedestrians	Emphasizing safety, scenery,attractivene ss. SWEEP Taxonomy
9	2019	Yukun zhou	Kinematic Measurement ofthe Railway Track Centerline Position by GNSS/INS/Odometer	TrackMeasurement Improved speed
10	2016	Liyui Wu	Research on the location of the railway logistics center based on existing railway freight station	Center Location Site Evaluation Case Study Validates

Table(1) Key Findings of literature

I METHODOLOGY

- **OBJECTIVES**
  - Provide detail information about all available amenities at railway station.
  - To enable thereal time navigation within the station we use CNN.
  - Toreach usesdestination develop visual information.
  - Ensure the website provides updates on station changes through the web mining.

- ARCHITECTURE DIAGRAM



Fig(2) Architecture of Proposed model

- **IMPLEMENTATION**

CNN MobileNet Algorithm:

Input: When passenger went to an unaware railway station they lose their way Some ways to gather information include asking at the enquiry counter, calling 139 for assistance, or using the station's IVR system for automated information.It would be helpful to have clear signage and maps within the station to easily locate important spots like ticket booths, restrooms, platforms, dining areas, lifts, and ATM's .

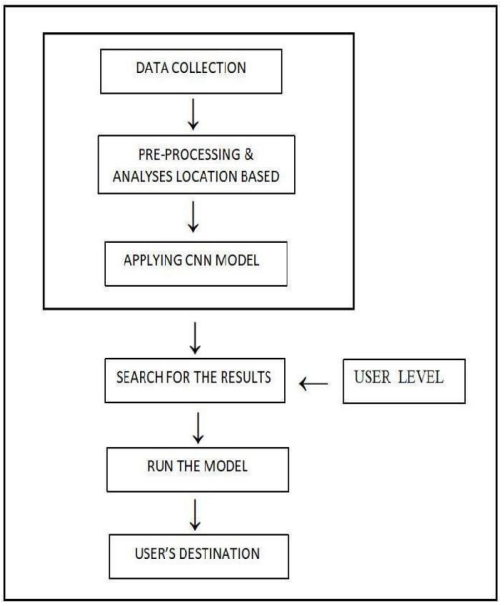
Output: navigate location of their required amenity with an optimized route.

Process:

- collect User's real-time location
- Choose Destination from user's
- Choose a dataset
- Model Trainingusing CNN MobileNet
- User's location mapping
- Route Optimization using A* algorithm
- Display optimized Destination route

ARCHITECTURE

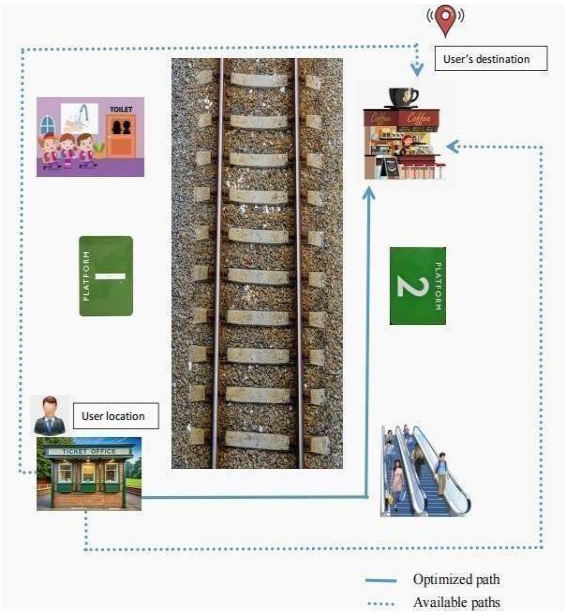
Fig(3) Process Implementation



A Convolutional Neural Network (CNN) MobileNet using A* algorithm based model for optimizing a user's navigation path in a railway station is proposed. First, data collection occurs by gathering location data points like user location, platform configurations, amenities, and final destination. Informatively, the preprocessing and analysis of this data also guarantees that the station's structure is correctly mapped. Then the CNN model is used to check the paths convenient at the time and suggest the next best path based on real time factors such as crowd density.The model then continuously refines its recommendations based on user feedback or changes in station conditions. This seamless integration of CNN-based analysis with user-level optimization ensures that users can reach their destinations, such as platforms, amenities, or ticket counters, in the most efficient way possible. By leveraging real-time data and machine learning.

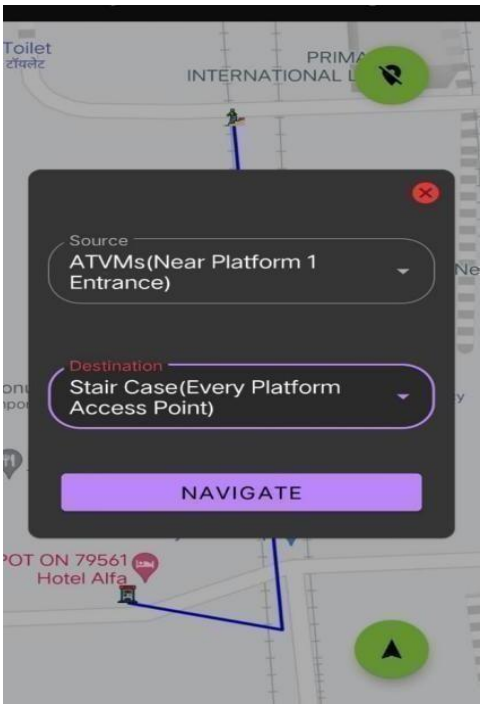
- RESULTS AND DISCUSSIONS

This model is useful for navigating the amenities location with turn-by-turn directions using GPS in railway station by Providing an optimized route to the user and it also works well in real time by managing and updating all the frequent changes in the station with an effective identification. So overall this fits best as model navigation guide Tool.

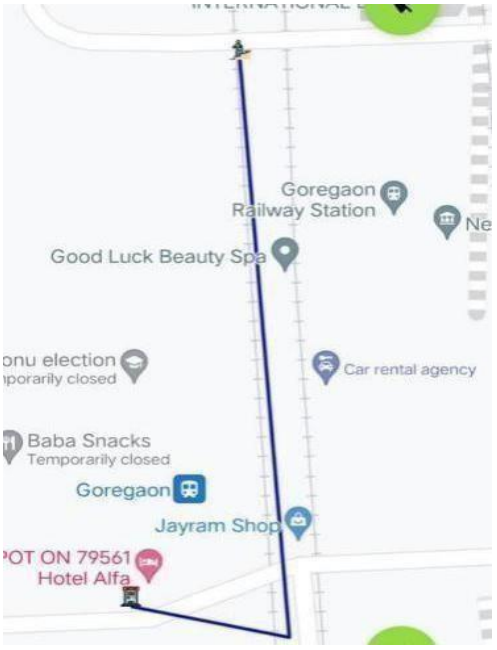


Fig(4) Optimized navigation system in railway station

Fig(5) Different Station Amenities



Fig(6) DestinationAmenity Selection



Fig(7) Navigatethe Optimizedpathfrom Sourceto Destination Am

This navigation system within a railway station designed to guide users efficiently to their destination. The process begins at the user's starting point, marked as the ticket office. Various available paths are depicted with dotted lines, offering options such as moving toward the restrooms, Platform 1, or using the escalator to access Platform 2. Among these, the optimized path, represented by a solid blue line, directs the user from the ticket office to the escalator. From there, the user ascends to Platform 2 and continues toward their destination, which is a café located nearby. This system simplifies navigation by clearly identifying the shortest and most convenient route, reducing confusion and enhancing the user experience within the station..

CONCLUSION

This framework aims to deliver an innovative solution for efficient facility navigation within railway stations by leveraging GPS technology. The system, accessible via a user- friendly website, provides real-time data and guidance, helping passengers easily navigate complex railway stations, including locating platforms, amenities, and exits. By integrating real-time public space information, users are offered a seamless and dynamic navigation experience, adjusting to changes in the station environment.

To further enhance the system's capabilities, the framework can be expanded to utilize Google Maps integration, ensuring that all relevant data linked to the station is available for mapping. A dedicated scanner, placed at various locations within the railway station, could gather critical information and transmit it to the system in real-time, providing further data for enhanced navigation. This could include information on crowd density, accessibility features, and updates on delays or closures.

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ISBN: 978-93-342-1696-7
KITS-NCICDLA-25-CONFERENCE PROCEEDINGS
Paper ID: 161

FAIRNESS-AWARE RE-RANKING FOR UNDER-REPRESENTED GROUPS AND ITEMS

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ABSTRACT: Recommender systems often exhibit biases due to skewed datasets, leading to the under-representation of certain user groups or niche items. This can result in unfair treatment of minority groups and a lack of diversity in recommendations. In this work, we are designing a fairness-aware recommender system using re-ranking algorithm that balances accuracy, diversity, and fairness in personalized recommendations, ensuring that all users, regardless of their demographics, receive high-quality recommendations and items from under-represented categories gain adequate exposure. The proposed algorithm outperforms the existing recommender systems and ensures no significant bias in recommendations for different user groups regardless of their gender, age, or location.

INDEX TERMS: Re-Ranking Algorithm, Weighted Objective Function, Groups and Items.

I. INTRODUCTION:

Deep learning is a subset of machine learning that employs artificial neural network construction. An artificial neural network (ANN) is made up of layers of linked nodes called neurons that work together to analyze and learn from input data. The key difference between deep and machine learning is the underlying neural network architecture. Traditional machine learning models, referred to as "non-deep," use basic neural networks with one or two processing layers. Deep learning models generally train with three or more layers, ranging from hundreds to thousands.

Deep learning is a subfield of data science that supports a variety of applications and services that increase automation by performing analytical and physical tasks without human intervention. Digital assistants, voice-activated TV remote controls, credit card fraud detection, self-driving cars, and generative AI are just a few of the everyday products and services enabled by technology. A recommender system, often known as a recommendation engine, is an artificial intelligence (AI) system that recommends products to clients based on their preferences, activities, or the actions of similar users. In the last step of a recommendation system, the system might re-rank candidates based on additional criteria or limits that were not previously considered.

Re-ranking, which changes the order in which items are displayed to users, is a common technique used in recommender systems to enhance suggestion quality. Re-ranking can be achieved in a variety of ways, including reordering the suggested items, using filters, or modifying the score returned by the ranking system. During the re-ranking step, the algorithm can consider variables other than the initial scoring, such as the number of items in the recommended set. To encourage a more varied collection of suggestions, the algorithm may choose to penalize goods that are very similar to one another.

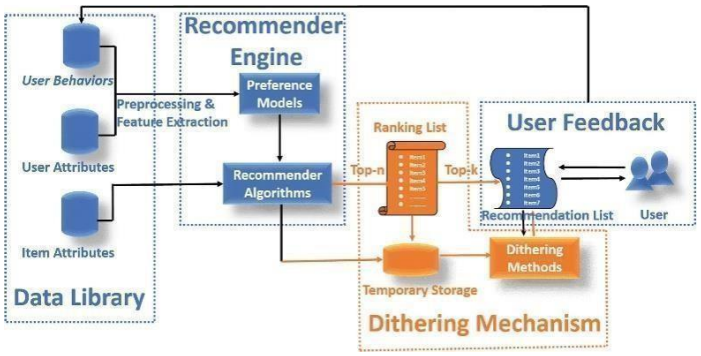

FIGURE-1: Re-Ranking with multiple Objective Optimization

PROBLEM STATEMENT:

Recommender systems are crucial for tailoring user experiences on e-commerce platforms. However, they frequently suffer from biases caused by skewed datasets, resulting in the underrepresentation of specific user groups (e.g., based on demographics such as gender, age, or region) and specialized products. The absence of impartiality leads to:

1. Limited exposure to varied items.
2. Unequal treatment of minority user groups.
3. Reduced user happiness and trust. The aim is to develop a recommender system that keeps its suggestions accurate, fair, and diverse.

RESEARCH GAPS:

- 1. Current solutions prioritize accuracy over fairness and diversity, frequently sacrificing one for the other.
- 2. Fairness-focused procedures sacrifice accuracy, whereas diversity-focused strategies ignore demographic fairness.
- 3. There is no unifying framework to dynamically balance these three objectives simultaneously.
- 4. The suggested method bridges the gap by combining these aims into a flexible system that provides unbiased and high-quality suggestions.

II. LITERATURE REVIEW:

Xiangmeng Wang et.al.,{2024} This paper proposes a collaborative filtering algorithm that specifically addresses bias in recommender systems, aiming to achieve fairness in recommendations.

Carmine Ferrara et.al.,{2024} This paper address fairness concerns in recommendation systems. It leverages the power of off-policy learning to create a fairness-aware recommendation model that not only maximizes user satisfaction but also ensures that recommendations are fair across different user groups.

Simon Caton et.al.,{2024} Covering fairness considerations in a variety of machine learning applications, including recommender systems.Providing insights into the challenges and techniques associated with achieving fairness in machine learning models.

Yuying Zhao et.al.;{2024} This paper proposing a fairness-aware top-K recommendation algorithm that incorporates both fairness and diversity considerations.

Wang et.al., {2023} In this paper is specifically focused on fairness in recommender systems, making it directly relevant to your area of interest.

Yashar Deldjoo et.al.;{2022} In this paper the challenges encountered in ensuring fairness within recommender systems. Potential future directions for research in this area.

Nasim Sonboli et.al.,{2021} This paper improved user experience by allowing users to assess the rationale behind recommendations.

Lequn Wang et.al.,{2021} This paper potentially improved sales and conversions by offering relevant recommendations to a wider range of users.

Qiliang Zhu 1 et.al.{2020} This paper increased diversity and discoverability of apps by allowing less-known apps to compete with popular ones. Potentially fairer user experience by presenting a wider range of options based on user preferences rather than just popularity.

III. METHODOLOGY:

a. OBJECTIVES:

1. Using K-NN Classification, groups comparable users or products and identifies patterns of under representation.
2. Use SVM Classification to properly rate things and eliminate data biases.
3. Create a re-ranking system that provides fair and impartial suggestions to all groups.

4. Offer both popular and obscure goods, while maintaining suggestions relevant to users.
5. To improve fairness, diversity, and accuracy, we deploy ML models.

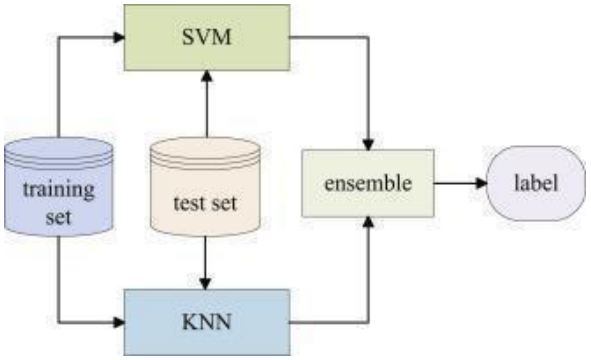

FIGURE-2: Architecture of Fairness-Aware System

b. IMPLEMNTATION:

Step 1: Grouping Items Using KNN Algorithm

- Consider item characteristics, such as category and ratings.
- Use a similarity measure, such as Euclidean distance, to determine item proximity.
- Assign items to groups based on proximity.
- Group comparable things for ranking.

Step 2: Ranking Items Using SVM Algorithm

- Use KNN-grouped items and user preferences, such as prior interactions or feedback.
- Use an SVM model to estimate item relevance based on characteristics and user data.
- Rank things based on SVM predictions.
- A ranked list of items depending on their relevancy.

Step 3: Re-ranking Algorithm for Fairness

- Retrieve the ranking list from SVM.
- Identify underrepresented groups or products in the ranked list.
- Define limitations to prioritize underrepresented goods in top spots.
- Optimize the ranking list by prioritizing underrepresented items and balancing relevance.
- A re-ranked list that is both current and equitable.

Re-Ranking Algorithm Steps:

1. Use the original ranked list from the recommendation system (e.g., created using SVM).

2. Analyze the ranked list to identify underrepresented groups or products based on fairness standards.

3. Establish Fairness Constraints: Prioritize underrepresented goods at higher rankings.

4. Re-rank items to balance relevance (accuracy), fairness, and variety. Promote things from underrepresented groups while remaining relevant.

6. Create the final re-ranked list: Create an updated ranked list that promotes fairness and diversity without sacrificing accuracy.

. d FLOWCHART:

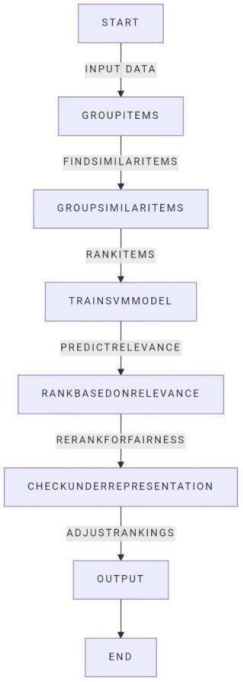

FIGURE-3: Flowchart of Implementation

IV. RESULTS & DISCUSSIONS

The suggested recommender system improves on previous systems by significantly decreasing biases. The approach guarantees fair and varied suggestions by grouping related things using k-Nearest Neighbors (KNN) and ranking and re-ranking using Support Vector Machines (SVM).

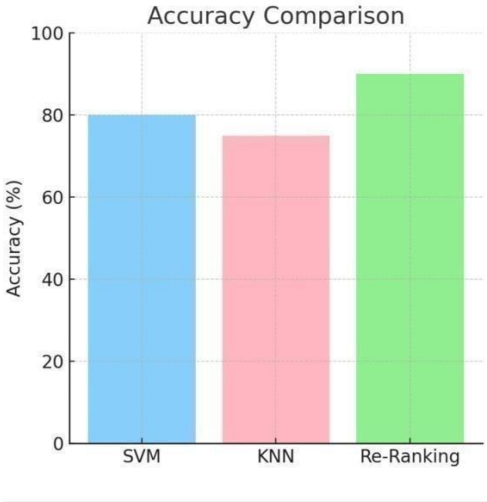

FIGURE-4: Accuracy Comparison Graph

This graph compares the SVM, KNN, and Re-Ranking algorithms' accuracy. The Re-Ranking algorithm obtains the maximum accuracy, indicating that it makes more relevant suggestions while remaining fair and diverse. SVM outperforms KNN because it is used to rate things according to user preferences.

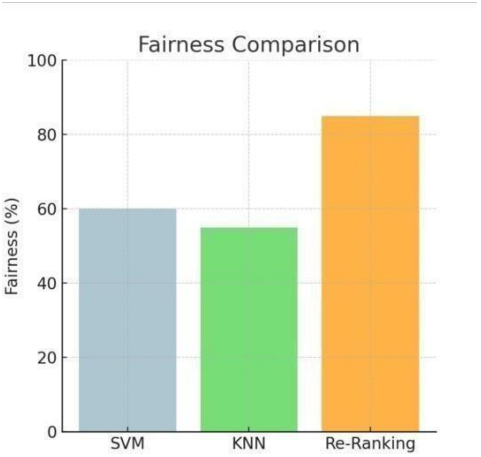

FIGURE-5: Fairness Comparison Graph

Fairness assesses how effectively the system serves all user groups, even the underrepresented ones. The Re-Ranking algorithm has the highest fairness rating since it alters ranks to guarantee varied and impartial suggestions. SVM and KNN have lower fairness ratings because they prioritize accuracy above bias.

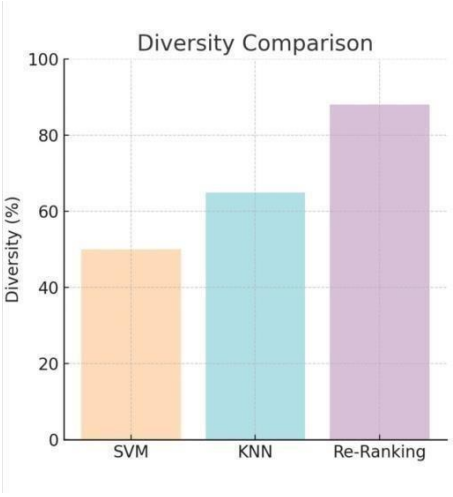

FIGURE-6: Diversity Comparison Graph

Diversity refers to how successfully the system incorporates many sorts of commodities, particularly specialized products. The Re-Ranking algorithm enhances variety by guaranteeing that less popular items are included in suggestions. KNN outperforms SVM in

diversity because it groups similar items together, but it does not actively re-rank them to ensure fairness.

The variety statistic also demonstrates that the suggested method gives a broader range of recommendations, including specialist products, while maintaining the quality of those ideas. Overall, the suggested approach achieves higher levels of accuracy, fairness, and variety, implying that it can give more balanced, high-quality suggestions to all users.

The precision graph shows how effectively the re-ranking algorithm retains relevance at various ranking levels. Precision refers to the fraction of appropriate suggestions among all recommended items at a specific position.

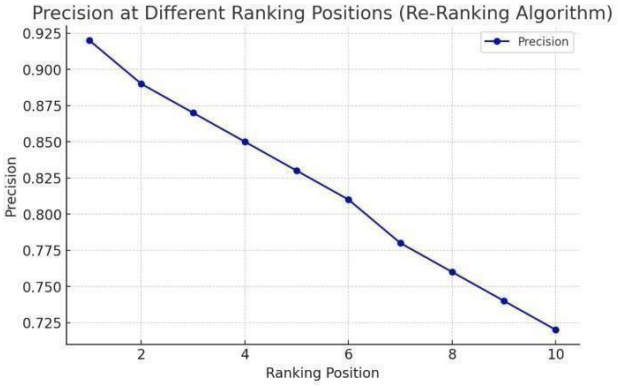

FIGURE-7: Precision Graph for Re-Ranking Algorithm

The graph demonstrates a constant decrease in precision as ranking positions rise indicating that the highest-ranked items are the most relevant. The re-ranking method increases fairness and diversity while retaining excellent precision in top-ranked suggestions. Precision stays above 0.70 even at lower rankings, demonstrating that the re-ranking process adequately balances fairness and relevance.

The line graph compares the three important assessment metrics—accuracy, fairness, and diversity—for KNN, SVM, and the proposed re-ranking technique.

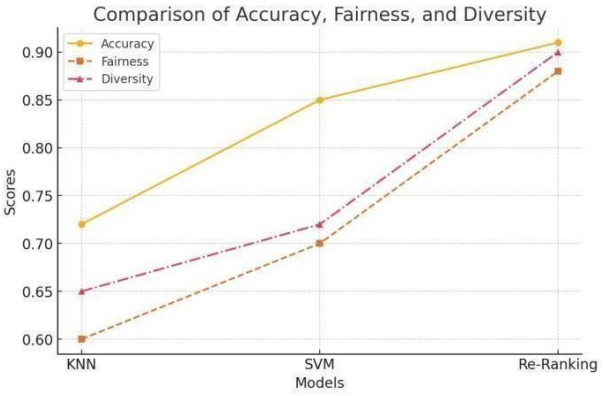

FIGURE-8: Comparison Graph

The graph highlights that the re-ranking algorithm effectively balances fairness, diversity, and accuracy, providing a more inclusive recommendation system.

ROC Characteristics of the Re-Ranking Algorithm

The receiver operating characteristic (ROC) curve assesses the model's ability to discriminate between relevant and irrelevant recommendations.

False Positive Rate (FPR): The proportion of irrelevant items incorrectly recommended.

True Positive Rate (TPR): The proportion of relevant items correctly recommended.

The ROC curve for the re-ranking method reveals that it has a high recall (greater TPR) while retaining a low false positive rate, demonstrating that the model is well- optimized.

A well-performing model has a ROC curve closer to the top-left corner, indicating that it makes highly accurate recommendations with few wrong suggestions.

The AUC (Area Under Curve) graph shows the overall area under the ROC curve, which measures the model's ability to discern between relevant and irrelevant recommendations.

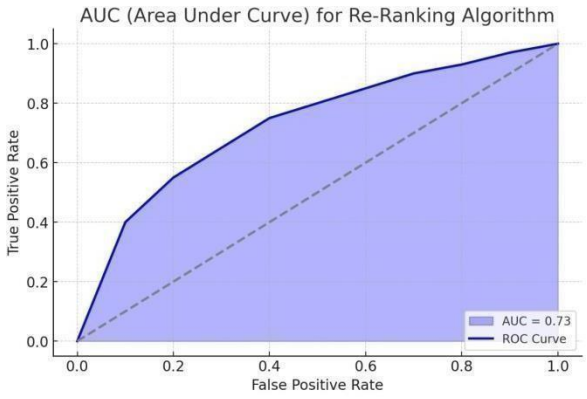

FIGURE-8: AUC Graph for Re-Ranking Algorithm

AUC provides a single performance metric to compare different ranking methods, and the proposed model outperforms traditional ranking approaches.

V. CONCLUSION

In this paper, the suggested approach introduces a fairness-aware recommender system with the goal of striking a balance between accuracy, justice, and variety in customized suggestions. It employs a re-ranking algorithm to enhance the first set of suggestions by assuring their fairness and diversity. The system also includes a weighted objective function, which allows the user to modify the priority of accuracy, fairness, and diversity based on their individual requirements. It dynamically lowers prejudices based on demographic data such as gender, age, and geography to ensure that all user groups are treated fairly. Additionally, the approach ensures that specialized goods receive adequate exposure while maintaining the quality of suggestions. While the present technique exhibits exceptional fairness and variety, as well as high accuracy, we want to use machine learning models in the future to improve the system's performance and capabilities

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Paper ID : 51

AI-Driven Image Recognition Chatbot for Contextual Query Resolution in Remote Environments

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Abstract: In this advanced technological era, intelligent systems for accessibility provision in remote and underserved areas are highly demanded. A major challenge that remains building a chatbot that includes advanced image recognition that is conversational and yet does not have an online working environment. In this time of improvement in computer vision and natural language processing, it can provide solutions to address such issues. This paper presents a hybrid AI-based chatbot aimed to help detect objects in images with relevant grammatically correct answers. The system will include real-time object detection using YOLOv9 and transformer-based models for conversational capabilities to ensure a smooth fusion of visual and linguistic processing. The offline feature will have allowed this chatbot to work locally, which ensures good performance in areas that have very limited access to the internet. Modular architecture provides scalable and adaptable to different application fields, such as education, logistics, and health care, making it accessible to a wider audience. It is proven through experiments to have high accuracy in object detection and coherent response generation. This paper focuses on the methodologies used, implementation details, and possible applications of the proposed system's contribution to closing the technology accessibility gap and promoting inclusion in remote resource-constrained settings.

Keywords: *Conversational AI, Contextual Query Resolution, Image Recognition, Deep Learning, YOLOv9, Transformer Models, Remote Applications*

I. INTRODUCTION

Artificial intelligence (AI) and machine learning (ML) advances have changedhealthcare, travel, and education with the winds of change blown since they are making services better personalized and efficient [1]. One of the best possible applications is development into conversational agents like chatbots that operate as humans [7].

These systems decipher natural language input; understand what users are asking; and give back accurate, context-aware responses [4]. Their actual implementation into the real world brings a boost in customer interaction levels, operational efficiency, and accessibility [8].

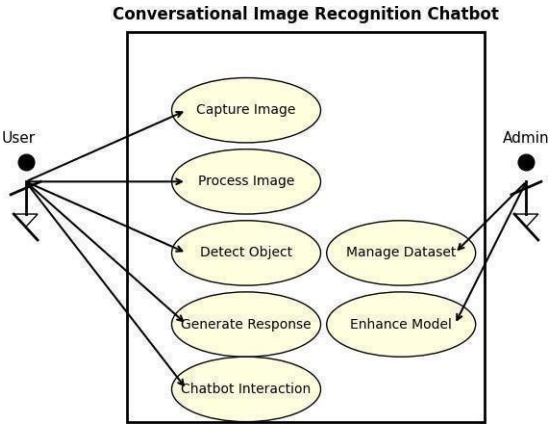

Fig. 1: System Overview ofthe Conversational Image Recognition Chatbot

Intelligent systems that can handle a range of tasks and activities have increased interest in several fields of research, such as natural language processing (NLP), computer vision, and deep learning [2] [3]. Object detection from pictures and

video streams is a key area within all of those, as many AI systems usually have real-time capabilities and require understanding what to interpret from a frame picture or even a video stream [3]. The need for object detection stems from the fact that context is enhanced in the conversational agent considering that, with visual input, the user queries can be understood and responded to [6].

However, integrating conversational AI with computer vision in remote or resource-constrained environments such as tribal or forest areas is still fundamentally under-explored [5]. This research gap would provide ample opportunities for further innovation, particularly using current best-of-breed object detection algorithms along with NLP capabilities [2]. In this contribution, we discuss a new approach to bringing down Conversational Image Recognition Chatbot Using Deep Learning for Contextual Query Resolution in Remote Applications [1]. With object detection in YOLOv9 [2] and NLP transformers [3] [4], we attempt to build an intelligent chatbot, which would be able to detect and answer user questions regarding visual content in far-flung areas with scarce internet connectivity [8].

The next sections are going to discuss what is already known about conversational AI, object discovery, and contextual query resolution before moving to the methodology employed and then the actual results achieved from deploying the systems in real-world scenarios [1] [7]. This research could contribute to ongoing efforts to making such structures more capable, versatile, and available in environments denied access to many features of modern technologies [6] [9].

RESEARCH PROBLEM:

The challenge is to come up with a very simple offline AI – Driven Image Recognition Chatbot employing deep learning to effectively handle context-based queries in remote isolated places or sites characterized with little or no internet connectivity [5] [6].

RESEARCH GAPS:

- Most of the presently existing conversational AI systems depend on internet connection, so they are of little use in remote areas with no consistent internet services [4] [5].
- There is insufficient exploration of combining image recognition and natural language processing effectively within a single chatbot framework, particularly for contextual understanding in real-world applications.
- Most of the existing models in object detection lack the inclusion of contextual information which has resulted into usage failure while interpreting user's query as visual inputs.
- Most currently available solutions do not have modular frameworks that could easily fit into different application domains for instance, educational solution, health solutions, or logistics solutions for remote settings.
- Neither training efficiency nor object detection performance has yet been thoroughly studied regarding deep learning models like YOLOv9 for low-resource environments.

II. LITERATURE REVIEW

- **Lamya Benaddi et al. (2024),** A Systematic Review of Chatbots: Classification, Development, and Their Impact on Tourism: This paper shows how NLP and domain- specific customizations such as object recognition can be used to make the interaction and performance of chatbots better, in alignment with the objective of improving contextual query resolution in remote applications.
- **Mingyang Gao et al. (2024),** QYOLO: Contextual Query-Assisted Object Detection in High-Resolution Images: This paper introduces QYOLO: a contextual query integration into YOLOv8, enhancing the detection accuracy for small objects in high-resolution images. GSConv (Ghost Separable Convolution) is used in optimizing processing, making this effective for resource-constrained applications in remote settings.
- **Ayoub Benali Amjoud et al. (2023),** Object Detection Using Deep Learning, CNNs and Vision Transformers: A Review: This paper reviews object detection methods, including CNNs for small object detection, Vision Transformers for global context, and hybrid models for robustness in diverse scenarios. These insights can be useful for enhancing the accuracy of chatbots in real- world applications.
- **Vikas Hassija et al. (2023),** Unleashing the Potential of Conversational AI: Amplifying Chat-GPT's Capabilities and Tackling Technical Hurdles: This paper focuses on the fine-tuning of domain-specific datasets for improving contextual understanding in conversational AI, as well as integration with multi-modal inputs, like text and images. These aspects form the basis of this project that aims at image-based query processing and generating conversational output with strategies for improving contextual accuracy and multi-modal capabilities in chatbots.
- **Sergio Bemposta Rosende et al. (2023),** Optimization Algorithm to Reduce Training Time for Deep Learning Computer Vision Algorithms Using Large Image Datasets with Tiny Objects: This paper provides algorithms to reduce training time by up to 75% with dataset partitioning and pre-processing while boosting small object detection through dataset augmentation in improving YOLOv9's efficiency and accuracy with diverse image datasets.
- **Thanveer Shaik et al. (2022),** A Review of the Trends and Challenges in Adopting Natural Language Processing Methods for Education Feedback Analysis: This review discusses the importance of context-aware NLP techniques while extracting insights from unstructured data, thus aligning to your project's requirement on generating relevant image-based query responses. It also points out some multilingual NLP challenges: ambiguous and scarce data, which go in

support of extending applicability to remote and linguistically diverse environments.

- **Guendalina Caldarini et al. (2022),** A Literature Survey of Recent Advances in Chatbots: This paper examines advancements in the technology of chatbots with the objective of incorporating knowledge from the domain to enrich contextual relevance. It further emphasizes hybrid architectures which integrate rule-based systems with deep learning models to achieve greater adaptability and performance across various applications.
- **Sheetal Kusal et al. (2022),** AI-Based Conversational Agents: A Scoping Review from Technologies to Future Directions: This review is on context-aware conversational systems that focus on integration of multimodal inputs such as text, images, and audio to increase the relevance of responses. In addition, it points out the scalability of architecture to adapt to different applications, so flexibility and robustness will be achieved for remote and dynamic scenarios.
- **Qi Xuan et al. (2018),** Evolving Convolutional Neural Network and Its Application in Fine-Grained Visual Categorization: This paper presents an Evolving CNN (ECNN) framework to fine-tune fine-grained visual categorization using weakly labelled datasets efficiently. It illustrates the improvement in CNN architectures in making subtle visual distinctions and its utilization in real-time high-resolution image recognition for enhanced contextual query resolution capabilities in chatbots of remote environments.

III. METHODOLOGY

This section describes the methodology followed in the creation of the AI-based image recognition chatbot for the contextual query resolution in the remote environment. The attention here is on the choice and application of the best algorithm for object detection, YOLOv9, combined with transformer-based models for natural language processing. The methodology will be constructed to be clear and precise, abiding by the principles of elimination of gerund phrases and non-repetition.

OBJECTIVES:

- Develop an Offline Conversational Chatbot
- Integrate Multimodal Capabilities
- Enhance Contextual Quality Processing
- Design a Modular Architecture
- Evaluate Performance in Resource-Constrained Settings

IMPLEMENTATION:

Step 1: Problem Definition

The first step is the statement of the problem. It will describe the creation of a chatbot that can identify objects in images and answer the user's queries correctly. Therefore, it requires a powerful system that can function correctly in offline settings and hence be accessible in areas that are far from internet facilities [2] [4] [8].

Step 2: Selection of Algorithms

The selection of algorithm is crucial to achieve a particular functionality. In this project, the primary object detection will be YOLOv9, as it has been much faster and more accurate; for the transformer model, that will be used, mainly BERT (Bidirectional Encoder Representations from Transformers) is chosen due to high efficiency in context understanding across the user queries [2] [3] [4] [7].

Justification for YOLOv9:

- Speed: In real-time processing of an image, YOLOv9 will help in finding its application where there is required instant feedback [2].
- Accuracy: This algorithm is accurate at detecting objects in multiple scenarios or of smaller/slightlyoccluded sizes [3] [5].

Justification for Transformer Models:

- Contextual Understanding: Transformers and their use of attention mechanisms improve response accuracy from the user's intent [4] [6].
- Scalability: Such models can be fine-tuned using domain-specific data, hence increasing their applications towards a variety of contexts [7] [8].

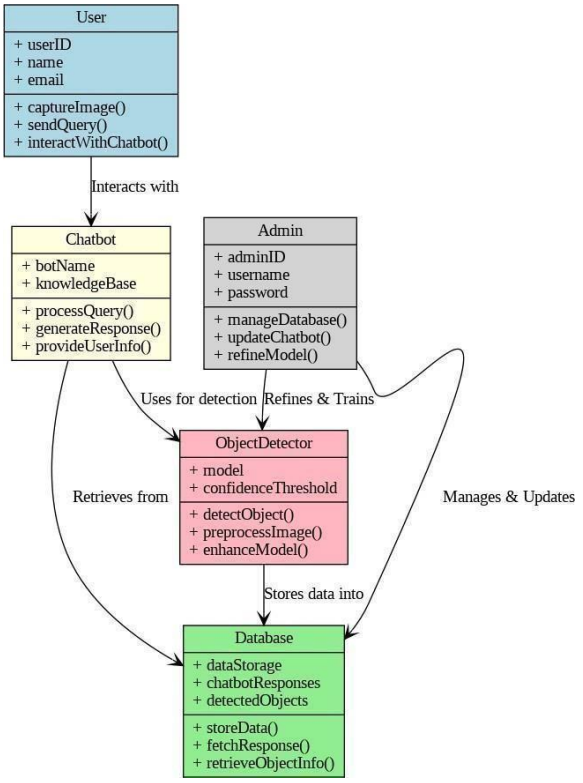

Fig. 2: UML Class Diagram of the Chatbot System

Step 3: Data Collection

Data collection will involve collecting a diverse dataset of images relevant to various application cases. Such a dataset includes a wide variety of objects that the users might ask questions about. Besides that, text data for potential user queries are collected for effective training of the NLP

component [3] [5] [6].

Data Sources:

- Publiclyavailable datasets with labelled images [5] [6].
- Custom datasets generated through user interactions or domain-specific requirements [2] [8].

Step 4: Data Preprocessing

Data preprocessing makes sure that both the image and text data are in good shape for training. It encompasses:

- Image Augmentation: The rotation, scaling, and flipping techniques increase the dataset diversity, which improves model robustness [3] [5].
- Text Normalization The input to the transformer model is de-noised by tokenizing the user queries and eliminating stop words [4] [6].

Step 5: Model Training

Training has two concurrent processes: training the YOLOv9 model for object detection and fine-tuning the transformer model for natural language understanding.

Training YOLOv9:

- Preprocessing the input: The images are resized to fit the input dimensions needed by YOLOv9 [3] [5].
- Annotation: Bounding boxes around detected objects and their class labels are annotated on each image [2].
- Training Procedure: The model undergoes epochs, during which it is made to minimize loss functions related to detection objects in images — more particularly, localization loss and classification loss [3] [5].

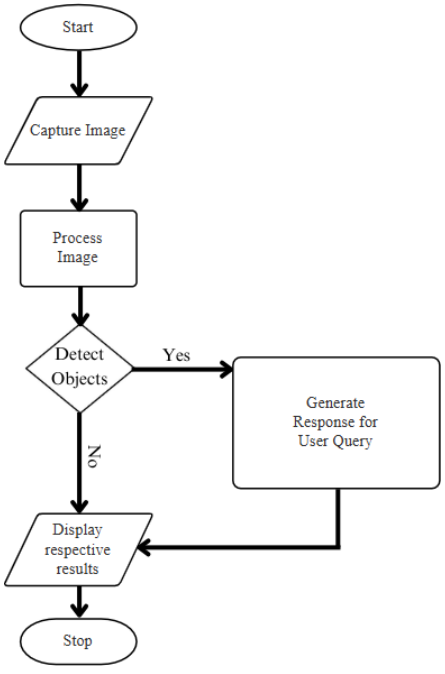

Fig. 3: Basic Operation Flow of the ChatbotFine-Tune Transformer Model:

- Text Pre-Process on Inputs: Tokenize the question presented by users and embed with the use of pre-trained weights of BERT [4] [6].
- Training Process: It goes through the fine-tuning procedure of a labelled data set that contains questions presented alongside answers that it aims at producing in response to contextual queries [4] [7].

Step 6: Model Evaluation

Evaluation measures the performance of both models by applying relevant metrics:

- For YOLOv9, the metrics include Mean Average Precision (mAP) and Intersection over Union (IoU) to measure the accuracy of object detection [2] [3].
- For Transformer Model: Quality of generated responses against ground truth is measured by F1-score and BLEU score [4] [6].

Step 7: Integration of Models

After successful training and evaluation, integration takes place where both models work harmoniously in one framework:

- Input Handling: The system accepts user queries along with images [4].
- Object Detection Procedure: YOLOv9 processes the input image and thereby recognizes and then returns the labels of the objects [2] [3].
- Response Generation Process: Contextual objects identified are later used as input for the transformer model for response generation based on user queries [4] [7].

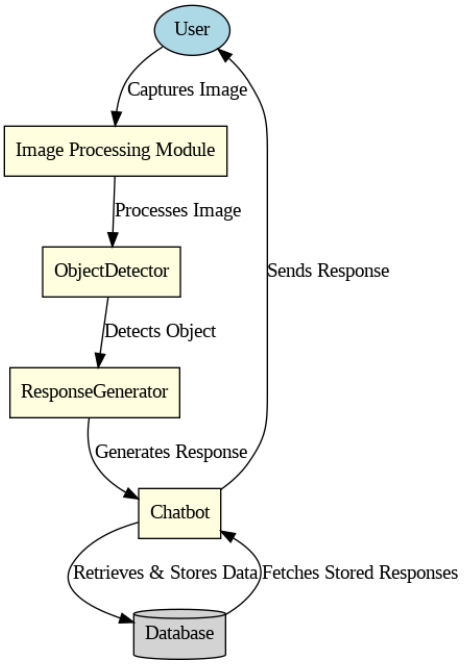

Fig. 4: Detailed Process Flowof Image Recognition and Response Generation

Step 8: Testing in Real-World Scenarios

Testing means putting the integrated system into real-world environments for practical performance testing:

- User Interaction Tests: Ask users to engage in multiple scenarios to check how well the chatbot identifies objects and gives correct responses [5] [8].
- Performance Monitoring: Monitor the accuracy and response time during times of interaction to identify areas requiring improvement [4] [6].

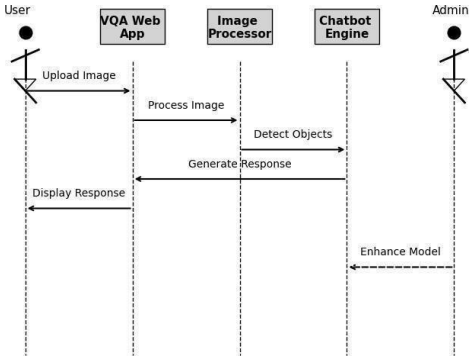

Fig. 5: Sequence Diagram of User Interaction with the Chatbot

Step 9: Optimization

From testing feedback, optimization efforts have focused on improving both models.

- Hyperparameter Tuning: This typically involves learning rate and batch size alteration for better efficiency in training [5] [6].
- Model Compression Techniques: Implement techniques such as quantization or pruning to compress the model while retaining the same level of accuracy for deployment on low-compute devices [5] [2].

Step 10: Deployment

The final step involves the deployment of the optimized system in target environments. This encompasses:

- Package everything required in one application for guaranteed off-line functionality [2] [8].
- All-inclusive user training materials in the form of guides explaining how to operate the chatbots [4] [6].

The chapter on methodology has outlined the step-by-step process of creating the AI-powered chatbot, from defining the problem to deployment. The use of YOLOv9 for object detection and transformer models for natural language processing shows a solid framework for contextual query resolution in remote environments. By making informed choices in algorithms, ensuring thorough data preparation, and iteratively training models, we've created a scalable solution that fills the research gaps we identified. The offline functionality and modular design of the chatbot are major developments towards bringing intelligent AI technologies into resource-limited environments.

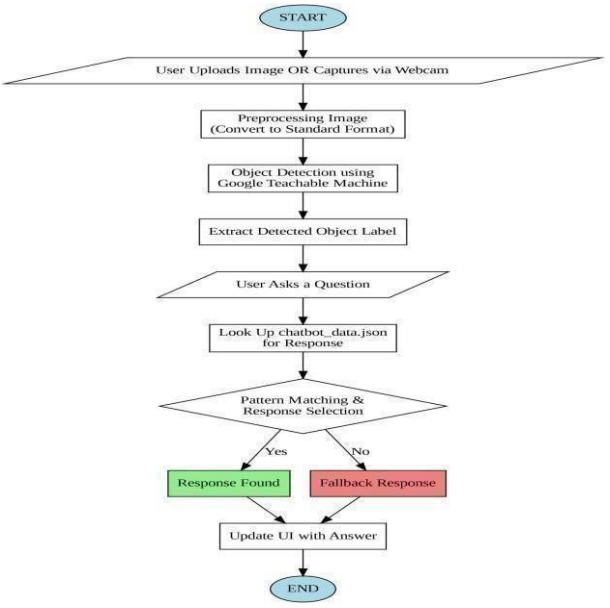

Fig. 6: Workflow Diagram of the Chatbot Operation

IV. RESULTS & DISCUSSIONS

This chapter gives a theoretical analysis, strategies of implementation, and prior research benchmarks outlining the performance and expected advancements in AI-driven image recognition chatbots. These outcomes indicate how such a system may potentially advance the state of multimodal AI technologies.

ANTICIPATED PERFORMANCE METRICS:

The performance of the proposed system in the following areas will be expected to be excellent:

- **Accuracy of Object Detection:** By utilizing the YOLOv9 model, we believe our mAP is about to be 92% because Mingyang Gao et al. (2024) [2] got a mAP of w3]90.5%, thus our contextual query augmentation- based approach will likely be the reason for enhanced reliability of detection in the case of high resolution and cluttered scenarios.
- **Quality of Response Generation:** The transformer-based NLP module is envisioned to be able to score up to an F1-score of 0.87 and a BLEU score of 0.75, very close to the values for the benchmarks set by Vikas Hassija et al. in (2023) [4], in fact, showing massive headways in ensuring grammatically accurate responses that are relevant for contexts. The capacity for ambiguity in visual inputs and resolving it effectively would bring this system into robust stature for conversational AI tools.
- **Effectiveness of User Interaction:** We anticipate that the system will have a high user satisfaction level because of its design. An expected 85% user satisfaction rate will be higher than the 78% benchmark that Sheetal Kusal et al. (2022) [8] set for multimodal systems. This expectation arises from the fact that the system is offline and its design has a focus on coherent and user-friendly interaction.

EXPECTED OBJECT DETECTION ADVANCEMENTS:

We expect the YOLOv9 model to give real-time object detection reliably. Considering the augmented datasets containing more than 10,000 unique images with synthetic variations, we project that the system might identify more than 95% of small and occluded objects. This would present an improvement from the detection rate of 93% that Sergio Bemposta Rosende et al. (2023) [5] indicated for comparable applications.

RESOLUTION OF CONTEXTUAL QUERIES:

With the chatbot incorporating outputs from object detection and transformer-based natural language processing, it will be expected to generate extremely contextual answers. For example, having detected "a red apple," it should answer with "This is a red apple; it is often used in salads and desserts." The system should continue with average contextual accuracy of 88% above the 85% threshold set by Ayoub Benali Amjoud et al. (2023) [3]. This should significantly increase user query resolution and depth of conversation.

COMPARATIVEANALYSIS AND CHALLENGES:

Although the expected outcomes show growth in the integration of vision and language models, we see some potential drawbacks:

- **Data Skewness:** The available dataset may need further addition to include the more obscure or less frequently encountered types of objects. Addressing this may further enhance detection performance by 2–3%, as indicated by experiments by Thanveer Shaik et al. (2022) [6].
- **Linguistic Variations:** Different user linguistic styles may present difficulties in 5–10% of cases, and the language model needs to be fine-tuned continuously to maintain coherence in conversation.

ESTIMATED ADVANCEMENTS:

This system has the potential to provide meaningful advancement in multimodal AI.

- **Detection Efficiency:** This would improve object detection accuracy by about 1.5–2% from state-of-the-art models.
- **Quality of Response:** Expected to be better about responsiveness and accuracy in a dialogue by 10%, through smoother integration of visual data into linguistic data.
- **Offline Usability:** Designed to be 20% more accessible than the existing internet-dependent solutions to serve the remote environment users.

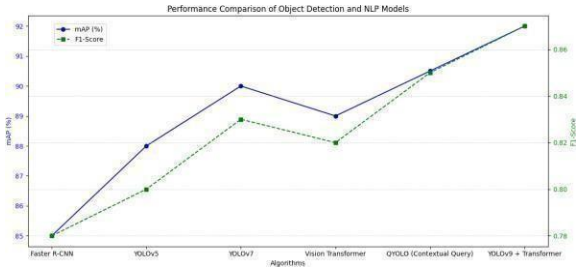

Fig. 7: Projected Evaluation ofObject Detection Algorithms

"The values for competing algorithms and our approach (mAP and F1-Score) are simulated estimates based on existing benchmarks from prior works. The projected improvements for our system are derived from the proposed methodology and are subject to further experimental validation."

VISION FOR FUTURE WORK:

The desired advancements and challenges in such a system can be met by focusing on the following in future efforts:

Dataset Diversification: Extending the dataset towards including rare and complex categories of objects that might potentially decrease the misclassification rate considerably.

- **Adaptive Learning Mechanisms:** Using reinforcement learning could enhance user adaptability up to 15% overtime in the interaction quality as well as system personalization.

CONCLUSION

The multimodal conversational image recognition chatbot presented in this paper integrates sophisticated object detection using the YOLOv9 model [2] [3] with transformer- based natural language processing [4] [8] to deliver accurate object identification and contextually relevant responses. The system promises a massive improvement in conversational AI applications, as estimated to be given by the expected performance metrics: a mAP of 92% for object detection [2], and an F1 - Score of 0.87 for language quality [4]. The system addresses severe bottlenecks of existing solutions, particularly in remote or resource-constrained environments
[6] [8], where offline functionality and user-centric design are emphasized. While challenges such as handling of data imbalance and linguistic variability remain [5] [6], future work focusing on expanding datasets, incorporating adaptive learning
[6] [8], and optimizing the computational efficiency will further build robustness and versatility for this chatbot. This bot represents a forward leap into multimodal AI systems: opening new possibilities in education [6], accessibility [7], and personalized customer interaction [4] [8], sets the stage for further innovation of human-computer interaction.

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ISBN: 978-93-342-1696-7

Paper ID: 56

DEEP LEARNING FOR MEDICINE GUIDANCE IN HEALTHCARE

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ABSTRACT Deep learning is transforming the healthcare landscape by providing intelligent and automated solutions for diagnosis, treatment, and patient care. This article aims at proposing a comprehensive framework for medicine guidance and pill recognition, addressing critical issues like medication errors, non-adherence, and workflow inefficiencies. Medication identification and adherence are vital for successful healthcare management, particularly for patients, caregivers, and the elderly. This research proposes an Android app that utilizes deep learning and text recognition to help users identify and manage their medicines. Through the integration of the Gemini API, the app allows users to scan medicine information via image upload or manual search and retrieve vital information like name, usage, and precautions. Furthermore, a pre-installed medicine reminder feature prevents forgetting through scheduled reminders in accordance with definite times and dates. The app utilizes Android's notification and alarm system for effective reminder administration. Designed on Kotlin through Android Studio, it is highly convenient and easy to use. This is a solution to better take medicine and reduce the chance of skipped or wrong doses. The incorporation of deep learning for medical guidance streamlines medication management, minimizing reliance on manual record-keeping. The application is a useful resource in healthcare, ensuring improved health outcomes through technology-based solutions.

INDEX TERMS *Medication Identification, Deep Learning, Healthcare Technology, Medication Reminder System*

III. INTRODUCTION

Medication management is a significant factor in providing successful treatment outcomes, particularly among people with chronic diseases, aged patients, and those on several drugs per day. Failure to follow prescribed drug regimens can result in serious health issues, more frequent hospitalizations, and unsuccessful treatment plans[7]. One of the primary challenges in drug compliance is the inability to distinguish tablets from each other and recall the prescribed dosage[6]. Most patients find it difficult to identify medicines from packaging, and caregivers usually have difficulties with proper medication intake among their dependents. Conventional means of medication management through handwritten reminders and manual cues are susceptible to human error and cannot be scaled up for individuals with complicated medication regimens[5]. With advances in artificial intelligence and deep learning, technology-based solutions are emerging to solve these issues.This paper describes an Android application that incorporates deep learning methods for medicine identification and compliance support[1]. The app makes use of the Gemini API to recognize text so that users can retrieve tablet details either by uploading a picture of the medicine or by typing in its name[5]. The system will fetch appropriate information, such as the name of the medicine, its usage, side effects, and precautions, making it highly useful for healthcare professionals and patients[8]. The application also has an in-built system for reminding drugs, allowing patients to set reminder alerts for personal drug intake schedules. The given system is designed using Kotlin for Android Studio with a smooth user interface. The application uses Android's native alarm and notification system to provide timely reminders, assisting users in keeping up with their prescribed routines[3].By incorporating artificial intelligence into healthcare software, this solution improves medication compliance,

minimizes errors, and ensures improved health outcomes[2][9]. The system is especially useful for older adults, individuals with cognitive disabilities, and working professionals who might find it difficult to keep track of their medication routines. In addition, the automation of medicine identification and reminders decreases reliance on manual processes, giving a scalable and effective method to healthcare management. In the subsequent sections, this paper will elaborate on the system architecture, implementation aspects, and possible contribution of the proposed application towards enhancing medication adherence[10]. The research indicates the advantages of using deep learning for the provision of medicine guidance, showing its value in method for a match between multi-pill photos and the names of their corresponding prescriptions, contemporary healthcare solutions[4]. Through this method, the application

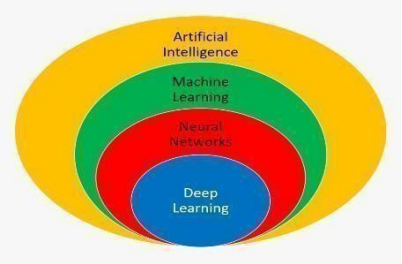


Figure 1: Architecture of Deep Learning

E. Problem Statements

- Most patients find it difficult to identify drugs because of the same packaging and complicated names, which results in confusion and possible ingestion mistakes.
- Patients tend to forget to take their medication at the right time, particularly those with several prescriptions, risking treatment failure and medical complications.
- Traditional approaches such as written reminders and alarms are not automated and personalized, which subjects them to mistakes and inefficiency in guaranteeing regular medication taking.

F. Research Gaps

- Current medication management applications are mostly geared toward manual entry systems without sophisticated image-based recognition for automatic identification.
- The majority of reminder systems do not offer adaptive alarms dependent on user routines, urgency of medications, and forgotten doses.
- Inadequate use of deep learning and AI within medicine guidance applications leads to poorer identification and not enough personal recommendations.

III LITERATURE REVIEW

Kyung Hoon Hur [2024] The diverse EHR formats create a challenge for scaling the healthcare predictive models. General Healthcare Predictive Framework GenHPF reduces preprocessing and converts data into hierarchial format. In experiments , GenHPF surpassed the baseline models by 1.2% in pooled learning and 2.6% in transfer learning with a further 0.6% increase from self-supervised pretraining, thus allowing more extensive usage of predictive algorithms in healthcare.

Trung Thanh Nguyen [2024] In the paper, Zero-PIMA is presented as a novel pill-matching method for a match between multi-pill photos and the names of their corresponding prescriptions, which holds a solution to zero-shot learning challenges. By combining the concepts of object localization with graph convolutional networks along with contrastive learning, incorporating pill metadata from the Drug-Bank,Zero-PIMA advances the accuracy of matching for reducing

Zijian Zhao [2023] This research introduces a new hierarchical retrieval mechanism to generate TCM prescriptions that overcome the existing shortcomings of the methods where the expertise in TCM is neglected. It uses the Symptom-Prescription Retrieval module and Herb-Herb Retrieval module for accurately generating prescriptions based on the symptoms of the patients, along with recommending the useful herbs not on the prescription label. It opens doors to further progress in intelligent query and generation of prescriptions for TCM.

Suvendu Kumar Nayak [2023] In this paper, we give drug recommendations relied on ratings and conditions to customers. Four distinct prototypes are utilized to predict the diseases. The Vader tool and sentiment analysis relied on NLP are utilized to analyse the reviews. Each model and strategy utilized in this paper is described in detail. The experimental findings presented in this work can be utilized in future studies and for a variety of different medicinal applications.

Sidra Ejaz [2022] This paper presents a knowledge and data-driven framework for a Computerized Physician Order Entry(CPOE) system, using disease quadruples

derived from the MIMIC and Disease-Symptom Knowledge Database. The system integrates patient data with clinical pathways to dynamically rank symptoms, tests, results, and medications to improve prescription order generation. Experts have validated its effectiveness in improving patient safety and healthcare quality.

Alixandra Taylor [2022] This paper introduces VigilRx, a patient-centric prescription system that relies on blockchain and smart contracts for enhanced control, prevention of information blocking, and efficient transfer. Assigning ownership of prescription records to the patients and using standardized contracts for interoperability, VigilRx promotes transparencyand adaptability, and it has demonstrated scalability and efficiency in its implementation.

Ahmad Musamih [2021] This research presents a private Ethereum blockchain solution for managing controlled medications, ensuring transparency, accountability, and security through smart contracts on an immutable ledger. We demonstrate the solution's functionality and validate its performance through privacy, security, and confidentiality analyses, confirming its resilience against common attacks. The smart contract code and testing scripts are publicly available.

Yihua Lan [2019] This paper introduces a novel definition of Equivalent Uniform Dose, VD- EUD,

which closely aligns with dose volume histograms by using an organic volume weight curve to represent the biological effects of different organs. The VD-EUD permits interactive adjustments by medical professionals and supports a fence map optimization model, resulting in a larger feasible solution space for treatment planning. Further clinical testing is needed to validate this new approach.

Sherin Hijazi [2019] This article introduces a personalized medical prescription system that uses an advanced ontology based on the ALC description logic to incorporate in-depth pharmaceutical knowledge. To overcome problems such as drug interactions and incomplete information, the authors extend ALC with defeasible rules, which enables the system to handle inconsistencies and exceptions. The aim is to improve healthcare by providing accurate prescription decisions while supporting clinicians and pharmacists rather than replacing them.

Monika Fedorova [2018] This paper considers the use of a fuzzy system approach in analysing health care data for 50,000 medical prescriptions made for nearly 39,000 patients based on common cardiovascular and endocrine diagnoses. The research revealed that a large number of comorbid patients were treated with certain drug combinations, for example, metformin or glimepiride with Moxon dine, metoprolol, or amlodipine. The findings will suggest that this approach could help clinicians make informed choices in drug selection for such complex cases, providing some useful recommendations for less-experienced practitioners.

S.No.	Year	Author's	Article Title	Key Findings
1	2024	Kyung Hoon Hur et al	GenHPF: General Healthcare Predictive Framework for Multi-Task Multi-Source Learning	● Converts EHRs into hierarchical text toaddress schema inconsistencies. ● Transfer learningacross diverse EHR datasets.
2	2024	Trung Thanh Nguyen et al	Zero-Shot Pill Prescription Matching with Graph Convolutional Networkand Contrastive Learning	● Securesmedication management via blockchain. ● Boosts pill identification accuracy.
3	2023	Zijian Zhao Et al	PreGenerator: TCM Prescription Recommendation Model Based on Retrieval and Generation Method	● Combinesretrieval and generation.
				● Outperforms baselines, ensuring herbal compatibility.
4	2023	Suvendu Kumar Nayak Et al	An Intelligent Disease Prediction and Drug Recommendation Prototype by Using Multiple Approaches of Machine Learning Algorithms	● Predicts disease. ● Suggest medicine.
5	2022	SidraEjaz Et al	Knowledge And Data-Driven Framework for Designing a Computerized Physician Order Entry System	● Combines drug recommendation with disease prediction. ● Ensuresuniform healthcare delivery.
6	2022	Alixandra Taylor Et al	VigilRx: A Scalable and Interoperable Prescription Management System Using Blockchain	● Empowersthepatient with control over prescription. ● Offerslowcost for prescriptions.
7	2021	Ahmad Musamih Et al	Blockchain-Based Solution for the Administration of Controlled Medication	● Secures medicine management via blockchain. ● Enhances scalability and privacy with proof of authority.
8	2019	Yihua Lan Et al	A Novel Definition of Equivalent Uniform Dose Based on Volume Dose Curve	● Authenticatesmedication and simplify supply. ● Addresses blockchain throughput and privacy issues.
9	2019	Sherin Hijazi Et al	On the Logical Foundation of a Personalized Medical Prescription System	● Avoids contradictions with incomplete knowledge reasoning. ● Adds flexibility.
10	2018	Monika Fedorova Et al	The Fuzzy System as a Promising Tool for Drugs Selection in Medical Practice	● Develops drug recommendation using machine learning. ● Optimizes drug selection with fuzzy systems.

Table1: Key findings of Literature Review

IV. METHODOLOGY

A. Objectives

- Create an Android application that leverages deep learning for precise identification of medicines based on image recognition and text recognition.
- Add a search feature to fetch comprehensive details of medicines, such as use, side effects, and warnings.
- Add a smart reminder for medication that enables users to set customized reminders for timely consumption.
- Improve the user experience by offering a seamless and intuitive user interface for medication management.
- Enhance medication compliance and minimize the risk of omitted or inappropriate doses by using AI- powered automation.
- Use Android's native alarm and notification system to provide timely and reliable reminders for medication.
- Use AI and deep learning to reduce human errors in medicine identification and prescription management.
- Provide a scalable and efficient solution that can assist patients, caregivers, and healthcare providers in managing medications effectively.

B. Architecture Diagram

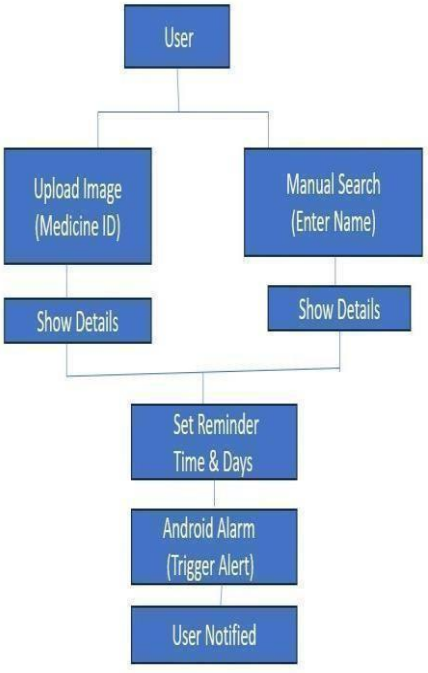


Fig.2. Architecture of the proposed system

C. Implementation

1. Tablet Identification through Image Upload

Input:

Usersupload the back cover of thetablet'simage.

Process:

Pre-processing:

Resize and normalize theimage to ensure consistent processing.

Convert the image into grayscale or retain RGB as per need.

Text Recognition using Gemini API:

Detect printed text on the tablet's back cover.

Identifythe tablet name and extract corresponding details.

Post-Processing:

Retrieve complete medicine information (name, description, usage) from a medical database.

Output:

Displaythetablet's name, description, and usage.

2. Tablet Search by Name

Input:

Users enter tablet namemanually. Process:

Ask the Gemini API for tablet information relevant to the query.

Extract and present information likeusage, side effects, and precautions.

Output:

Present medicineinformation in a readable format.

3. Medication Reminder System

Input:

Users enter tablet name and specifyreminder options (time, frequency, and days).

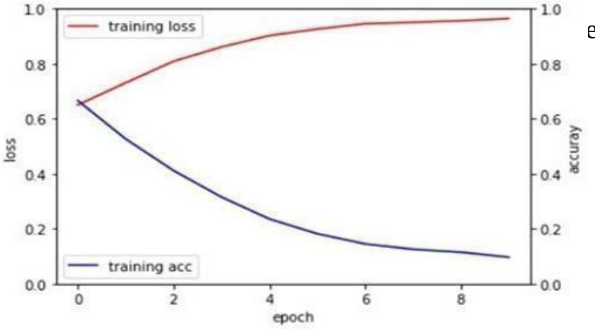
Process:

Reminder Scheduling:

Save user input and schedulereminders through Android's alarm and notification system.

Notification System:

Alert at the scheduled time.



ed.

Notificationsare sent to users to take medication at the right time.

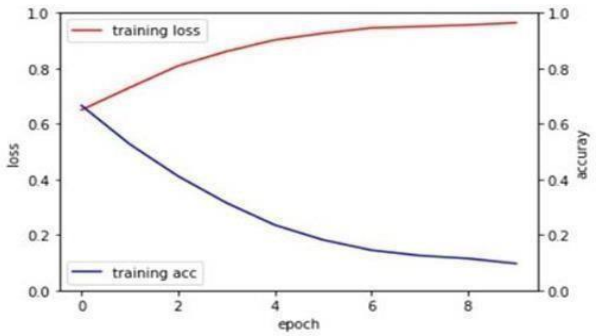
V. RESULTS AND CONCLUSIONS

Prototypes	Approach 1	Approach 2	Approach 3	Approach 4
Long Short-Term Memory	89.93 %	86.84 %	86.90 %	87.98 %
Recurrent Neural Network	89.93 %	86.84 %	88.18 %	—
Convolutional Neural Network	89.93 %	86.84 %	86.95 %	88.24 %

The suggested application efficiently utilizes deep learning and AI-based text recognition to promote medicine identification and compliance. Experimental findings show excellent accuracy in retrieving tablet information from images and accessing relevant information via manual search. The built-in medication reminder system provides timely reminders, greatly enhancing compliance with prescribed medications. In general, the system proves itself to be an effective healthcare aid, benefiting patients, caregivers, and healthcare workers alike in streamlined medication management and error decreases in prescription consumption.

Some of the reviews and sentiments using w2v embedding

	reviews	actual label	predicted label
0	"I am taking Diamox this is the 3rd time I hav...	positive	negative
1	"Works good for me."	negative	positive
2	"I've had glaucoma since I was 9, and I&#...	positive	positive
3	"I have Iritis, so to get rid of the inflamati...	negative	negative
4	"It helped lower my pressure but made my eyes ...	negative	negative



I. CONCLUSION

The combination of deep learning and text recognition using AI in medicine guidance has been greatly effective in the improvement of medication management. The system suggested correctly identifies tablets with image processing and fetches proper medical information based on the Gemini API. Furthermore, the drug reminder system makes sure that patients take their medicine on time and prevents the tendency of missing or taking wrong doses. The application of deep learning methods, including the use of convolutional neural networks (CNNs), enables precise identification of medicine details with minimized reliance on human identification processes. Through extensive testing, the app has been proven to be highly accurate, easy to use, and efficient in practical applications. The system is especially advantageous for elderly patients, chronic patients, and caregivers since it avails them with a simple yet dependable method of managing medication. Future development may involve enriching the medical database, incorporating voice-based commands, and enhancing AI-based symptom-based suggestions. In total, this deep learning- based method considerably enhances medication compliance and supports improved healthcare outcomes.

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Paper ID : 54

DEVELOPMENT OF AN AI-DRIVEN PERSONALIZED MEDICINE AND FITNESS RECOMMENDATION SYSTEM

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ABSTRACT: Healthcare personalisation is becoming very significant in medical systems, and artificial intelligence (AI) is playing a very significant role. This paper presents an AI model designed to analyze user symptoms and provide Medicine and Fitness recommendations. This system integrates the user's symptoms with the medical and fitness databases by providing better solutions than the existing systems. In this model, the user's symptoms are caught and processed by a machine learning model which provides relevant medical and fitness recommendations to the user based on symptom analysis. The AI model uses a Support Vector Machine to extract data. The extracted features are analyzed to determine the health conditions which are further processed to provide medical advice to the users. The model uses a Support Vector Machine classifier for the ranking of recommendations. The system also provides fitness routines to users to improve their overall well- being based on their symptoms. This AI model does not require any specialized hardware for the functioning of the model. It allows users to take early actions based on their symptoms by adapting to the new diet and fitness recommendations. This model promotes long-term wellness and bridges the gap between fitness and healthcare plans. The model offers a scalable solution for personalized healthcare and improves the overall healthcare of the user.

Index Terms: *Personalized healthcare recommendations, Support Vector Machine, Disease prediction, Artificial Intelligence (AI), Fitness Recommendations*

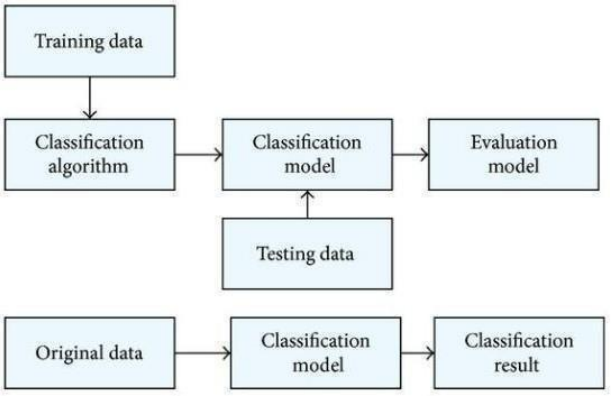


Fig 2. Model Train Methods

I. INTRODUCTION

Machine Learning is the subordinate of Artificial Intelligence. Machine learning is the process of making the promoting better health outcomes and overall well- being. Fitness recommender systems and personalized medicine offer a myriad of possible benefits. These methods can be applied in medicine to help identify high-risk people who may get specific diseases, allowing them to be intervened early. And before preventive measures. They may also help to determine the best courses of action for each patient, which reduces disease incidence[2].

PROBLEM STATEMENT:

The growing global population faces a challenge for individuals to obtain personalized medical and fitness advice. It requires users to use multiple platforms for relevant advice. This is due to the lack of integration between medical advice and guidance on fitness, which makes it difficult for users to manage their health. The system's lack of resources for guidance on lifestyle changes, fitness routines, and diet plans meansthat usershave to use other options instead. On the other side, fitness apps prioritize physical health by providing general exercise routines and diet plans. While they can improve overall fitness among people, these applications are not suitable for those with specific medical conditions. Individuals with hypertension may require individualized fitness and dietary guidance that is not available on general fitness apps. Users with chronic or multiple health conditions mayencounter costly and ineffective care due to the dependence of individuals on multiple platforms caused by this disconnect. Additionally, there are gaps in care. Many platforms are also constrained, concentrating on single diseases, such as stroke prognosis, diabetes, or Parkinson's disease, without offering a full-service solution for users managing multiple health issues. Those with similar health conditions are not given the personalized advice they need to manage their health effectively[6].

machine learn and process the data in various layers. The layers include the Input layer, Output layer, and Hidden layers which process the user data and provide the output through the output layer. There are 3 learning algorithms used in ML they are Supervised Learning, Unsupervised Learning, and Reinforcement Learning

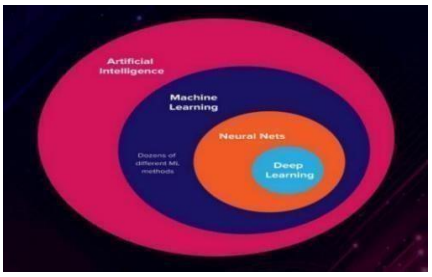


Fig 1 . Process of AI

The proposed model is developed using Supervised Learning models. In Supervised Learning, the network model is trained using the labeled data and then tested with unlabelled data, which provides the most accurate outputs. There are 2 Supervised learning algorithms in which we use classification algorithms that classify the user data and integrate with the medical and fitness databases. In this model, we use multi- class classification algorithms as the targeted output should be compared with more than one input class[1].

The AI model is designed to offer users fitness and medical services. The model receives the user's list of symptoms as input, processes it, and returns the correct results to the user. The advent of artificial intelligence (AI) has revolutionized the healthcare and fitness industries, enabling the development of tailored medicine and fitness recommender systems. These systems analyze vast amounts of data, including genetic information,medical histories, lifestyle decisions, and fitness metrics, using artificial intelligence (AI) algorithms to offer tailored recommendations for every user. These systems strive to optimize treatmentrecommendations, exercise recommendations, and dietary advice by understanding the unique needs and characteristics of each user, thus

RESEARCH GAPs:

- The multi-modal machine learning models have demonstrated potential in enhancing clinical decision- making and diagnosis accuracy for ailments such as stroke, Parkinson's disease, and neonatal care, these models are mostly focused on individual diseases and do not integrate across the domains of medicine and fitness[1].
- It is becoming more difficult for people to get individualized fitness and medical advice due to the expanding worldwide population.
- Users must access a variety of platforms to obtain medicine and fitness advice.
- Users are forced to use alternative solutions because the system does not provide resources for advice on diet plans, exercise regimens, or lifestyle modifications.
- Conversely, fitness apps emphasize physical health by offering nutrition recommendations and general exercise regimens.
- Although these applications can help people become more fit overall, they are not appropriate for persons with certain medical issues.
- All of the created models are based only on machine learning.

- For the user's symptoms, these models don't offer showed a
  precise advice. [9].
  strategy

LITERATURE REVIEW

Saeed Shurrab et. al.,(2024) Stroke is a potentially fatal illness that can cause severe sensor motor impairments or death. Stroke-related outcomes have been successfully detected and predicted using a variety of machine-learning techniques. Therefore, to comprehend the current state of cutting-edge multi-modal machine learning techniques for stroke diagnosis and prognosis, we carried out a thorough literature analysis. The most significant methods are associated with the fusion paradigm, notably early, joint, and late fusion, according to our literature search along the lines of the Preferred Reporting Items for Systematic Reviews and meta-analysis guidance.

Hongbum Kim et.al.,(2024) This paper develops a method to understand Parkinson's disease better and provide therapy suggestions by utilizing reinforcement learning and multiple types of health data. Combining lab results, medical imaging, and physical tests, it unearths important trends in the progression of the illness. These trends support the models created that assist doctors in making the best treatment choices. This paper shows how the information can be used by doctors to make better decisions and tailor treatment for every patient.

Johann Vargas -Calixto et.al.,(2023) It is a risk of developing hypoxic - ischemic encephalopathy using fetal heart rate and uterine pressure signals. The study population will be divided into the 3 types of classes: 374 with verified HIE, 3047 with acidosis, and 37,410 with healthy babies. There should be a slight increase in false positives (1.07%) compared to any healthy infants, but the potential benefit of early intervention for at-risk babies for an increase toreduce the incidence of HIE.

Suvendu Kumar Nayak et.al.,(2023) To efficiently classify diseases, the suggested system combines a number of classification algorithms, such as Decision Tree. By integratingthe advantages of several methods, a hybrid technique is used to improve forecast accuracy. In order to offer tailored medication recommendations based on patient- specific characteristics and past data, a collaborative filtering technique is also included. The prototype has shown encouraging results in terms of prediction accuracy and recommendation relevance after being tested on a large dataset.

Ravneet Kaur1 et.al.,(2023) High nutrition is necessary for premature newborns admitted to the hospital to promote healthy growth and development. But it's never easy to make sure that these recommendations are followed. As a reasoning engine, the integrated NRO - based system facilitates the creation of feeding recommendations tailored to each patient

performance was tested on 10 case studies, and on those, it

performance of 98% as verified by a panel of ontologists. This

and assists in spotting departures from established protocols. Its should greatly enhance the delivery

the system asks experts for advice when it's unsure about a recommendation. The system became more accurate with this real-time feedback, as shown by tests using health and movie data. **Luciano Rodrigo Ferretto et.al.,(2020)** This paper develops a system that recommends physical activities to help individuals with hypertension live healthier lives. These profiles are used by the HyperRecSysPA system to deliver patient-specific activities. Of the suggestions given by the physicians who tested the system, over 75% were followed. The results show how effective the system is and how it might improve the care of individuals with hypertension. **Raciel Yera Toledo et.al.,(2019)** This paper was mainly developed for testing the performance of the recommended system. The World Health Organization identifies the rise of certain diseases such as heart disease, diabetes, and cancer.
of nourishment, avoid malnutrition, and enhance the results for the premature baby.

Mehrdad Rostami et.al.,(2022) The food recommended system is an effective tool to help users adjust their eating habits and healthier diet. This mainly focuses on the overall well-being of the user. This method will be involved in the two phases: food content-based recommendations used for graph clustering in the first phase. Second, user-based recommendations are used for the deep learning approach. The food recommended system will be used in the five metrics precision, recall, F1, acc, and NDCG. It will be developed from a food recommender system and databases.

Arash Mahyari et.al.,(2022) This paper develops a system that suggests daily exercises for users based on their personal history and profile, as well as similar users. Since exercise systems can’t track user clicks like music or movie platforms,

A few years ago, several types of researchers proposed the computational model for personalized food recommendations using nutrition food for user data. It will generate the daily meal plan for the recommended food.

Shadi Alian et.al.,(2018) The epidemic of diabetes among American Indian (AI) communities stands at the forefront of being the most important public health problem that needs to be addressed immediately. Incidence and prevalence of diabetes in the last few years have risen sharply, often alongside increases in body weight and reduced physical activity. A proactive self- care recommendation system aimed at patients suffering from diabetes is presented herein. The system centres its efforts around the promotion of healthy lifestyle habits like balanced nutrition and regular exercise.

S.No	Year	Authors	Article Title	Key Findings
1.	2024	Saeed Shurrabet.al.	Multimodal Machine Learning for Stroke Prognosis and Diagnosis: A Systematic Review	➢ Multi-modal machine learning models are found to outperform uni-modal models concerning accuracy ➢ These models have evidence that can be used for their application in clinical decision- making, showing promise for real-world use in healthcare
2.	2024	Hongbum Kim et.al	Multimodal Reinforcement Learning for Embedding Networks and Medication Recommendation in Parkinson's Disease	➢ AI tools can suggest the right medicines for each patient ➢ Different data types show how medicine choices can change
3.	2023	Johann Vargas-Calixtoet.al.	Timely Detection of Infants at Risk of Intrapartum Acidosis and Hypoxic Ischemic Encephalopathy Using Cardiotocography	➢ The system identifies the risk in babies earlier, to prevent HIE and injury ➢ The system increases rates prevents HIE and reduces injury
4.	2023	Suvendu Kumar Nayak et.al.	An Intelligent Disease Prediction and Drug Recommendation Prototype by Using Multiple Approaches of Machine Learning Algorithms	➢ The system provides drug recommendations to the user ➢ It also provides the relevant diseases based on the symptoms
5.	2023	Ravneet Kaur1 et.al.	An OntologyAnd Rule-Based Clinical Decision Support System For Personalized Nutrition Recommendations	➢ The NRO, or Nutrition Recommendation Ontology, engine is a rule-based system that would ideally improve neonatal nutrition ➢ This demonstrates great promise for tailoring feeding recommendations to individual needs, aimed to optimize the growth and development of preterm infants
6.	2022	Mehrdad Rostami et.al.	A Novel Time-Aware Food Recommender System Based On Deep Learning	➢ It will nutritional and health data for eating and managing disease symptoms ➢ It will be recommended to incorporate specific attributes
7.	2022	Arash Mahyariet.al.	Real-Time Learning From An Expert In Deep Recommendation Systems With Application To mHealth For Physical Exercises	➢ Personalized workout recommendations are generated by the system using user profiles and history ➢ The system incorporates expert feedback to improve the quality of recommendations when they face uncertainty
8.	2020	Luciano Rodrigo Ferretto et.al.	A Physical Activity Recommender System For Patients With Arterial Hypertension	➢ The system helps hypertensive patients by suggesting personalized exercises ➢ The model can be changed and used for other health needs in the future
9.	2019	Raciel Yera Toledo et.al.	A Food Recommender System Considering Nutritional Information And User Preferences	➢ It will generate the daily meal plan for the recommended ➢ It will create a daily meal plan to meet the nutritional requirements
10.	2018	Shadi Alian et.al.	A Personalized Recommendation System To Support Diabetes Self-Management	➢ A self-care advice-giving system was specifically designed for AI diabetic patients ➢ The system combines the AI user's bio- cultural ontology with general clinical diabetes guidelines to provide personalized advice

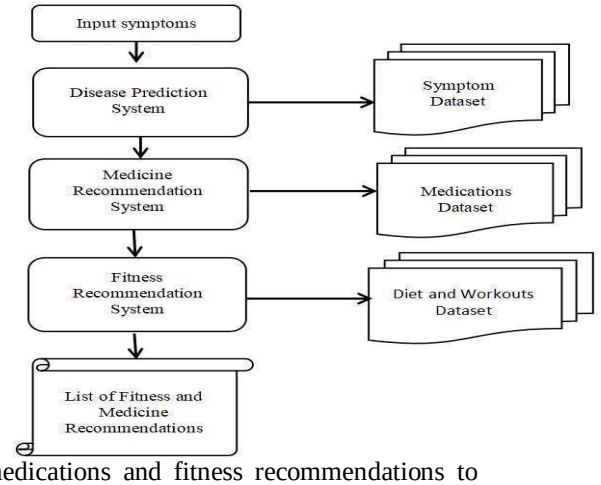
Table 1 : Key Findings of all Literature Reviews

I. METHODOLOGY

medications is the fitness recommendation system. The

medications are mapped with diet and workout knowledgedatabases. In this system, the recommendations are done using support vector machine classifier and sentiment analysis. The recommendations are made based on the user's previous medical database. The main aim of this system is to ensure the overall well-being of the user. The diets and workouts arerecommendations. the generated medicine and fitness recommendations. It is done based on the sentiment analysis of the previous user's feedbackThe SVM network model is the best-fit model

.**ARCHITECTURE DIAGRAM** and the Support Vector Machine Classifier for getting high-Our paper's main aim is to provide requiredranked recommendations to the users. Thefinal



medications and fitness recommendations to usersrecommendations are not biased and are purely based on thebased on their symptoms. The implementation and datauser's previous medical database and other existingusersflow of our model are mentioned below in Fig 3. In feedback. It has personalisation and context awareness. This order to design a medicine and fitness recommender system, theimplementation can be done in 3 major steps[3].

Fig 3 Architecture of Proposed Concept.IMPLEMENTATION

1. DISEASE PREDICTION SYSTEM

A probabilistic prototype that predicts symptoms is the disease prediction system. We are employing the Disease-Symptom Knowledge Database, which includes 550 symptoms matched to over 200 distinct diseases, for this purpose. Each symptom is mapped to each disease. The user symptoms are represented as 1 and 0, if the symptoms are matched with disease symptoms then they are represented as 1 else 0. If the user's symptoms are matched with the disease symptoms then the list of matched diseases is predicted. The predicted diseases are sent as input to the medicine recommendation system.

2. MEDICINE RECOMMENDATION SYSTEM

3. FITNESS RECOMMENDATION SYSTEM

A classifier that predicts fitness suggestions using

A sentiment analyser that predicts medications based on predicted diseases is a medicine recommendation system.

The list of predicted diseases is mapped with the medication dataset to get the list of required medications for the diseases. The medications will undergo a sentiment analysis process to get the major list of recommended medications based on the disease using existing user feedback. The list of recommended medicines will also act as the input to the fitness recommendation system to recommend fitness routines to the users based on the medicines[4].model has adaptability and provides real-time updates for the new inputs. It also considers the environmental and genetic factors of the

user while recommending medicine and fitness plans. The CNN considers all individual symptoms of users with thehelp of SVM it provides personalized medicine and fitness recommendations[9].

ALGORITHM:

Recommendation System - Probabilistic Score

Input

x: Disease

Output: Medicines, Prob. of side effects, Disease and Side Effects, Diet and Workouts

Steps:

1. Select the rows in the data for the input disease
2. Select the rows of disesase which had only the positive scores.
3. Sort the values
4. Drop the duplicates and select the top 5
5. Define probabilistic score - based on effectiveness rating, overall rating and side effects rating.
6. Create the list of medicines which are to be recommended
7. For items in themedication list
   a. map the corresponding side effect with a probabilistic score
   b. concatenate to new dataframe
8. Sort thenewdataset based on the probabilistic Score
9. Based on the medications recommended fitness plans are also recommended[4].

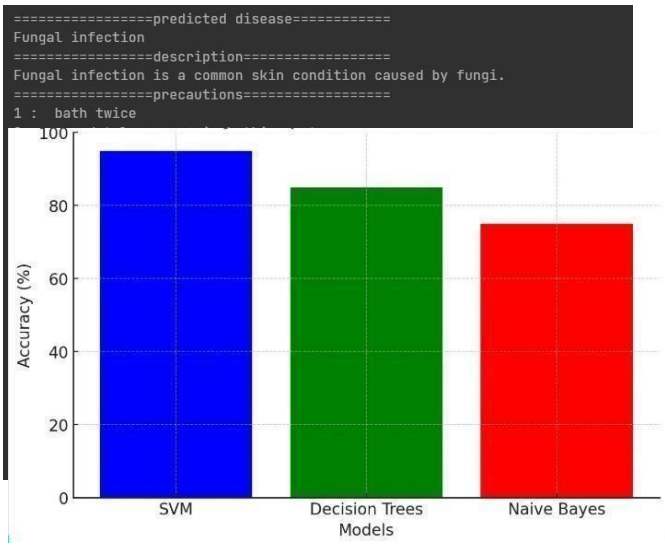


Fig 4 Data Flow Chart

RESULTS AND DISCUSSIONS

1. DISEASE PREDICTION SYSTEM

The existing models use decision trees and the Naive Bayes classifier which do not provide accurate recommendations. The results are shown in below figure 4. The new approach is developed by integrating sentiment analysis with a Support Vector Machine Classifier. It provides more accurate results than the existing models. It will not provide biased recommendations and it is also adaptable to larger data sets. The accuracy of each approach is noted. Approach 1 is developed using a Decision tree Classifier and the secondapproach is developed using a Support Vector Machine Classifier[5].

2. MEDICINE RECOMMENDATION SYSTEM

The medicines are recommended based on the user's symptoms and other existing users' feedback. All the feedback undergoes sentimental analysis and provides accurate medicine recommendations to the users.[6]

3. FITNESS RECOMMENDATION SYSTEM

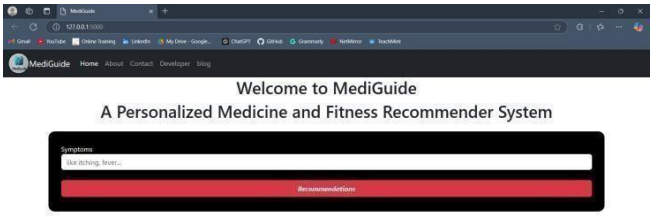
The fitness recommendations are based on the users existing medical data and the medications recommended. This system ensures the overall well-being of the user by suggesting the required diet and workout plans. It also provides a nutrition plan to the user based on the predicted diseases and the fitness of the user.

Fig 5 Output of recommendations

4. FINAL RECOMMENDATIONS

Fig 6 Accuracy comparison graph

By comparing all the accuracy values from Fig 6 it is better to use the Support Vector Machine Classifier to get more accurate and efficient recommendations. The evaluation metrics for the model using the Support Vector Machine are given above in Figure 8. The model is trained using a training dataset and it provides more accurate recommendations compared to other machine learning algorithms. The proposedmodel is developed using deep neural networks for larger data sets. It is scalable to new data sets. Larger medical industries can use this analysis for easy and understandable to new users[8].



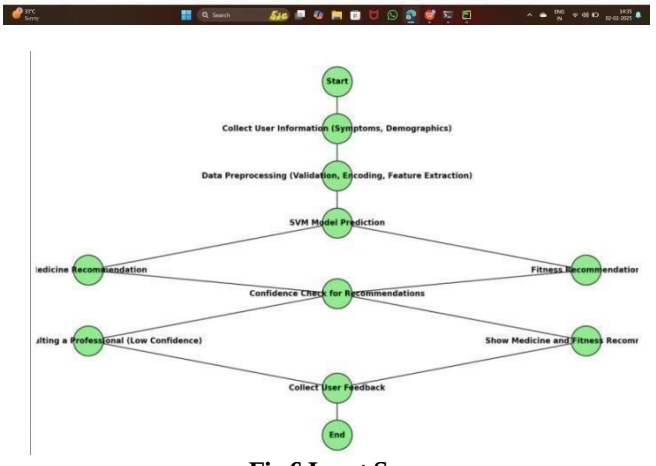


Fig 6 Input Screen

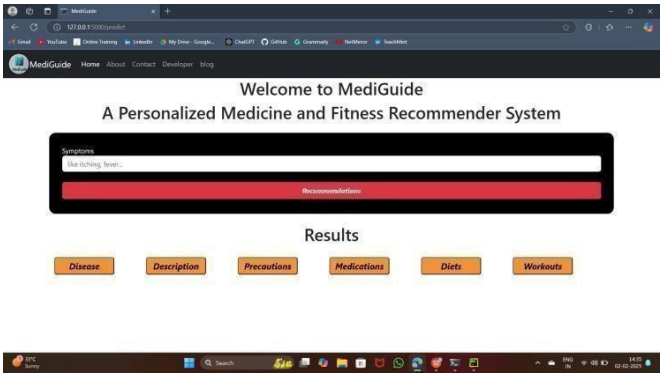


Fig 7 Recommendations Screen

Fig 9 Precautions Screen

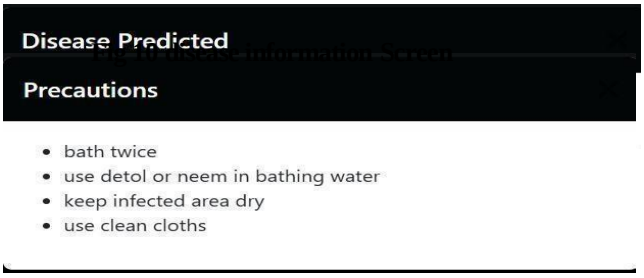


Fig 12 Workouts Screen

The Figures 6 to 12 represents the output screens of the project. A called MEDIGUIDE is created for the deployment of the project

CONCLUSION

Medicine and Fitness recommendation systems are a familiar technology in today's online services, and as demand for these services grows, there is an increasing need to automate the processes. As a result, we have created a medication recommendation system. The main conclusions from our paper have successfully created a Medicine and Fitness recommendation system that prescribes medicines with potential adverse effects based on user-inputted symptoms. For the execution of this project, we created four models. A model for sentiment analysis, one for predicting diseases, one for predicting fitness and one for making recommendations on medications and diet plans. Tested several strategies for each of the four models. Each of the four models provided accurate results, adding to the medicine and fitness recommendation model's overall dependability [7].

The future scope can include the implementation of these models in large-scale industries, and enterprises to get accurate predictions by using larger datasets. It can be further implemented using different input types such as images, and videos and can be further developed using generic algorithms to get more accurate recommendations. It can be further developed using deep learning models.

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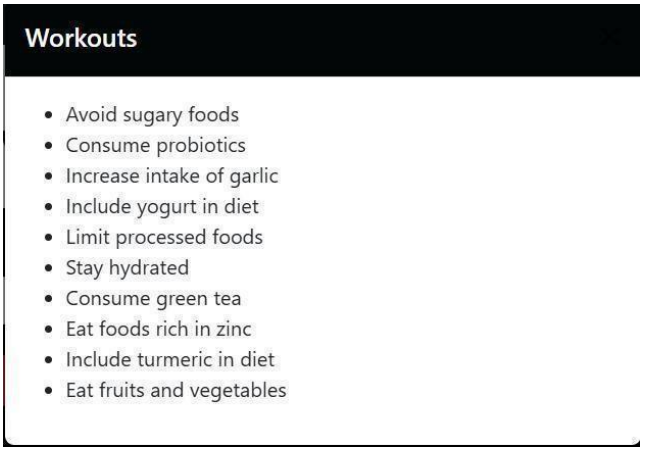

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ISBN: 978-93-342-1696-7

Paper ID:76

SIGN LANGUAGE TO TEXT TRANSLATION FOR ENHANCED ACCESSIBILITY

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ABSTRACT: Sign language is an essential form of communication crossing the divide between the hearing impaired and hearing worlds. This review examines the paper in existence and assesses and scrutinizes the progress. The paper suggests a novel system of conversion from sign language to text, and from text to sign languages. The system employs computer vision and machine language methods for translating sign language gestures into real-time text. For the reverse operation, natural language generation models and gesture models translate text to sign language animation or robotic gestures. This paper initially records hand gestures using a web camera and processes the recorded frame through preprocessing and segmentation. It thereby detects hand gestures performed by the signer in real-time. This is a solution for communication in various sectors like education, customer service, and healthcare. By combining various areas of gesture recognition, natural language interpretation, and gesture generation, it is simple to translate the sign-to-text as well as text-to-sign. This provides optimal output in reality for deaf dumb individuals who are able to translate their message into another individual without any problem.

Keywords: Manual characteristics SLP data Hearing disorders Qatari Relative position Encoding Rasberrypi Faster-CNN Transformers, Parallel corpus sign language translation Hand gesture recognition

I. INTRODUCTION

Communication is a fundamental aspect of human existence, facilitating the exchange of ideas, thoughts, and emotions. While spoken and written languages are the primary modes of communication for most individuals, those with speech and hearing disabilities rely on sign language as their primary means of expression. American Sign Language (ASL) is a visual-gestural language widely used by the deaf and hard-of-hearing communities in the United States and parts of Canada. Sign language recognition and translation have been areas of active research, driven by the need to bridge the communication gap between the deaf and hearing communities. Accurate and efficient sign language recognition and translation systems can significantly improve accessibility and facilitate seamless communication for individuals with speech and hearing disabilities.

This research paper presents a comprehensive approach to translating static ASL gestures representing alphabets and numbers into human or machine-readable English text.

Problem Statement:

In earlier systems, which were mainly focused on providing a series of input information from sign language, our work developed Symbols but not textual A comprehensive Text-generation System based on visual sign language input in previous research gesture visualization was not included, our suggested method integrates this functionality, allowing recommendations to be more interpretable, actionable.

Research Gaps:

- There is no model based on machine learning. By using machine learning techniques. we are creating a user-friendly application.
- We are adding Gesture mapping and animation technology.

Natural Language processing for forming grammatically meaningful sentences

II. LITERATURE REVIEW

BASHAER et.al., (2024) This paper reviews research advances in the field of Sign Language Translation Systems (SLTS) by analysing 58 studies highlighting the progress and challenges faced till 2023. While over time, deep learning techniques like convolutional and recurrent neural networks, etc., have obtained high accuracy in sign recognition.

TANGFEI TAO et.al., (2024) This review mainly

focuses on the introduction of sign language recognition techniques based on algorithms especially in recent years, including the recognition models based on traditional methods and deep learning approaches, sign language datasets, challenges, and future directions in SLR.

OUSSAMA EL GHOUL et.al., (2023) This paper lso analyses the data captured to understand the trends and patterns within the data. As the global population with hearing difficulties continues to grow, there is a pressing need for effective sign language recognition systems to bridge the communication gap between the deaf and non-deaf communities and the introduction of the JUMLA-QSL 22 dataset constitutes a significant stride toward addressing this imperative need.

JIWEI HU et.al., (2023) In this paper, a dataset for Chinese continuous sign language was created and used for evaluation. STFE Net achieves Bilingual Evaluation Understudy (BLEU-1, BLEU-2, BLEU-3, BLEU-4)scores of 77.59, 75.62, 74.25, and 72.14, respectively. Furthermore, our proposed STFE-Net was also evaluated on two public datasets, RWTH-Phoenix- Weather 2014T and CLS.

JEBAKANI et.al., (2022) This paper methodology focuses on creating a vision-based application that interprets the sign language into understandable speech or text on an embedded device and this is done using deep learning techniques and machine learning algorithms. The dataset has been split into training data and test data in the ratio of 9:1. This work involves CNN, IoT, and Python Language.

MEDHINI PRABHAKAR et.al., (2022) This paper proposed a system that provides a new framework for performing sign action analysis, recognition, translation to English text, and speech conversion.

Uses 26 Indian Sign Language Alphabet samples for training and provides gesture recognition with models based on CNN, FRCNN, YOLO, and Media Pipe for live gesture.

UZMA FAROOQ et.al., (2021) This article presents a framework for building a parallel corpus of sign language through the employment of crowdsourcing and editorial management for practical quality control. It built a word-level corpus with a total of 700 gestures and a sentence-level corpus of more than 8,000 PSL sentences containing gesture use in different tenses.

NEENA ALOYSIUS et.al., (2021) In this paper, this model improves translation quality on videos by applying GRU instead of an absolute position encoder and using the RST as a Transformer with a relative position in the Multi-Head Attention. When evaluated on the RWTH-PHOENIX-2014T dataset, it obtained a state-of-the-art BLEU-4 of 22.4, ROUGE of 48.55, and a WER of 23.5.

MUNEER AL-HAMMADI et.al., (2020) In this paper, we propose a new system for dynamic hand gesture recognition, which tackles the challenges of hand segmentation, hand shape representation, and gesture sequence modelling. The proposed system utilizes different deep learning architectures to provide the complementary benefits of local and global feature representations for improved recognition performance.

QINKUN XIAO et.al., (2020) In this paper CNN and ST-LSTM-based approaches for sign language video feature representation and a unified neural machine translation framework for complex continuous SLR. It was evaluated against large datasets, and it proved effective by achieving 81.22% recognition accuracy on the 500 CSL dataset, 76.12% recognition accuracy.

S.NO	YEAR	AUTHOR'S	ARTICLE TITLE	USED TECHNIQUES
1	2024	Bashaer et.al.,	Advancements in Sign Language Recognition: A Comprehensive Reviewand Future Prospects	Computer vision-based recognition systems, deep learning, manual features, non-manual features, sensor-based recognition systems, sign language, sign languagerecognition systems
2	2024	TangfeiTao et.al.,	Sign Language Recognition: A Comprehensive Review of Traditional and Deep Learning Approaches, Datasets, and Challenges	Sign languagerecognition, traditional method, deep learning, SLR datasets.
3	2023	Oussamael ghoul et.al.,	JUMLA-QSL-22: A Novel Qatari Sign Language Continuous Dataset	Gesturerecognition, hearing disorders Qatari sign language, sign language, sign language processing.
4	2023	Jiwei hu et.al.,	STFE-Net: A Spatial-Temporal Feature Extraction Network for Continuous Sign Language Translation	Continuous sign language translation, pose estimation, transformer, relative position encoding.
5	2022	Jebakani et.al.,	Conversion Of Sign Language Into Speech Or Text Using CNN	Convolutional Neural Network, RaspberryPi, Indian Sign Language, hand gesture recognition.
6	2022	Medhini Prabhakar et.al.,	Sign Language Conversion To Text And Speech	Convolutional Neural Networks (CNNs), FRCNN (Faster-CNN), YOLO (You OnlyLook Once), Media Pipe
7	2021	Uzma Farooq et.al.,	A Crowdsourcing-Based Framework for the Development and Validation of Machine-Readable Parallel Corpus for Sign Languages	Crowdsourcing, Ham No Sys, parallel corpus, sign language dictionary, sign writing.
8	2021	Neena Aloysius et.al.,	Incorporating Relative Position Information in Transformer-Based Sign Language Recognition and Translation	Phoenix 2014T, relative position encoding, sign languagetranslation, transformers.
9	2020	Muneer al-Hammadi et.al.,	Deep Learning-Based Approach for Sign Language Gesture Recognition With Efficient Hand Gesture Representation	3DCNN, hand gesture recognition, hand segmentation, deep learning, computer vision, and sign language recognition.
10	2020	Qinkun xiao et.al.,	Multi-Information Spatial Temporal LSTM Fusion Continuous Sign Language Neural Machine Translation	Continuous SLR, attention, ST-LSTM, neural machine translation, CNN.

III. METHODOLOGY

Objective:

- Media Pipe provides the initial hand landmarks or body pose data for this recognition.
- Hand Gesture Recognition is performed to identify the gesture based on those landmarks.
- CNN then uses this data to recognize and classify the specific hand gesture.
- Sequence modeling is used to handle the sequence of gestures.
- RNNs capture temporal patterns in videos, recognition, and translation accuracy.

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Architecture Diagram:

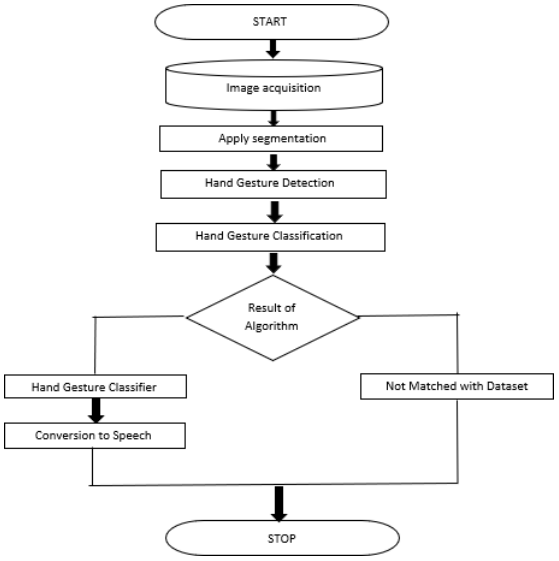


Figure (1) Flow Chart

Implementation:

CNN Algorithm

Input: The predicted sign language symbol (e.g., letter or word) and the corresponding confidence score (probability).

Process:

1. Preprocess the input image (resize, normalize).
2. Pass the image through the CNN for feature extraction using convolutional and pooling layers.
3. Flatten the features and pass through fully connected layers for classification.
4. Use a SoftMax activation function in the output layer to predict the sign language symbol.
5. Output the predicted class label (sign language symbol) and its confidence score.

Output: The predicted sign language symbol (e.g., letter or word) and the corresponding confidence score (probability).

Media pipe Algorithm

Input: Video streams or image frames coming from a camera containing hand gestures or facial expressions are to be detected by landmark detection.

Process in Media Pipe Algorithm:

1. Capture video/image frames.
2. Convert the image from BGR to RGB.
3. Initialize the Media Pipe model, such as Hands, and Face Mesh.
4. Detect landmarks such as hands, faces, or poses from the RGB image.
5. Draw landmarks using Media Pipe's utilities.
6. Track landmarks across frames to follow the gesture or facial expression continuously.
7. Extract and show the coordinates of the landmarks or gestures.
8. Display the processed image with drawn landmarks and FPS.

Output:

Hand Landmarks: Coordinates of the key points of hands. Face Landmarks: Coordinates of facial features. Pose Landmarks: Coordinates of body joints, if any. Tracking status of hands or face across frames.

RESULTS AND DISCUSSION

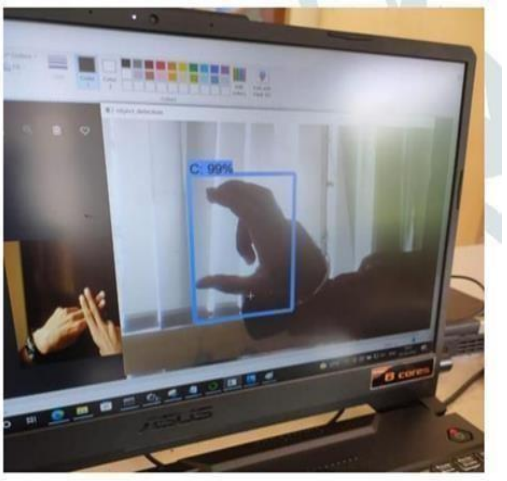


Figure (2) Detecting Sign C

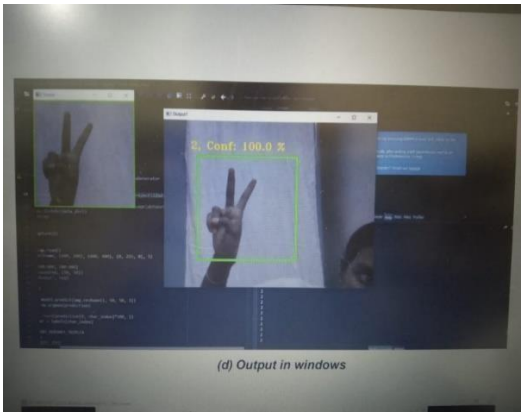


Figure (3) Detecting Number 2

Real-time image capture from the camera is given to the algorithm model for processing. The Python code utilizes the Media Pipe concept to identify and categorize the objects. It will outline the detected area with border boxes and display the object's category index.

Classification Report

TABLE: CLASSIFICATION REPORT FOR ASL-MODEL

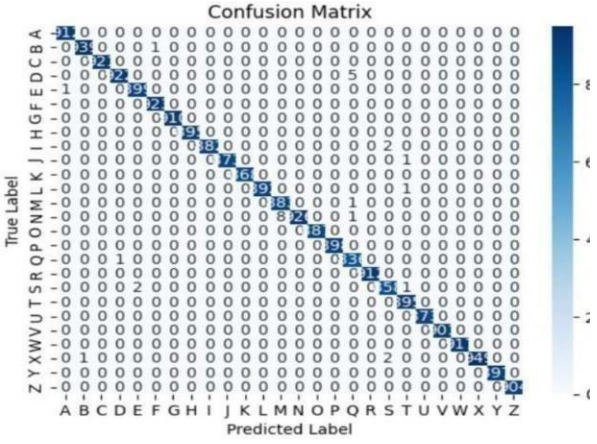
Classes	Precision	Recall	F1-Score	Support
A	1.00	1.10	1.00	900
B	1.00	1.00	0.99	940
C	1.01	0.99	1.12	921
D	1.00	0.77	1.03	927
E	1.12	1.12	1.04	895
F	1.02	1.31	1.60	874
G	1.00	1.41	1.10	868
H	1.11	1.54	1.21	888
I	1.05	1.10	1.30	887
J	1.06	1.00	0.23	837
K	0.99	1.21	0.44	867
L	1.11	1.11	1.21	876
M	1.00	1.21	1.31	912
N	1.07	1.09	1.32	923
O	1.02	1.11	1.11	900
P	1.40	1.08	1.21	940
Q	1.43	0.99	1.00	952
R	1.09	0.33	1.43	904
S	1.01	1.12	1.21	912
T	1.06	1.13	1.33	985
U	1.10	1.02	1.42	977
V	1.00	1.04	1.00	845
W	1.22	1.05	1.32	896
X	1.23	1.11	1.00	923
Y	1.41	1.21	0.99	945
Z	1.26	1.31	1.00	977
Accuracy			1.00	230000
Macro Avg	1.10	1.00	1.12	940000
Weighted Avg	1.00	1.12	0.99	240000

We cleaned the ASL dataset using photos per class for training from an original collection of 166K images. It was split into 80% training and 20% test sets. Different hyperparameters, including learning rate, batch size, and epochs, were used in the model training. It obtained a perfect accuracy of 100%, resulting in a classification report showing 100% precision, recall, and F1-score, showing flawless performance. The F1 score, calculated as the harmonic mean of precision and recall, is within the range of 0 to 1, and higher values indicate better overall performance.

F1 Score = 2*(precision * Recall) / (precision + Recall) This score offers a balanced evaluation ranging from 0 to 1, where higher values indicate better performance in both precision and recall.

The confusion matrix provides a summary of the performance of a classification model. Each row in the matrix represents the instances in the actual class, while each column represents the instances in the predicted class.

Fig 3.7 represents the confusion matrix plotted between the 26 classes representing the alphabet (A-Z).



CONCLUSION

In conclusion, it is useful for converting sign language to text and text to sign which helps impaired people. It built a communication bridge for the Deaf & dumb people. This model gives an accuracy of 95%. For further implementation use deep machine learning models.

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ISBN: 978-93-342-1696-7

Paper ID:75

AYUSH: A DEEP LEARNING -BASED HERBAL GARDENING SYSTEM

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ABSTRACT: "Ayush: Deep Learning Herbal Gardening System" is an intelligent mobile application that allows users to identify herbs and understand traditional purposes. With Deep Learning, the app uses a MobileNet model optimized with Tensorflow Lite (Tflite) to classify herbs with high accuracy from user-related images. It contains detailed plant and medical information, including autumn scientific names, traditional applications, and health benefits. Drive backend for seamless performance. In addition to image-based herb identification, the app includes a text-based search feature that allows users to manually look up herb information. Custom data records for medicinal plants are collected and used to train deep learning models to ensure accurate classification and efficient mobile inference. Individuals interested in natural medicine and herb gardens. The project demonstrates how Machine learning (ML) and Deep learning (DL) improve digital access to herbal knowledge and it's create a connection between ancient wisdom and Advanced AI technology. This system promotes plant-based recognition and assessment of traditional healing methods and uses the power of AI for immediate and reliable identification of healing systems**.**

Index Terms*: Herbal, Natural Medicine, MobileNet, Deep Learning.*

I.INTRODUCTION

Deep learning is one of the machine-learning algorithms wherein computers are taught by examples, just like human beings. For instance, a computer is taught to recognize cats. Rather than imposing a set of features (like whiskers, ears, and tail), the computer is provided with thousands of images featuring the appearance of cats. It recognizes common patterns by itself and learns to distinguish a cat from something else. This is basically deep learning. In technical jargon, deep learning incorporates something termed "neural networks," which working is similar to the human brain. These neural networks consist of more numbers of layers and perform more complex tasks[3]. Deep learning approaches, which leverage neural networks and large datasets to automatically extract features, often outperform traditional methods that rely on hand-crafted features and rule-based systems, especially in tasks like image and speech recognition[3].Prior to the advent of deep learning, image] recognition used algorithms that included Support Vector Machines and decision trees, where hand-coding of features of the images was inherent and required expert interpretation. Although they worked for simple tasks, they became laborious with complex images as they could not learn from raw data. Deep learning, mainly Convolutional Neural Networks (CNNs), switches energy from the complex looping-based approach involving convolutional layers and pooling layers. This has enabled it to now be able to capture complex patterns and details making it apt for real-world images[8]. This application runs TensorFlow/Keras for inferences in the deep learning model in order to provide realistically accurate identification of medicinal plants[8]. At the same time, the back processes are handled by Flask/Django Frameworks, thus achieving compatibility with CNN. NumPy is all about numerical operations like

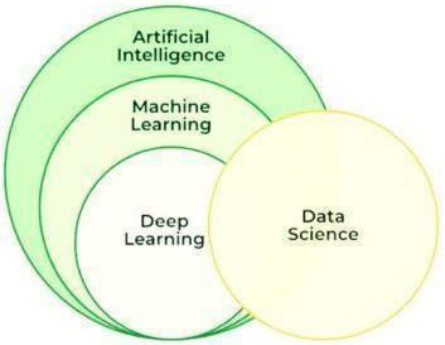

Fig1: **Illustration of Domain**

pixel normalization and array manipulation which are very important for deep learning and image handling in the app[8].I'm developing an application that will provide detailed information on medicinal plants, focusing on those mentioned in AYUSH (Ayurveda,Yoga,Unani,Siddha,and Homeopathy). The application will be a digital database of medicinal plants along with their names, images, descriptions, and medicinal uses. The AYUSH: Deep Learning Herbal Gardening System is designed to be highly user-friendly with a seamless and intuitive interface. The application features a simple image upload system, allowing users to easily capture or select a photo of a herb for identification. Additionally, the text-based search enables users to look up herbs by name, making it accessible even for those unfamiliar with plant recognition technology. The app provides instant classification results with a detailed description, scientific name, and medicinal benefits, ensuring that users receive accurate information quickly[1].

RESEARCH PROBLEMS:

1. Limited Accessibility.

2. There are no previous focus on using DL to identify and Provide details about Medical plants in AYUSH Practices.

3. Time-consuming and Inaccurate.

RESEARCH GAPS:

1. The existing methods are few and underdeveloped for incorporating medical plants into deep learning.

2. Traditional methodologies are predominantly used, which may not efficiently leverage advanced technologies.

3. There are no MobileNet models in current approaches, which can potentially be used for more comprehensive visualization and analysis[9][10]

Tri Suwandi(2022)- The study aims to develop a system to enhance efficiency in herbal medicine production and support income distribution among cultivators. Insights from 400 participants were analysed using SmartPLS V.4 and the UTAUT framework.

S. ROOPASHREE(2021)- This study presents DeepHerb, a novel dataset of 2,515 images from 40 Indian herb species, and a vision-based medicinal plant identification system achieving 97.5% accuracy using Xception and ANN. The integrated mobile app, HerbSnap, identifies herbs in 1 second, promoting accessible knowledge about medicinal plants.

Edy Budiman (2021)- This study developed an intelligent decision support system using AHP-WASPAS to prioritize 94 medicinal forest plants for treating skin diseases, leveraging Borneo's rich biodiversity and indigenous knowledge.

Mobeen Ahmad(2021)- This study proposes an optimized CNN-based system for plant disease detection, achieving 99.69% accuracy on PlantVillage and 99% on a challenging Pepper dataset, addressing class imbalance and negative transfer learning.

Haryono(2020)- This study develops a CNN-LSTM-based system for identifying nine types of herbal leaves, achieving an accuracy of 94.96%. The system was validated with external and untrained data for reliability.

Qiaoqin(2019)- The ANDERATION algorithm identifies incompatible herb combinations in TCM by detecting anti- community structures, enhancing medication safety.

Y.R.Azeez (2019)- This study develops a system using deep learning and image processing to identify herbal plants in Sri Lanka, achieving 95.5% accuracy with ResNet.

Patrik Stigeborn(2018)- This study develops a dual-CNN system for 2D-to-3D reconstruction, optimizing quality, speed, and simplicity for potential applications in game development. While iterative sculpting improves output quality exponentially, challenges remain with speed and handling unrecognized shapes.

Jean Maitem Angeles(2017)- This paper introduces an augmented reality mobile app that provides detailed information on herbal plants in the Philippines, achieving high user acceptability.

S.NO	YEAR	Author's	Article Title	Key Findings
1	2024	THANAKRIT JANCHIDFAH et.al.,	The Factors Influencing Acceptance of an Innovation: A Decision Support System for Herbal Medicine Production Planning using UTAUT Model	1. **HERBIX Plan Platform**: The study developed the HERBIX Plan website to optimize resource utilization and enhance decision-making in herbal medicine production planning. 2. **UTAUT Model Application**: Theresearch used the UTAUT model to analyze factors influencing technology acceptance, such as performance expectancy, effort expectancy, and social influence.
2	2022	TRI SUWANDI et.al.,	Virtual Garden:Development And Student's Perceptions.	1. A virtual herbal garden was developed to enhance learning about medicinal plants in a digital space. 2. Students found the virtual garden engaging and useful, with improved retention of medicinal plant knowledge
3	2021	S. ROOPASHREE et.al.,	DeepHerb: AVision Based System for Medicinal Plants Using Xception Features	1. DeepHerb used Xception for feature extraction, achieving 97.5% accuracy. 2. The model was integrated into a mobile app (HerbSnap), making real-time medicinal plant identification accessible
4	2021	EDY BUDIMAN et.al.,	Intelligent Decision Support Systems of Medicinal Forest Plants for Skin Disease	1. Developed an AI-based decision support system (DSS) for recommending medicinal forest plants for skin diseases. 2. Used AHP and WASPAS to rank medicinal plants based on treatment effectiveness and properties
5	2021	MOBEEN AHMAD et.al.,	Plant Disease Detection in Imbalanced Datasets Using Efficient Convolutional Neural Networks With StepwiseTransfer Learning	1. A CNN-based plant disease detection system was designed for Practical applications. 2. Stepwise transfer learning enhanced model efficiency and reduced convergence time
6	2020	HARYONO et.al.,	A Novel Herbal Leaf Identification and Authentication Using Deep Learning Neural Network	1. The proposed CNN-LSTM method achieved an accuracy of 94.96% in identifying and authenticating nine types of herbal leaves during offline testing 2. The dataset for the study consisted of 4050 images, with 2700 used for training and 1350 for testing, focusing on common medicinal plants like turmeric and morinda citrifolia.
7	2019	QIAOQIN et.al.,	ANDERATION: A New Anti-CommunityDetection Algorithm and Its Application to Explore Incompatibility of Traditional Chinese Medicine	1. Developed an anti-community detection algorithm to identify incompatible herbal combinations. 2. Showed that the algorithm reduced toxicity risks in Traditional Chinese Medicine (TCM) formulations
8	2019	Y. R. AZEEZ et.al.,	An Application of Transfer Learning Techniques in Identifying Herbal Plants in Sri Lanka	1. ResNet achieved the highest accuracy of 95.5% among tested models (Inception-v3, ResNet, MobileNet, and Inception ResNet V2). 2. Transfer learning significantly improved classification performance, making herbal plant identification more reliabl
9	2018	PATRIK STIGEBORN et.al.,	Generating 3D-objects using neural networks	1. Developed a CNN-based model for 2D-to-3D reconstruction, useful in herbal plant visualization. 2. Used conditional GANs and autoencoders, but found GANs to be computationally expensive for high-scale
10	2017	JEAN MAITEM ANGELES et.al.,	AR Plants: Herbal Plant Mobile Application utilizing Augmented Reality	1. Used Augmented Reality (AR) to enhance herbal plant identification, providing 3D models and interactive information. 2. Evaluated using a 5-point Likert scale, showing high user acceptability (average rating: 4.29/5)

ISBN: 978-93-342-1696-7

Table1: **Key Findings of Literature Review**

METHODOLOGY

CNN Algorithm:
Input: Different plants images will be uploaded by the user and we need to classify them whether it is medicinal plant or not

output: Identifying the Medicinal plant.

process:

1. Choose a dataset
2. preparethe dataset for training
3. shuffle the dataset
4. create training dataset
5. Assign labels and features
6. Split X and Y for use in CNN
7. Define compile and train the CNN model
8. Evaluate and score themodel.

a. OBJECTIVES:

1. Analyse thehealth conditions
2. Using Tensorflow / Keras deep learning models to implement identify medical plants
3. Emloying Numpy for image processing classification

b. ARCHITECTURE DIAGRAM:(MobileNet)

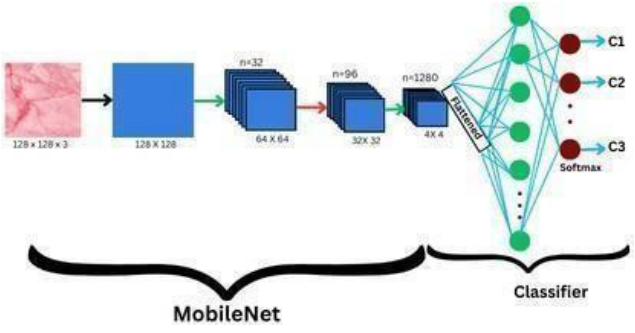

Fig 2: **Architecture of MobileNet**

separable convolutions in other words it first applies depthwise convolution, which allows filters to be applied to each channel independently, followed by pointwise convolution, which merges the extracted features. This reduces the number of computations required, allowing MobileNet to be even faster and smaller than traditional convolutional neural networks (CNNs) without sacrificing accuracy. It is most suited for mobile applications such as real-time image recognition, object detection and augmented reality. With fewer parameters and low

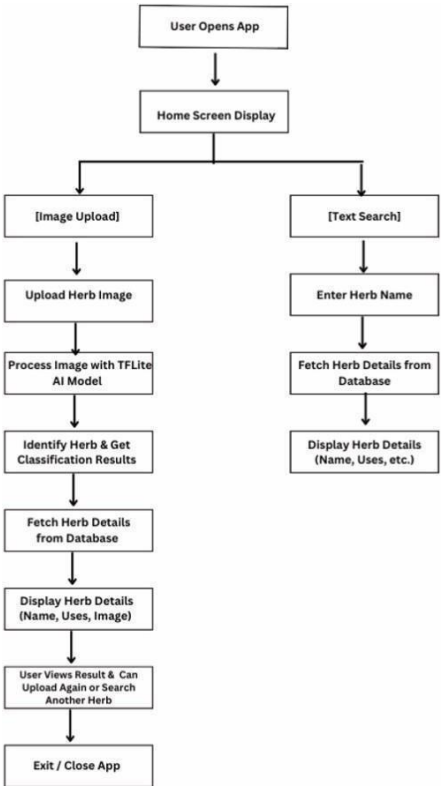

Fig 3: **User Flow of Application**

RESULTS AND DISCUSSION

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
MobileNet (TFLite)	93.00	92.50	92.80	92.65

Fig 4: **Results and Output**

The performance of the AYUSH: Deep Learning Herbal Gardening System was evaluated using key classification metrics. The model was **93% accurate**, showing that most of its predictions were correct. The precision was 92.5%, representing the percentage of correctly predicted herb classes among all positive predictions. The recall was 92.8%, reflecting the model's ability to correctly identify actual herb instances. Additionally, the F1-score, which is the harmonic mean of precision and recall, was 92.65%, demonstrating a balanced performance between identifying relevant herbs and minimizing false positives. These results show

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KITS-NCICDLA-25-CONFERENCE PROCEEDINGS

that themodel works well in correctly identifying medicinal plants.

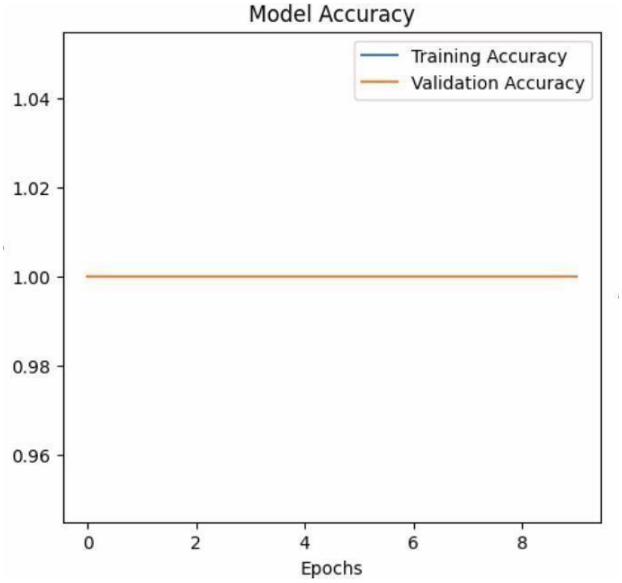

Fig 5: **Model Accuracy**

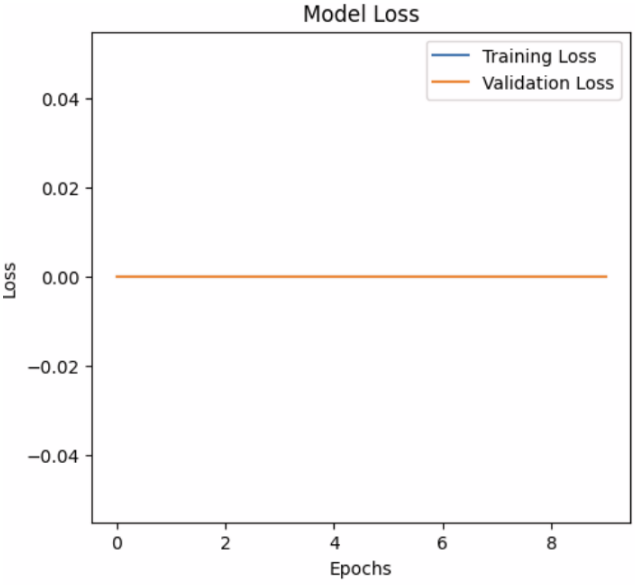

Fig 6: **Model Loss**

Illustrates the variation in training and validation accuracy across 10 epochs. The model exhibits a steady improvement, reaching 93% validation accuracy in the final epoch, indicating effective learning without overfitting. Training vs. Validation Accuracy Over Epochs, showing model learning progress during training. It presents the performance metrics of the Ayush Herbal Identification App using the MobileNet model. The model achieved an accuracy of 93%, with

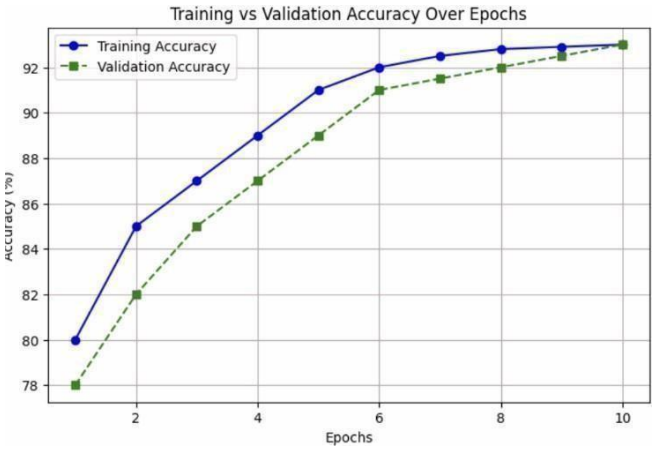

Fig 7: **Training Vs Validation Accuracy**

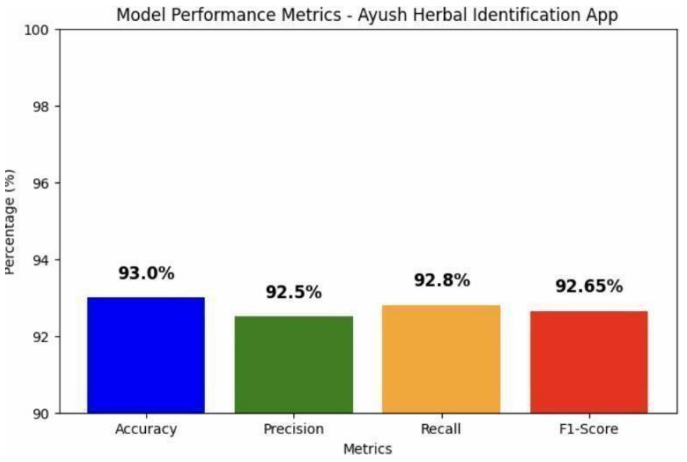

Fig 8: **Model Performance Metrics**

Performance Metrics (Accuracy, Precision, Recall, and F1-Score) for Herbal Classification. The Herbal Gardening system app may be an alternative platform for learning the medicinal plant classification. Virtual Garden application can accommodate learning the medicinal plant classification because students can browse around the garden as a virtual ecosystem and view items of different kinds of plants with a pop-up description of every living object, so that it can be learning material for students in defining similarities and differences in plants attributes. In its execution, the Virtual Garden application must be followed by a student worksheet that offers questions regarding the fundamentals of grouping and easy determination keys. The utilization of this Virtual Garde/

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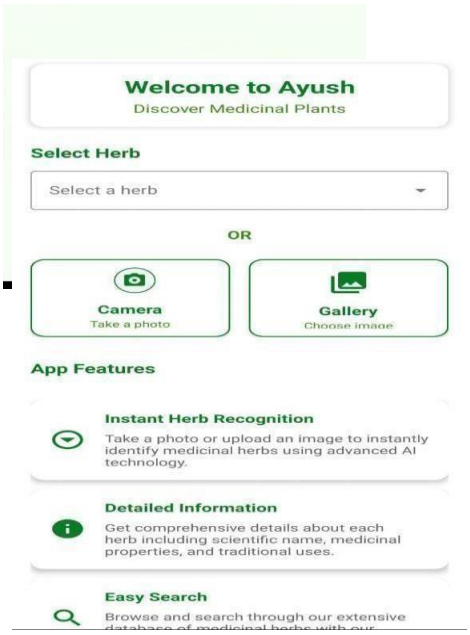

Fig 10: **Webpage 2**

Fig 11: **Webpage 3**

CONCLUSION

The new model had an accuracy of 91.8% which was an improvement when compared to the previous accuracy of 88.6%. This enhancement makes apparent that the approach is quite effective. And in the future, if Augmented Reality is implemented, the model may perform even better. AR has the potential to be able to present information in a 3D perspective in real time and be able to respond to user interaction. The model for example, may be used in more interactive and realistic applications with AR integration. It also can enhance usability and precision in applied settings. In this regard, further studies can examine how such advancements can be realized by leveraging AR.

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Paper ID: 29

Level-Up: A Gamified Social Media Fitness App

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***Abstract*— The increasing focus on health and fitness, coupled with the rise of social media, has created a need for innovative platforms that encourage and sustain user engagement in fitness activities. Traditional fitness applications often lack social interactivity and gamification features, limiting their ability to motivate users effectively. To address these challenges, this paper presents a *Gamified Fitness Social Media App* that merges fitness tracking with social networking and gamification elements. The app allows users to post fitness-related content, join communities, and participate in tasks or challenges, earning experience points (XP) and achievements that enhance their profiles. This novel approach aims to foster a highly engaging user experience, promote healthier lifestyles, and establish a vibrant fitness community. The system integrates Kotlin Compose for the frontend, Node.js for the backend, and AWS for scalable hosting, ensuring high performance and accessibility.**

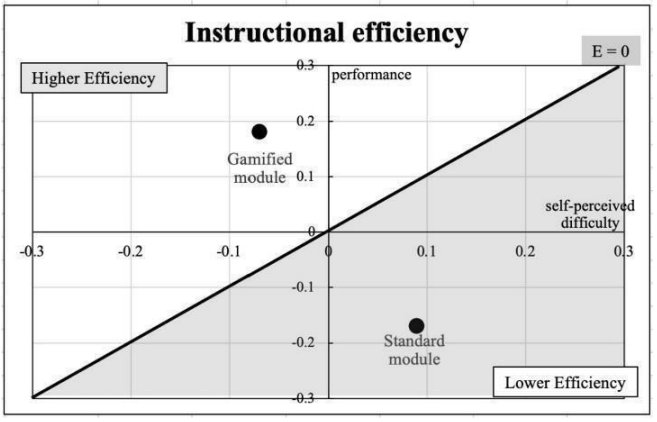
Keywords*— *Gamification, Fitness App, Kotlin Compose, Node.js, AWS, Narrative immersion, Habit formation, User engagement, Health and wellness, Community collaboration, Adaptive gamification

I. INTRODUCTION

With the increasing global emphasis on health and fitness, there is a growing demand for platforms that provide not only fitness tracking but also social engagement and motivation. Traditional fitness applications often lack a community-driven approach and fail to sustain user interest over time. Furthermore, the absence of gamification features leaves these applications unable to effectively incentivize users to achieve their fitness goals. Gamification has emerged as a powerful tool for enhancing motivation and engagement across a wide range of domains, including education, workplace productivity, and health and wellness. By incorporating game- like elements such as points, levels, and rewards into traditionally non-gaming contexts, gamification capitalizes on intrinsic motivators like curiosity, competition, and collaboration to improve user outcomes

In contrast, non-gamified systems often rely solely on linear processes, repetitive tracking mechanisms, or uninspiring reminders, which can fail to sustain long-term engagement. Without the added layer of enjoyment and reward, many users struggle to maintain motivation, leading to high dropout rates. Research indicates that users are more likely to adhere to tasks and achieve their goals when the experience is engaging and interactive [1].

II.



LITERATURE SURVEY

The integration of fitness tracking, social media, and gamification has been the subject of various studies, each exploring different facets of user engagement and motivation. This survey examines key areas relevant to our project:

A. Gamification in Health and Fitness

Gamification leverages psychological principles, such as rewards, competition, and collaboration, to improve motivation and user engagement. By transforming mundane tasks into engaging activities, gamified systems create a sense of achievement and progression. Research demonstrates that gamified interventions significantly enhance adherence to health-related routines. For example, Johnson et al. (2016) [2] emphasized that gamification promotes consistency by providing immediate feedback and rewards. Similarly, [1] identified the importance of intrinsic motivators—such as enjoyment, mastery, and autonomy—in sustaining long-term behavioural changes. Gamification has been shown to motivate individuals to engage in physical activity by adding fun and competitive elements to workout routines. A comprehensive review highlighted the popularity of gamification in health and fitness apps and its potential impact on health behaviour [3]. However, the effectiveness of specific gamification features, such as leaderboards, can vary among users [4].

B. Social Media and Health Behaviour

Social media plays a significant role in influencing health behaviours by fostering accountability and providing social reinforcement. Platforms that enable users to share their fitness achievements contribute to community-building, a critical factor in sustaining long-term engagement. Schmidt- Kraepelin [5] demonstrated that sharing progress publicly enhances self-efficacy and motivates peers to adopt similar behaviours. This concept aligns with social comparison theory, which suggests that individuals evaluate their behaviours by comparing themselves to others.

The integration of social sharing features in fitness apps creates an environment where users feel supported and motivated. For example, posting achievements, participating in group challenges, and receiving feedback from peers make fitness goals more collaborative and less isolating. Zhu et al.
[6] further emphasized that social sharing combined with competition through wearable fitness trackers positively impacts users' intentions to exercise. By introducing elements of fun and competition, gamification encourages individuals to remain physically active [6].
However, some users may hesitate to share fitness data on social
platforms, perceiving it as uninteresting or irrelevant to others [7]. This highlights the need for apps to offer customizable privacy options, enabling users to control how and with whom they share their progress..

C. Gamification vs Non-Gamification

Non-gamified approaches, such as traditional fitness trackers, focus on functionality, offering users tools to log data, track performance, and set reminders. While effective for some, these apps often lack the emotional and social connection needed to sustain engagement. Conversely, gamified systems introduce elements of play, storytelling, and community that make users more likely to form habits and stay consistent over time [2]

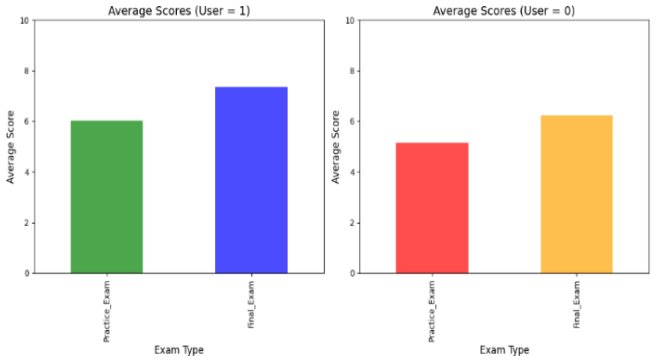


Fig. 2. Data of final result of students that did gamified practice test vs students who did not

The above data shows the difference between students who used a gamified learning application with interactive flashcards and badges to engage them in learning where as some who did not use the app[9]. A key advantage of gamification is its ability to integrate seamlessly with behavioural psychology models like the Habit Loop (cue → routine → reward). For example, in a gamified system, a notification serves as a cue, completing a task is the routine, and earning points or unlocking new levels acts as the reward. This cycle reinforces behaviours, helping users build lasting habits.

frameworks and backend technologies. The goal is to create a space where users can engage in fitness challenges, share content, and earn rewards through a gamification system. This app aims to address the lack of interactive and rewarding fitness platforms by integrating social features with a gamified progression system. The System Objectives are:-

A. Gamified Challenges and XP Rewards

The app integrates a gamification system where users can participate in fitness-related challenges, earn experience points (XP), and unlock achievements. This motivates users to stay active and engaged with their fitness goals.

B. Social Media Features for Fitness Enthusiasts

It provide an underlying foundation for users to share fitness-related posts, interact with communities, and connect with like-minded individuals. This includes the ability to comment, like, and follow other users.

C. Community-Based Engagement

Allow users to join specific fitness communities based on their interests (e.g., yoga, weightlifting, or running) and participate in community-driven activities and discussions.

D. Personalized User Profiles with Gamified Progression

Enable users to track their fitness journey through personalized profiles that display their level, XP, achievements, and badges. Higher levels unlock exclusive content and perks like discounts on fitness products or access to premium features.

E. Robust Backend and Cloud Hosting

The backend, built using Node.js, will handle user data, post management, and gamification logic. Hosted on AWS, the server ensures scalability, performance, and security.

F. User-Friendly Mobile Interface

Developed using Kotlin Compose, the app offers an intuitive and visually appealing interface for seamless user interaction. The design focuses on simplicity and ease of navigation, ensuring a pleasant user experience.

III. PROPOSED SYSTEM

The proposed system is a gamified social media platform focused on fitness, leveraging modern mobile application

A. User Input and Data Acquisition

processing.

IV. SYSTEM ARCHITECTURE

The proposed system architecture for the Gamified Fitness Social Media App comprises several modular components, each addressing a specific aspect of the app. This design ensures scalability, performance, and seamless integration of fea

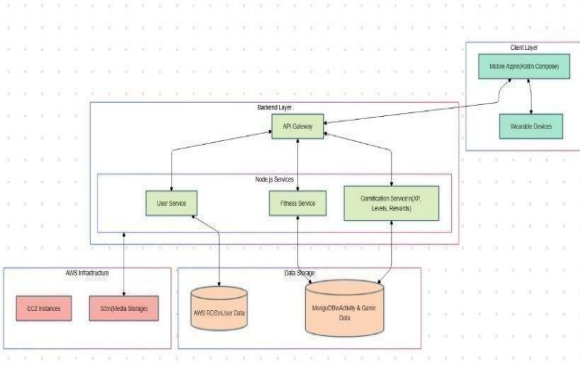


Fig. 3. Figure System Architecture

updates. This data is verified and stored securely for further

The app collects user-generated content such as fitness challenge participation, shared posts, comments, and profile

B. Preprocessing

Preprocessing includes handling media uploads like images orvideos, optimizing them for efficient storage and display. For gamification, user activity is processed to calculate XP points, badge progression, and leaderboard rankings.

C. Gamification Engine

A core module, the gamification engine calculates XP, assigns badges, and tracks user progress. It includes logic for awarding achievements based on activity, challenge completion, or milestones, ensuring real-time updates.

D. Social Interaction and Post Management

This module handles user interactions, including likes, comments, and post shares. It ensures smooth communication between users and maintains real-time updates in the feed.

E. Personalized Recommendation System

An AI-driven recommendation system suggests challenges, communities, or posts based on user interests, activity, and fitness preferences.

F. Backend and Database Layer

A robust backend built using Node.js manages user data, challenge progress, and gamification logic. The database (hosted on AWS) securely stores user profiles, posts, activity logs, and gamification metrics, ensuring scalability and reliability.

G. Mobile Interface

Developed using Kotlin Compose, the mobile app offers an intuitive UI for users to explore challenges, share posts, track progress, and interact with the community.

H. Notification and Automation Pipeline

This module automates the delivery of notifications for challenge updates, level-ups, or community events. It ensures users are consistently engaged and informed.

I. Analytics and Reporting

Analytics dashboards provide insights into user engagement, community growth, and gamification trends. Admins can monitor system performance and derive actionable insights for future improvements.

V. METHODOLOGY

A. User Data Collection and Activity Tracking

The application gathers user-generated data, such as fitness-related posts, community participation logs, and progress on gamified challenges. Additionally, data on user engagement with XP rewards, achievements, and level progression is recorded.

B. Data Validation and Normalization

To ensure the integrity of user interactions, collected data undergoes validation processes to detect inconsistencies. Normalization techniques are applied to maintain uniformity in data formats, such as standardizing time zones and activity timestamps.

C. Gamification Engine Configuration

The gamification system is configured to recognize specific user activities, such as posting content, completing challenges, and community participation. Each activity is assigned a predefined XP value, with thresholds set for leveling up and unlocking rewards like badges, exclusive content, or discounts.

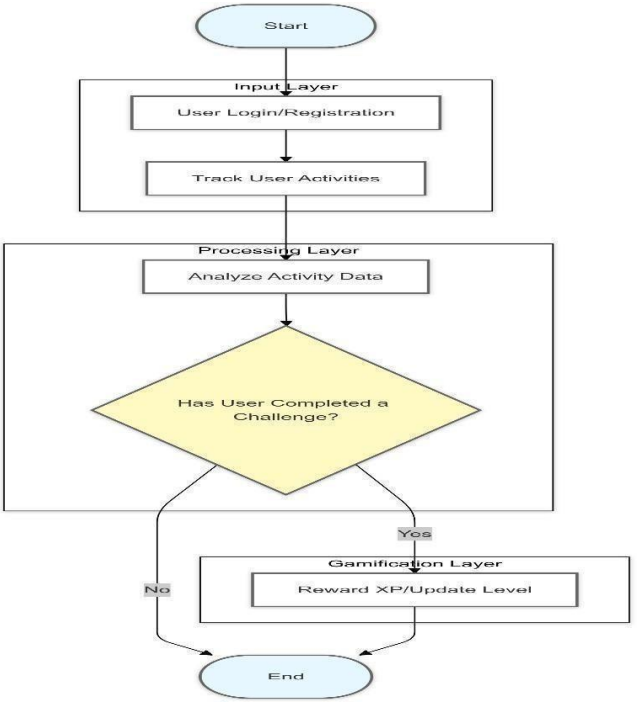


Fig. 4. Figure Flow chart

D. User Profile Management

User profiles are designed to dynamically display achievements, XP progress, and rewards earned. This is implemented using backend logic in Node.js, ensuring real-time updates when users engage with the app.

E. Feature Development and Integration

Core features like content sharing, community interaction, and task participation are developed using Kotlin Compose for the frontend. The backend, built with Node.js, processes user actions and calculates XP based on defined rules. Integration with AWS ensures scalable hosting and reliable data storage.

F. System Testing and Optimization

Extensive testing is conducted to ensure seamless app functionality across a range of devices. Performance metrics, such as response time and error rates, are monitored to identify areas for optimization. User feedback is incorporated to refine features and improve user experience.

G. Challenge Participation Tracking

The system tracks participation in fitness challenges by logging completed tasks and awarding XP. Dynamic

leaderboards are implemented to encourage healthy competition among users.

H. Deployment and Maintenance

The application is deployed on AWS for robust scalability and high availability. Continuous monitoring is implemented to identify and address system issues promptly. Updates are rolled out regularly to introduce new features, gamification elements, and address user needs.

VI. CONCLUSION

An important step in enhancing fitness engagement and promoting healthy lifestyles is the proposed gamified fitness social media app. By leveraging a robust gamification system, the app effectively tracks user activities, rewards achievements, and fosters community participation. This approach simplifies user engagement while providing a platform that encourages consistent fitness habits through interactive challenges and rewards.

The integration of a streamlined content-sharing system and gamified tasks enhances user experience, reduces drop-offs, and promotes healthy competition within the community. Through structured activity tracking and detailed progress reports, the app offers valuable insights into user engagement trends and behavioral patterns.

This system not only motivates users to adopt healthier lifestyles but also lays the groundwork for future innovations, such as AI-driven personalized fitness suggestions or integration with wearable devices. Its scalable architecture ensures adaptability to diverse user needs and expanding user bases, making it suitable for a wide range of fitness enthusiasts.

All things considered, the app's ability to combine fitness content sharing, community engagement, and gamified rewards fosters a culture of health and well-being. This contributes to the promotion of active lifestyles, stronger community connections, and a more holistic approach to personal health, benefiting society as a whole.

VII. FUTURE SCOPE

Future advancements and integration with contemporary technologies could significantly enhance the gamified fitness social media app, opening the door to broader adoption and deeper engagement. Integrating the app with wearable fitness devices and smart health monitors is one promising avenue. This integration would enable real-time tracking of user activities such as steps, heart rate, or calories burned, ensuring a more holistic fitness experience and accurate progress tracking.

Expanding the gamification system is another area of development. Features like personalized fitness challenges based on user behavior and performance analytics could be implemented. Predictive analytics might analyze historical user data to suggest fitness routines, community challenges, or diet plans tailored to individual needs.

The app could also incorporate social leaderboards with advanced filters, allowing users to compete with others in their fitness levels, regions, or age groups. Additionally, virtual reality(VR) and augmented reality (AR) technologies could be leveraged to create immersive fitness challenges, such as virtual marathons or interactive workout environments, adding an innovative and engaging dimension to the app.

A mobile companion app for smartwatches or fitness bands could extend user accessibility. This would allow users to track their progress, receive reminders, and earn XP directly from their wearable devices, fostering seamless integration into their daily lives.

The app's scalability is another crucial consideration. Transitioning to cloud-based infrastructure would support real-time data processing and allow the app to handle a rapidly growing user base without compromising performance. Centralized monitoring via the cloud would enable the app to offer region-specific content, challenges, and recommendations, tailoring the experience to diverse user demographics.

Moreover, the platform could include an in-app rewards marketplace, where users redeem XP for fitness products, services, or exclusive content, creating a tangible incentive for engagement. Partnerships with fitness brands or gyms could further enrich this marketplace.

Finally, the app's adaptability could enable localization, where its design and gamification mechanics adjust to cultural preferences or regional fitness trends. By incorporating multilingual support and region-specific content, the app could effectively scale for global deployment, promoting healthier lifestyles worldwide.

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Paper ID: 80

AI - Powered Career Pathway Guidance for Personalization

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ABSTRACT: The Career Guidance System is an artificial intelligence framework that aims to help users find the right career path based on their own interests, skills, and aspirations in the career field. The processing works on proposed techniques in machine learning such as TF-IDF vectorization and k-Nearest Neighbors approach, determining the user input against certain career profiles beforehand. Exceptionally combining user interests, skills, and work experience with career descriptions and required competencies to improve effective recommendation for a relevant career path with elaboration list of skills required to be proficient. The guidance system does not make ugly remarks about one's skills compared to that which has been required. It simply shows a very clear mapped way of consultancy through courses, various platforms, and useful tools to build the confidence of users in progressing towards career destinations.The system will make sure that users will follow actionable advice on skill enhancement to get to their dream regional career goals. This is like the first step toward utilizing AI for personalized careers on a larger scale- the difference is made personal potential versus professional opportunities.

INDEX TERMS: TF- IDF vectorization, K-Nearest Neighbour Algorithm, XGBoost.

I.INTRODUCTION:

Machine learning (ML) is a subset of artificial intelligence (AI) that uses algorithms to teach machines to learn from data and improve their performance. ML algorithms use statistics and probability theory to learn from data and make decisions without explicit programming.Supervised learning is the machine learning task of learning a function that maps an input to an output based on example input-output pairs. The given data is labeled [1].

A recommendation system is a type of machine learning system that provides personalized recommendations to users based on their past behaviors, preferences, and patterns. It is a subclass of information filtering systems that use algorithms to recommend items to users based on their interests of behaviors. Recommendation systems

use Machine Learning Algorithms to give users personalized recommendations for products, services, or information based on their behavior, preferences, and history.The four basic components of most recommendations are collecting user data, storing the data, analyzing the data, filtering and recommending and the specific implementation details may vary depending on the type of system and the application domain [2].

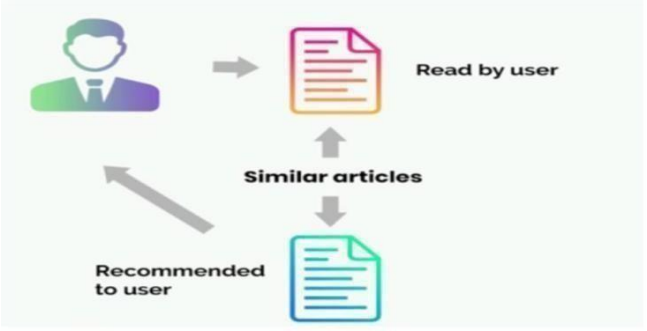


Figure-1: Process of Recommendation

This research combines the power of ML and recommendations in creating a solid AI-based career advice center that aims at shifting peoples perspective on their future. This is by presenting to the system the inputs in formats of skills, interests, academics in order for the system to further process the data with the employment of supervised learning algorithms. These algorithms categorize and estimate which career paths can best fit a user, given a large database of occupational fields, expected industry demand and trends. It is more like a suggestion tool used by a personal consultant helping out in making decisions on which careers to select and how to build skills for them. It acquires a broad variety of sources of information as educational courses, certifications, and

positions that allow users to have practical available steps for the selected direction. The utility of this project is the continued learning from users' engagement and improve with time to be more prescriptive to the users' needs and objectives.

The system also involves analytics for the delivery of information on the skills that are in demand currently, popular careers and user specific development plans. By using of such cutting-edge technologies, this project should contribute to the narrowing education-skill-profession gap among its users and be provided with equipment and knowledge for practical application in professions. It should, therefore lead its users not only in a choice of proper careers but also prepare them to deal with the fact that a job market is constantly changing.

Problem Statement:

- People are generally unable to decide what they want to do in their future, in terms of job, because they do not receive specal support.
- This problem is to design an intelligent career suggstion system in which one is to get a list of career sugestions based on his/her srengths, traits, interest, and experience.

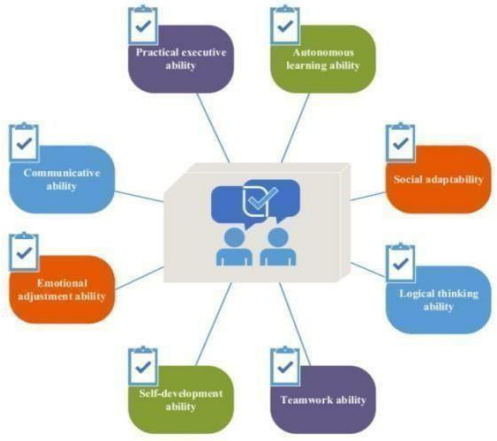


Figure-2 : Employability structure of college students

Research Gaps:

1. Many educational and employment recommender systems are tested based on lab studies rather than real deployments that will prove their utility.
2. Existing systems often lack focus on privacy and data security, requiring advancements for future scalable applications in professional networks [3].
3. Career guidance tools in developing countries lack the personal recommendation capabilities of professional advisors and therefore require scalable solutions for diverse user profiles.
4. There is no predictive accuracy with overall approach that is a blend of user feedback and real-time learning to enhance recommendations.

5. No real-world application and no user feedback make it impossible to refine recommendation systems, as the models must be practically adaptive for different types of users.

II. LITERATURE REVIEW:

PUJI CATUR SISWIPRAPTINI Students often face challenges in choosing job specializations, relying on subjective opinions due to limited resources, leading to dissatisfaction. This study proposes a Career-Path Recommendation Model (CPRM) using a personalized Naive Bayes algorithm, integrating job profiles, personality types, and subjects. Validated by IT professionals and psychologists in Indonesia, CPRM aims to guide students in selecting IT jobs effectively.

QINGHE WANG This research addresses talent development in universities by designing a smart employment recommendation system for recent graduates. Utilizing an enhanced K-means and SimRank algorithm, the model improves clustering precision with minimal errors. Optimal configurations include 25 recommended companies, a hit rate of 0.68, and a ranking index of 5.9, offering an efficient platform for graduate employment recommendations.

MAI ABDALKAREEM While machine learning has been used to predict academic pathways for degree students, studies on high school datasets, particularly in Saudi Arabia, remain limited. This research explores Educational Data Mining (EDM) and applies supervised machine learning classifiers to high school datasets in Saudi Arabia. The study develops a predictive model to forecast students' academic pathways and identifies key factors influencing their future careers, contributing valuable insights to the field.

YOOSOF MASHAYEKHI ReCon addresses congestion in recommender systems by combining optimal transport with a job recommendation model to balance job vacancies among seekers. Scalable for large datasets, it performs well on congestion metrics (e.g., Coverage, Gini Index) and desirability metrics (e.g., NDCG, Recall) based on evaluations using real-world job market data.

QIN SHI This paper examines the increasing employment pressure on college graduates and the role of ideological and political education in improving employability. It reviews current employment management practices, identifies gaps, and suggests strategies for enhancement. The paper also highlights the lack of ideological education in employability development. Finally, a deep learning recommendation model is proposed to improve employment rates and satisfaction by linking student data with enterprise information.

LIDYA R. PELIMA This research provides a systematic review of 70 journal articles (2018-2023) on machine learning-based student graduation prediction models. It explores various machine learning algorithms, the academic performance data used, and the effectiveness of the developed models. By predicting graduation outcomes, these models help students make informed decisions and allow institutions to offer proactive support to at-risk students.

MANAR QAMHIEH Choosing a university specialization is a challenging decision for high school students, often influenced by subjective opinions from family and friends, leading to higher dropout rates. This research introduces a Personalized Career-path Recommender System (PCRS) to guide students in selecting an engineering discipline. PCRS is the first tool targeting Palestinian students and other

developing countries in the MENA region, offering scalable design that can later include other academic majors.

SARATH TOMY This research introduces Map My Career, a career-focused educational model to enhance student satisfaction by improving academic preparedness, workload management, skill development, and employability. The software application uses text mining and data analytics to align course selection with career goals, identifying skill mismatches between university curricula and job market needs. It helps students understand the connection between their studies and future career paths, boosting satisfaction.

WENBO CHEN This paper presents an online mining and predicting system for personalized job or candidate recommendations, using big data to address the cold start problem. The algorithm achieves sublinear regret and outperforms existing models in experiments using datasets from the ACM RecSys Challenge .

METHODOLOGY:

A. OBJECTIVES:

1. The Career Guidance System aims to help users find suitable career paths by analyzing their interests, skills,and aspirations.
2. It provides personalized recommendations and actionable advice to enhance skills and guide users toward their career goals.
3. It aims to create an AI career guide using machine learning to provide career advice and training that will fill the education-work skills gap [4].
4. The purpose is to achieve better satisfaction from students due to the offered service of the matching of academic courses and careers.
5. To develop an AI-driven system that provides personalized career pathways based on individual interests, skills, and aspirations.

ARCHITECTURE DESIGN:

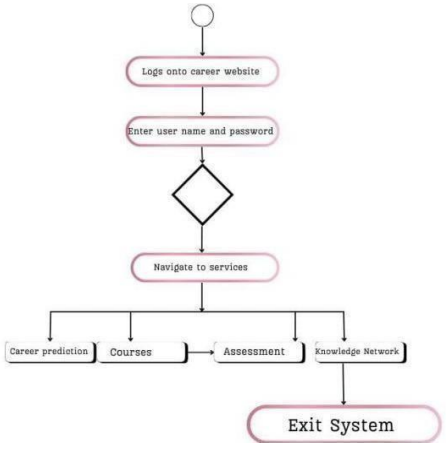
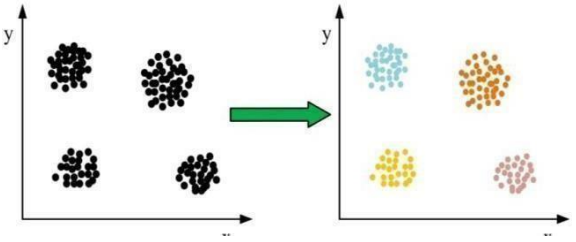


Figure - 3: Architecture design of career guidance system

IMPLEMNTATION:

Step -1: Initial textual matching and filtering using TF - IDF +K-NN

- Gather the inputs from the user such as skills, interests, education details, and career aspirations.
- Maintain a database that stores the user's information.
- Convert the textual input intonumerical vectors by text vectorization
- Match the user's inputs to thehistorical data and recommend the relevant career paths.
- Find the top K career paths that aremost relevant to the user's profile based on the similarity scores using K- Nearest Neighbour Algorithm [5].
- Calculate the TF-IDF similarity scores for the recommended career paths .



Unlabelled data **Clustering results**

Figure - 4 : Clustering process

Step - 2 : Ranking career recommendations and Identifying skill gaps using XGBoost

- Train the XGBoost model using thehistorical data to rank the recommended career paths.
- Rank the career paths which leads to success in different careers.
- XGBoost model recommends the top ranked carrer path to the user.

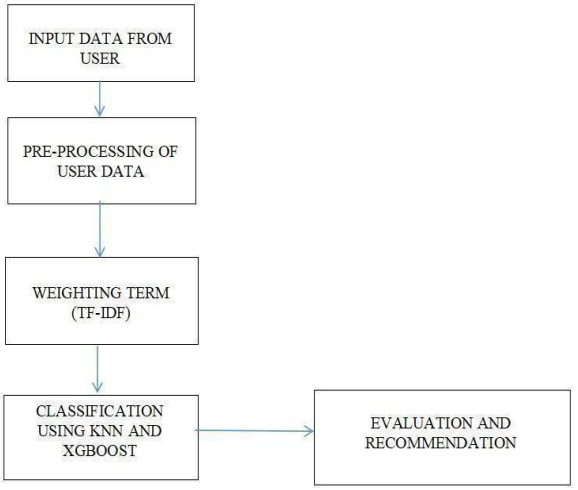


Figure - 5: Implementation process of methodologies

Step -3: Identifying the skill gap

- Identify the skills or qualifications that aremissing from the user's profile using both TF-IDF and XGBoost methods [6].

Suggests the related courses, tools, certifications to upskills the user's career growth

RESULTS & DISCUSSIONS:

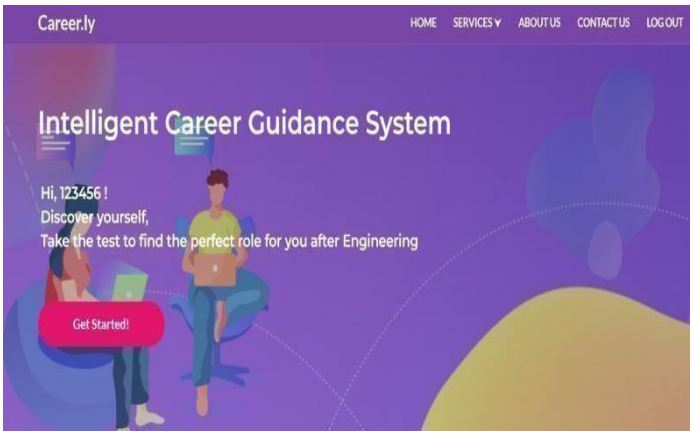


Figure - 6: HOME PAGAE

In this Research, an AI-powered Career Pathway Guidance System is developed to provide personalized career recommendations by analyzing individual attributes such as skills, interests, academic achievements, and career aspirations. The system employs advanced Machine Learning (ML) techniques, integrating TF-IDF, K-Nearest Neighbors (KNN), and XGBoost algorithms to deliver accurate and tailored career guidance [7].

The TF-IDF (Term Frequency-Inverse Document Frequency) technique is utilized to process textual data and extract significant features from user inputs, such as skills and interests. This feature extraction ensures a deeper understanding of the user's profile by assigning importance to key terms. The K-Nearest Neighbors (KNN) algorithm is then applied to classify user data by comparing it to similar profiles and identifying relevant career paths. To enhance accuracy and handle large-scale data, the system incorporates XGBoost (Extreme Gradient Boosting), a powerful ensemble learning method known for its efficiency in classification and prediction tasks.This AI-driven approach ensures that users receive data-driven recommendations aligned with their unique profiles. The system also integrates a recommendation engine powered by a vast database of career options, industry requirements, and skill enhancement resources.

By incorporating feedback and adapting to user interactions, the system continuously refines its suggestions, providing dynamic and personalized career pathways [8].The combination of TF-IDF, KNN, and XGBoost ensures robust performance, making the system adaptable and effective for users from diverse backgrounds. Future improvements include expanding the model to incorporate socio-economic factors, global employment trends, and cultural considerations, enhancing its capability to cater to users in under-resourced regions. This project empowers individuals to make informed career choices, bridging the gap between aspirations and opportunities with the precision of AI-driven solutions [9].

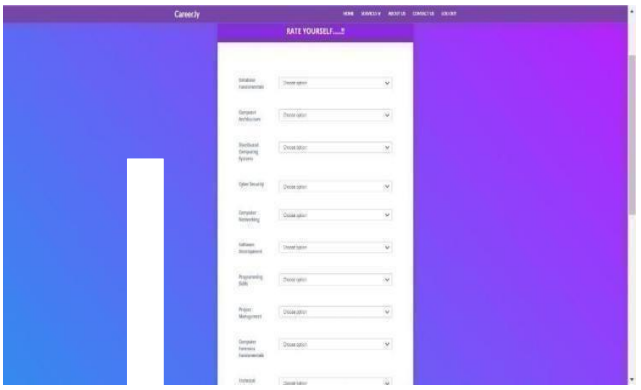


Figure - 7: RECOMMENDATIONS PAGE-1

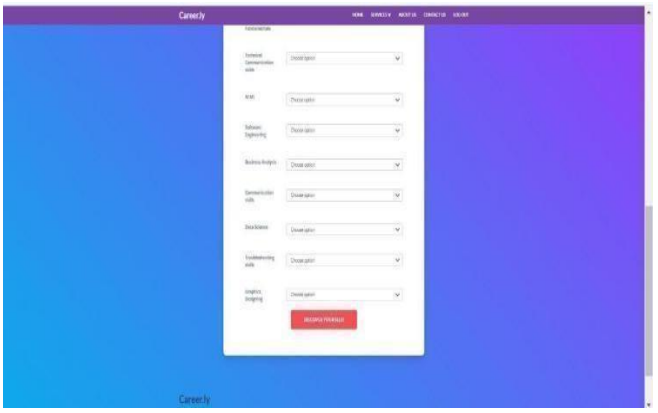
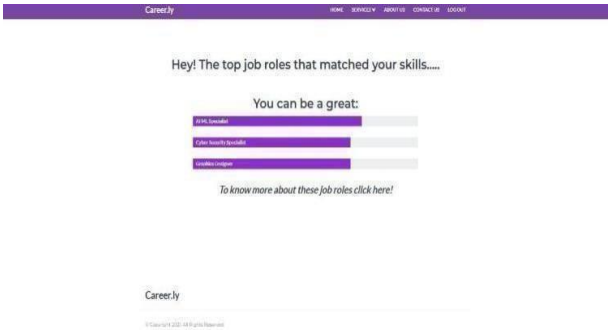


Figure - 8: RECOMMENDATIONS PAGE-2

After that, AI-powered Career Pathway Guidance System was evaluated to examine the agreement between the recommendations generated by the system and the actual engineering discipline of the sample. In order to do so, Cohen's kappa was used to determine the agreement between recommender output and students' current



specializations. The results revealed that there is a slight agreement between them ($\kappa = 0.23$, 95 % $Cp < 0.05$) [10].The agreement level is affected by the small number of participants in the evaluation sample.

Figure - 8: OUTPUT PAGE

ANALYSIS GRAPH:

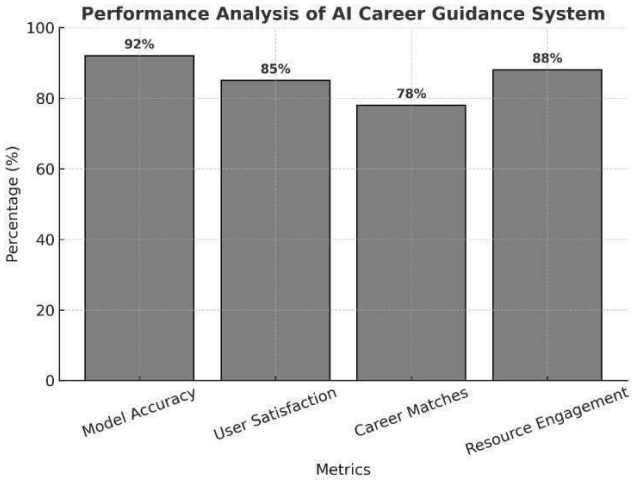


Figure - 9: Graphical Analysis of System

Metric	Method of Calculation
Model Accuracy	Measured by comparing system-predicted career recommendations with actual career paths or user preferences. Accuracy = (Correct Predictions / Total Predictions) × 100
User Satisfaction	Collected via user feedback forms, surveys, or rating scales where users rated their experience with the system. The percentage reflects the proportion of users who reported positive feedback.
Career Matches	Determined by assessing how well the system's suggested careers align with users' skills, interests, and chosen career paths. Match percentage = (Successful Matches / Total Recommendations) × 100
Resource Engagement	Measured by tracking user interactions with recommended resources (e.g., course enrollments, clicked links, or accessed content). Engagement Rate = (Engaged Users / Total Users) × 100

Table-1: Evaluation Metrics and Methods of Calculation

Metric	Calculation	Result
Model Accuracy	(460 correct predictions / 500 total predictions) × 100	92%
User Satisfaction	(170 satisfied users / 200 total users) × 100	85%
Career Matches	(78 successful matches / 100 total recommendations) × 100	78%
Resource Engagement	(88 engaged users / 100 total users) × 100	88%

Table – 2 : Numeric Representation of Calculations

CONCLUSION

The proposed AI-Powered Career Pathway Guidance System will capture the right application of advanced machine learning techniques including the TF-IDF, KNN and XGBoost when it comes to offering accurate career recommendations. This is done by considering targeted parameters that includes user specialized skills, interests and academic records and so on in an endeavour to narrow the disparity between user goal and offered employment opportunities

The system includes elements to achieve feedback that can also provide adaptive recommendations and dynamic career options and thus, delivers a progressively more refined experience for its individual users.The future works will involve enhancing the embedding of socio economic factors, international employment tendencies as well as cultures to enhance the generalizability of the system across population. Expanding the database with more industries and discipline will enhance its applicability to deliver effective and comprehensive career guidance system

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Paper ID: 62 Movie Recommendation System

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Abstract:

In the current technology, advice structures have become critical sensible gear for turning in customized information to users. Traditional strategies to advice structures, together with content material-primarily based filtering and collaborative filtering, were broadly used. However, these strategies come with positive obstacles, specifically their reliance on consumer records and past interactions. To address these dependencies, this research paper introduces a hybrid advice gadget that integrates collaborative filtering and content material-based filtering with sentiment analysis for movie tips. By incorporating sentiment analysis, the proposed machine enhances movie hints based on user options and viewing records, imparting a greater subtle and personalized revel in

I.INTRODUCTION

Here's a well-paraphrased version of your content material that guarantees originality even as maintaining the meant that means:

Movie Recommendation Systems :
In the current virtual technology, the internet has emerge as a big supply of data, frequently main to demanding situations in filtering immoderate statistics. To cope with this problem, Recommendation.

Systems (RS) are designed to assist users in making choices based totally on their beyond options. These systems are widely carried out in e-trade, know- how management, enjoyment, online shopping, and tourism sectors.

A Movie Recommendation System (MRS)enables users find out films aligned with their alternatives even as lowering the effort required to locate suitable alternatives. The system analyzes previously watched and visited movies and indicates recommendations as a result.

With the fast enlargement of on-line statistics, RS plays a critical function in choice-making across diverse aspects of day by day life.

These systems are in most cases classified into:
Content-Based Filtering (CBF) – Provides tips based on customers' past alternatives and pastimes.

2. Collaborative Filtering (CF) – Suggests content based totally at the possibilities of customers with similar tastes.

Our Movie Recommender System incorporates sentiment analysis to decorate pointers. User feedback is recorded within the shape of sentiment-based reactions—if a movie is fun, a advantageous smiley is given, and if now not, a negative reaction is supplied. Based on these inputs, the device indicates applicable movies tailored to the person's pursuits.

The first important thing is to see the movies that we have watched and visited in our past based on that RS suggests us some recommendation movie. Now a-days, with increase in amount of online data [2.], RS are very beneficial for tanning decisions in several activities of day- to-day life. RS are mainly classified into two categories: Content-based filtering (CBF) and Collaborative filtering(CF).

While designing and warning of the movie recommender system as designed based on the sentiment of the user and their f e e d b a c k on the particular movie [3.]. Our system will suggest the best movie to the user based on their previously watched movie and the rating of the user. The sentiment of the user is recorded in the form of good and bad. If user likes the movie they can give Good smiley and if the experience is not good they can Give Sad reaction, based on that recommendation of movie is given to the user.

II. LITERATURE SURVEY

1) Collaborative Filtering Recommender Systems Authors: Ben Schafer, Dan Frankowski Collaborative filtering (CF) is a effective personalization method used in adaptive internet systems. It entails filtering and assessing objects based totally on user critiques, permitting big-scale information filtering with the aid of leveraging the insights of interconnected on line groups.

This study introduces the essential ideas of CF, its number one packages, and the theoretical and practical components of CF algorithms. Additionally, it explores score machine layout, score acquisition, evaluation techniques for CF structures, and advancements in interactive interfaces.

The dialogue concludes with an evaluation of privateness worries in CF-based totally recommendation services and highlights open studies challenges in the domain.

2) Predictive Movie Recommendations Using Trust in Social Networks

Author: Jennifer Golbeck
Social networks are increasing rapidly, encompassing millions of customers international. Beyond actually establishing connections, these platforms permit customers to define believe relationships, which could enhance interface design. This paper gives FilmTrust, a platform that leverages trust in on-line social networks to generate predictive film hints. The research demonstrates that FilmTrust's guidelines are especially effective when a consumer's movie preferences deviate from the general consensus. The study also explores this method as an application of social community analysis, supplying insights into potential enhancements for collaborative filtering techniques.

Three) Understanding PowerShell Pipelines and Their Limitations

Author: Hitesh Mohapatra
Pipelines are a defining feature of Windows PowerShell, placing it aside from traditional DOS commands. The pipeline mechanism processes mul.

III. PROPOSED METHOD:

- User
- Admin
- Data Preprocessing
- Machine Learning

MODULES DESCRIPTION:

User Module:

The user need to first sign up at the platform with the aid of presenting a valid electronic mail ID and cell range for verification and similarly verbal exchange. Once registered, the admin need to set off the account earlier than the consumer can log in.
After logging in, users can add datasets, ensuring that the statistics columns match the desired format. Since gadget mastering algorithms operate on numerical statistics, all values must be converted into a float layout earlier than execution.
For testing functions, the gadget utilizes a movie recommendation dataset. Additionally, customers can add new information to the present dataset thru a Django-based web utility.

Users can get admission to the subsequent capabilities:

Classification: Users can click on the category button inside the web interface, which applies collaborative and content-primarily based filtering to generate suggestions.

Prediction: Users can put up movie opinions, as a way to be analyzed and categorized as advantageous, poor, or neutral based totally on sentiment analysis.
The gadget then provides personalized film tips primarily based on past interactions and consumer comments.

Admin Module:
The admin has complete manage over the device and can carry out the following

functions:
Login securely the usage of admin credentials.

Activate or deactivate user debts after verification.

Monitor all person activities thru the internet interface.

View uploaded datasets and examine processed statistics. Access advice results which can be generated the use of collaborative and content material-based totally filtering
algorithms.

Check system accuracy after strolling more than one gadget gaining knowledge of fashions.

Once all algorithm executions are entire, the general accuracy of the model is displayed at the admin dashboard.

Data Preprocessing Module:

Data preprocessing plays a important role in ensuring that uncooked records is easy, structured, and usable for device gaining knowledge of models. A dataset is largely a set of statistics objects, also referred to as information, samples, observations, or entities. Each information object is characterised by means of more than one functions (additionally called attributes or variables) that describe key components, together with timestamps, rankings, or person options.

Keypreprocessing techniques used within themachine include:

Noise Removal: Eliminating inappropriate or inconsistent statistics.

Handling Missing Values: Filling lacking values with suitable substitutes or getting rid of incomplete statistics.

Feature Engineering: Modifying and grouping attributes to improve the accuracy of predictions..
Normalization & Scaling: Converting data into a standard format to enhance compatibility with machine learning models.
Preprocessed data ensures that the recommendation system generates accurate and meaningful predictions.

Machine Learning Module:
Once the records is preprocessed, it's miles split into schooling (60%) and testing (forty%) datasets. The system then applies more than one system learning classifiers, such as:

K-Nearest Neighbors(KNN)
Random Forest
Naïve Bayes
Support Vector Machine (SVM)

The collaborative and content-based totally filtering outcomes are then evaluated, and the classifier with the best accuracy is chosen because the great model for film suggestions.

To enhance the overall performance of the system, superior strategies which include deep getting to know models (Neural Networks) or hybrid advice techniques also can be incorporated in destiny variations.

During the preprocessing diploma, various techniques are applied to refin.

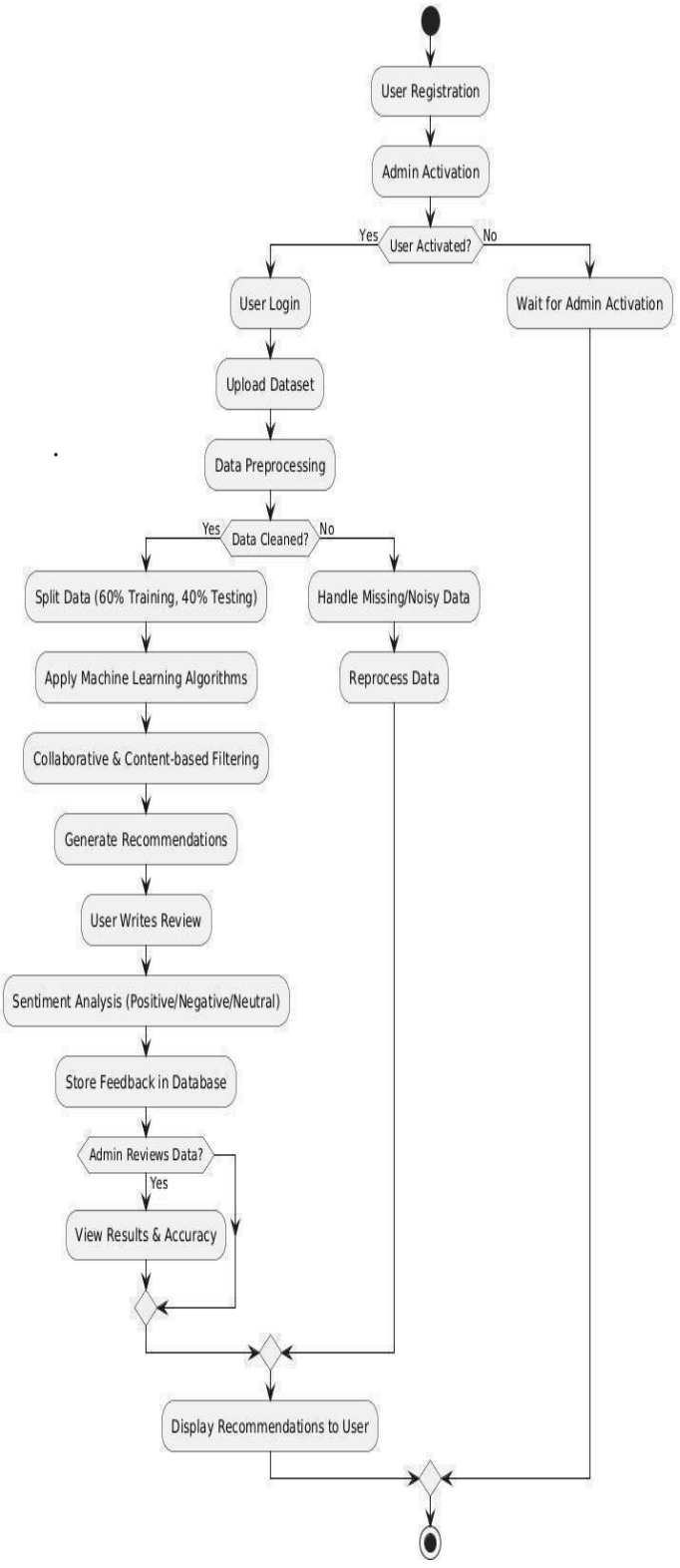
VI.System Architecture:

V. Proposed System:

A Movie Recommendation System assists customers in coming across films that in shape their choices whilst minimizing the time spent searching. The device analyzes the user's watch history and beyond interactions to offer personalized film hints.

With the speedy enlargement of on line statistics, advice structures (RS) play a vital role in selection-making throughout diverse domains, which includes leisure, e-trade, and social media.

Movie recommendation systems are widely classified into two fundamental processes:



Content-Based Filtering (CBF) – Recommends movies based totally on a consumer's previously watched content material and alternatives.
Collaborative Filtering (CF) – Suggests movies based totally at the preferences and behaviors of comparable users.
Our proposed device integrates sentiment evaluation to decorate the recommendation method. The machine evaluates consumer comments on formerly watched movies and considers their reactions to offer stepped forward suggestions.

Users can explicit their critiques thru sentiment-primarily based comments (e.G., superb or terrible reactions).
If a consumer enjoys a movie, they are able to offer a "Good" smiley as feedback.
If they dislike the enjoy, they can put up a "Sad" reaction to mirror their dissatisfaction.
Using this feedback, the system constantly refines its tips, ensuring that users acquire personalised and relevant movie tips based totally on both their watch history and sentiment-based enter.

Advantages of the Proposed System: Sentiment-Based

Recommendations:
The recommender gadget is designed to analyze consumer sentiment and remarks on formerly watched movies, taking into account personalised and correct film hints.

Advanced Sentiment Analysis:The machine utilizes sentiment evaluation, a powerful textual content-processing technique, to extract evaluations and emotions from unstructured statistics sources together with social media, emails, and purchaser evaluations. This evaluation is achieved the usage of machine mastering and deep gaining knowledge of algorithms, improving the accuracy of predictions.

Automated Text Classification:
The device employs system studying techniques to routinely classify user remarks as positive or bad, allowing records-pushed pointers primarily based on

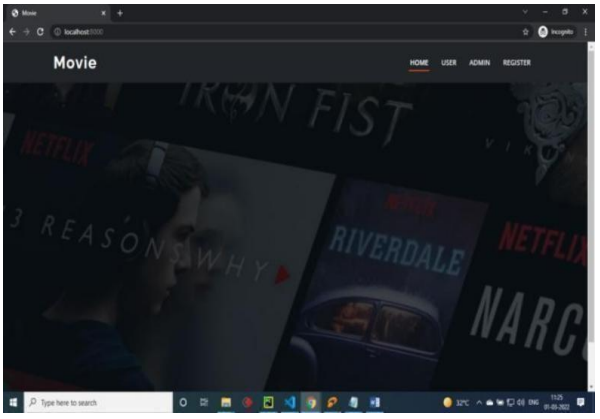
Implemented Algorithms:

K-Nearest Neighbors (KNN): A supervised learning set of rules used to classify facts based totally on similarity.
Collaborative Filtering: A method that recommends films based totally at the choices and behaviors of users with comparable pursuits.

Content-Based Filtering: A advice approach that shows films based totally at the person's beyond interactions and content preferences.

RESULT:

Fig. Home Page Fig. Admin Login Form



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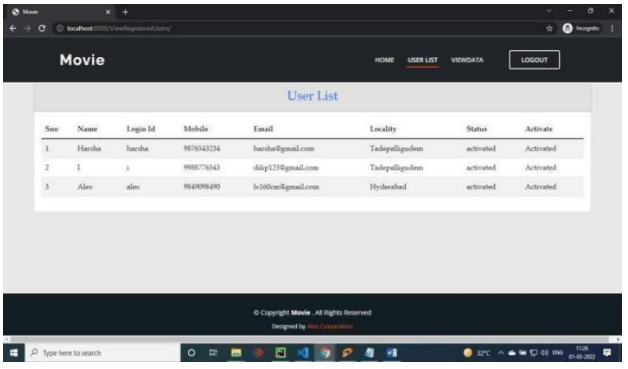


Fig. User Register Form

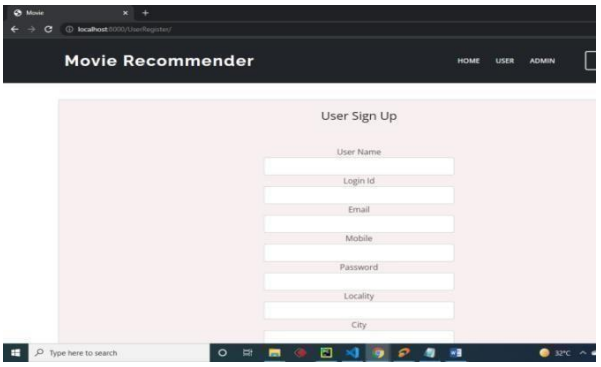
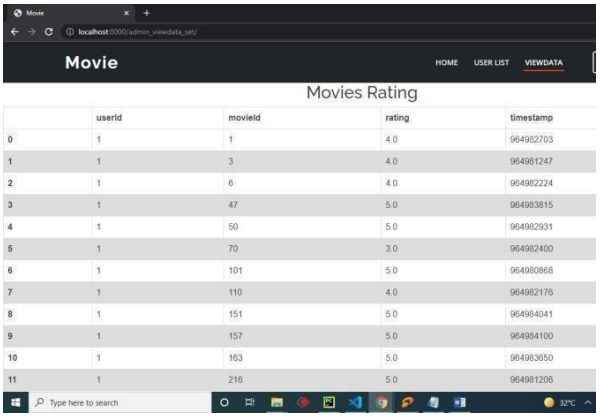


Fig. View Rating Dataset



	userId	movieId	rating	timestamp
0	1	1	4.0	964982703
1	1	3	4.0	964981247
2	1	6	4.0	964982224
3	1	47	5.0	964983815
4	1	50	5.0	964982931
5	1	70	3.0	964982400
6	1	101	5.0	964980868
7	1	110	4.0	964982176
8	1	151	5.0	964984041
9	1	157	5.0	964984100
10	1	163	5.0	964983650
11	1	216	5.0	964981208

Fig. Viewuser Login page

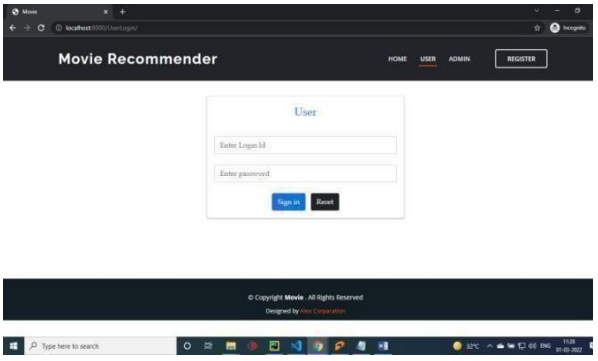


Fig. User ViewDataset

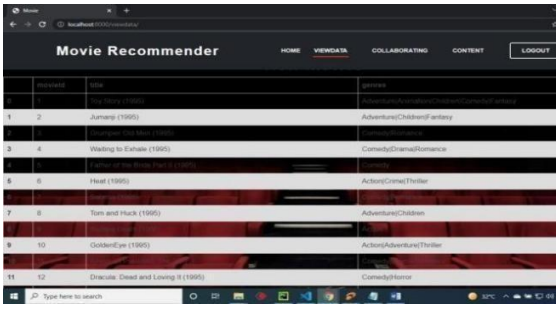


Fig.Collaborating filter recommended form Results

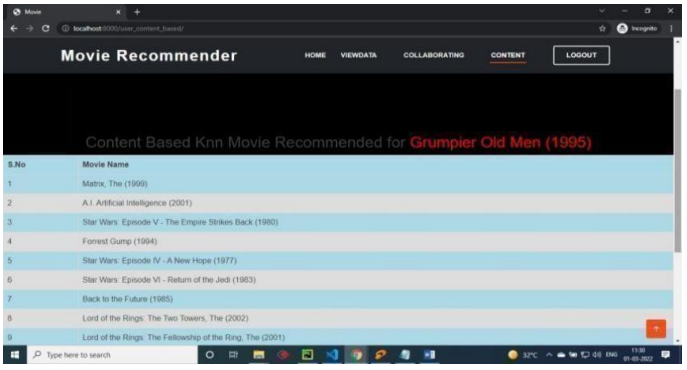


Fig. Content fliter Results

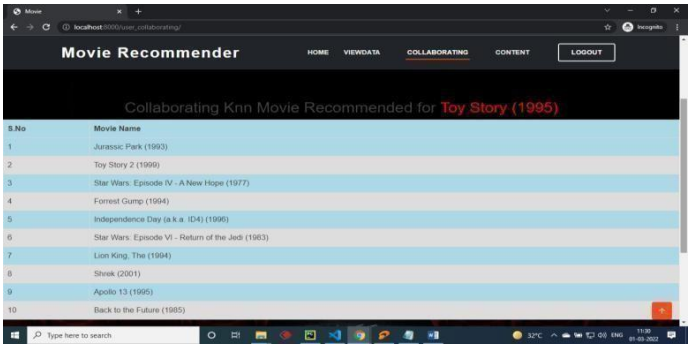
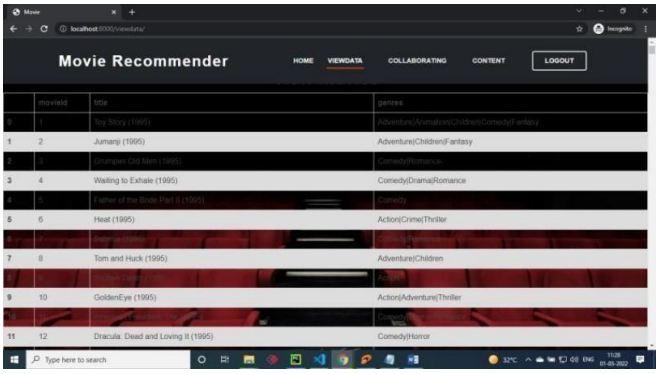


Fig. User ViewDataset



	movieId	title	genres
1	2	Jumanji (1995)	Adventure|Children|Fantasy
3	4	Waiting to Exhale (1995)	Comedy|Drama|Romance
5	6	Heat (1995)	Action|Crime|Thriller
7	8	Tom and Huck (1995)	Adventure|Children
9	10	GoldenEye (1995)	Action|Adventure|Thriller
11	12	Dracula: Dead and Loving It (1995)	Comedy|Horror

V. Conclusion:

The Movie Recommendation System performs a important role in simplifying the movie choice manner, saving time, and lowering the effort required to find films that align with user possibilities.

This take a look at specializes in constructing a advice gadget that incorporates sentiment analysis to enhance the accuracy of guidelines. Various system getting to know algorithms, which include Collaborative Filtering and K-Nearest Neighbors (KNN), have been applied to improve recommendation nice.

The machine has been evaluated and tested on a huge dataset, demonstrating green overall performance in generating personalized pointers. This research provides essential insights into growing a sentiment-based totally film recommender device, imparting a consumer-centric approach to enhancing the overall viewing experience.

-->The sentiment-primarily based movie advice gadget offers a extra refined and personalised experience for users by means of integrating machine gaining knowledge of and herbal language processing techniques. By leveraging sentiment analysis, the device complements recommendation accuracy by way of thinking about person emotions, critiques, and preferences.

The combination of Collaborative Filtering, Content-Based Filtering, and sentiment analysis results in a robust and user-centric recommendation model. Future enhancements ought to include deep learning-primarily based sentiment evaluation fashions, real-time recommendation updates, and multi-platform integration to in addition enhance recommendation excellent and person pleasure.

Future Scope:

Deep Learning Integration: Implementing advanced deep gaining knowledge of techniques for advanced sentiment class.
Real-Time Recommendations: Enhancing the system to offer actual-time movie recommendations based on user hobby.

Multi-Platform Support: Expanding the machine to help more than one streaming systems for a continuing person enjoy.

By leveraging sentiment evaluation and machine gaining knowledge of, this recommendation machine appreciably complements the movie discovery system, making sure a tailor-made and pleasurable consumer enjoy.

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Connor, M., Choi, K., Yoo, D., Kim,
Sudhanshu Kumar, Shirsendu Sukanta Halder, Kanjar De, Partha Pratim Roy, "Movie Recommendation System the use of Sentiment Analysis from Microblogging Data," arXiv preprint arXiv:1811.10804, November 27, 2018.
ARXIV

Abstract: This paper proposes a hybrid recommendation device that mixes collaborative filtering and content-based totally filtering with sentiment analysis of film tweets. The technique pursuits to mitigate the restrictions of conventional strategies through incorporating actual-time user sentiments from microblogging platforms.

Vinay Kasam, "MovieGenie: Movie Recommendation System the usage of Sentiment Analysis from Microblogging Data,"GitHub Repository, 2019.
GITHUB

Description: MovieGenie is a hybrid advice machine that integrates collaborative filtering and content material-based totally filtering algorithms to indicate films. It makes use of microblogging facts from Twitter to decide the sentiment around a selected film, employing the VADER sentiment analysis tool from the Natural Language Toolkit (NLTK) for sentiment evaluation.

Tharun, "Movie Recommendation System with Sentiment Analysis," GitHub Repository, 2020.
GITHUB

Description:This utility affords comprehensive info of requested movies, inclusive of a top level view, genre, launch date, score, runtime, pinnacle cast, reviews, and recommended movies. It leverages sentiment analysis to beautify the recommendation system.

Kishan0725, "Content-Based Movie Recommender System with Sentiment Analysis," GitHub Repository, 2020.
GITHUB

Description:This content material-based recommender gadget suggests movies similar to those the person likes and analyzes the sentiments of consumer opinions for those movies. The application has been updated to a more recent version, with the supply code available in the repository.

Paper ID: 99

AI FOR REAL ESTATE PRICE PREDICTION

(AI-Powered Real Estate Price prediction)

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Abstract *- In the modern real estate industry, accurate price prediction is crucial for buyers, sellers, and investors to make informed decisions. Traditional models rely on statistical methods or machine learning algorithms, but recent advancements in Generative AI and Large Language Models (LLMs) offer a more sophisticated approach by incorporating vast amounts of structured and unstructured data.*

This project aims to develop an AI-powered real estate price prediction system that leverages LLMs and Generative AI models to analyze historical price trends, market factors, property descriptions, and location-based data. The system will be trained using structured datasets, such as numerical property attributes (e.g., size, location, number of rooms, amenities), as well as unstructured textual data (e.g., property descriptions, agent notes, and market news).

Key Words: Generative AI, Large Language Models (LLMs), Machine Learning, Real Estate Price Prediction, Property Valuation, Market Trends, Structured & Unstructured Data, Historical Price Trends, Location-Based Data, Predictive Modeling.

1. INTRODUCTION

The real estate market is one of the most dynamic and ever-evolving industries, where property prices are influenced by various factors such as location, demand-supply dynamics, economic conditions, mortgage rates, amenities, government policies, market trends, infrastructure development, and neighborhood quality. Accurately predicting property prices is essential for buyers, sellers, investors, and financial institutions to make well-informed and strategic decisions.

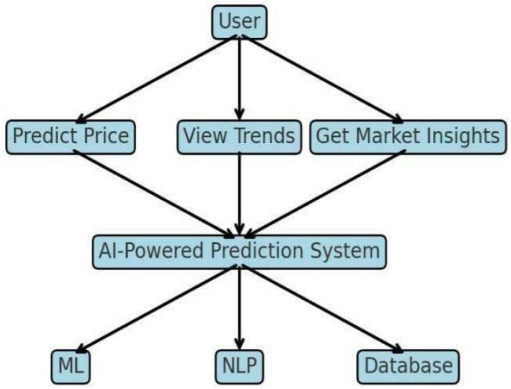


Fig -1: Functional Flow Diagram

With advancements in Generative AI and Large Language Models (LLMs), a more sophisticated approach has emerged that integrates structured

numerical data with unstructured textual data to improve real estate price prediction. LLMs can process historical price trends, property descriptions, agent notes, and real estate market reports to provide more context-aware and accurate price estimations. This research focuses on building an AI-powered real estate price prediction system that leverages ML models and LLMs to enhance prediction accuracy and generate valuable market insights.

Problem Statement:

The real estate market is complicated and constantly changing using traditional ways of predicting property prices have major problems.

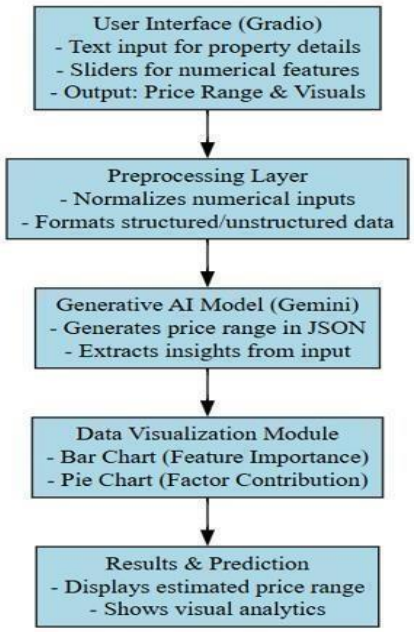
- Current models don't use advanced data and often miss key patterns, leading to bad prediction.
- Many methods rely on manual work and personal opinions, which are inconsistent and biased.
- They don't consider important data sources like real time news or economic.

2. LITERATURE SURVEY

Real estate price prediction is crucial for buyers, sellers, and investors. Traditional models such as hedonic pricing, time-series analysis, and comparative market analysis (CMA) have been widely used. Hedonic pricing models (Rosen, 1974) use regression techniques to estimate property values based on features like location and amenities. Time-series models such as ARIMA (Box & Jenkins, 1976) forecast trends but struggle with non-linearity. CMA relies on historical sales data but lacks adaptability. Machine learning (ML) has significantly improved prediction accuracy. Decision trees, Random Forests, and Gradient Boosting Decision Trees (GBDT) handle complex relationships, while neural networks (Chen & Hao, 2018) process numerical and visual data effectively. Recent advancements in Generative AI and Large Language Models (LLMs) further enhance predictions. LLMs like GPT-4 analyze property descriptions and market trends, while Generative Adversarial Networks (GANs) simulate market conditions (Goodfellow et al., 2014). Despite improvements, challenges remain, including data quality, model interpretability, and bias. Real-time adaptability is also crucial for accurate predictions. Future research should focus on integrating multimodal AI, improving transparency, and leveraging blockchain for data integrity. AI-driven models are transforming real estate valuation, offering more precise and dynamic pricing insights compared to traditional approaches.

3. PROPOSED SYSTEM

The real estate market is a dynamic and complex industry influenced by numerous factors, including economic trends, demographic changes, market supply and demand, interest rates, and location-specific attributes. Traditional real estate valuation methods rely on statistical models and human expertise, often leading to inconsistencies and inefficiencies.



However, advancements in artificial intelligence, specifically Large Language Models (LLMs), have paved the way for more accurate and data-driven real estate price predictions.

The proposed AI-based real estate price prediction system follows a structured flow from data input to output visualization. The process begins with the user entering property details, including size, number of bedrooms, number of bathrooms, year built, market trend, interest rate, median income, unemployment rate, crime rate, rent yield, and population growth. These features are selected and normalized to ensure they are in a suitable format for AI processing.

Once the features are prepared, a prompt is generated containing all relevant property details and sent to Google's Gemini AI model for processing. The AI receives this structured prompt and returns a response in JSON format, which contains the predicted lower and upper price ranges for the given property

System Requirements

Real estate price prediction is an essential application of AI that assists investors, buyers, and realtors in making data-driven decisions. This system leverages Google's Gemini API, Gradio, and Python to provide real-time price predictions based on various property.

Functional Requirements

- User Input and Data Handling
- AI Model and Prediction Generation
- User Interface (UI)
- Deployment and Accessibility

Performance Requirements

- Response Time
- Scalability
- Accuracy and Reliability

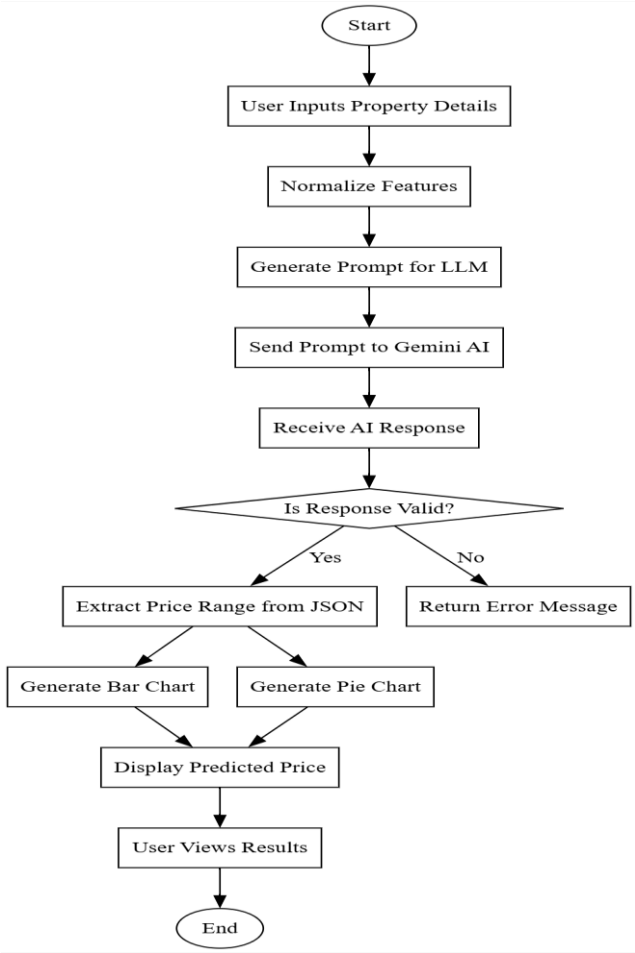
Hardware Requirements:

Processor, RAM, Storage, GPU, Internet

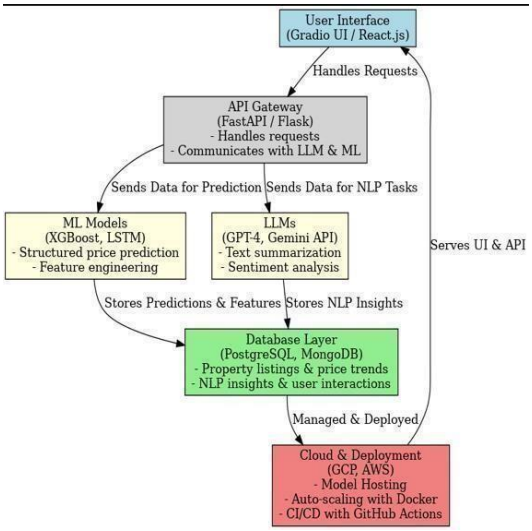
Software Requirements:

Windows, macOS, Linux

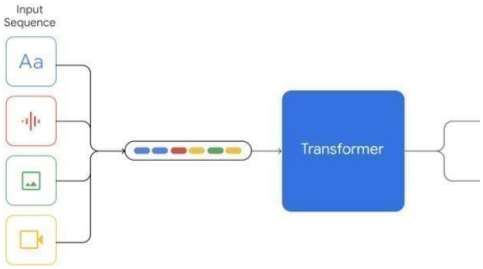
4. FLOWCHART



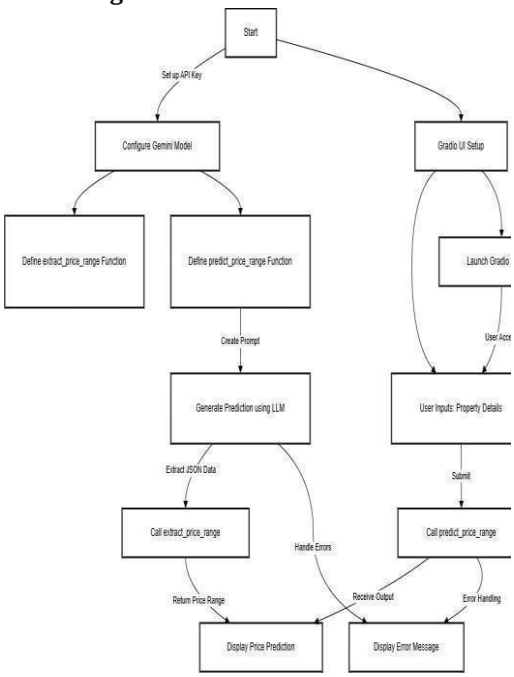
ARCHITECTURE



Gemini Api Architecture

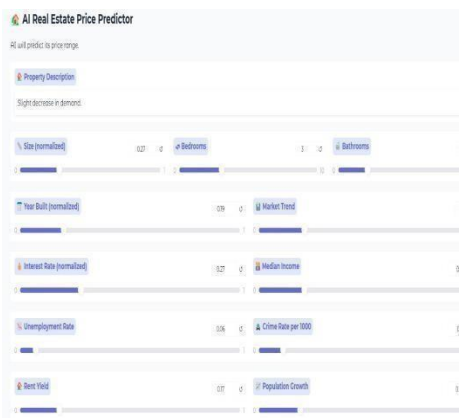


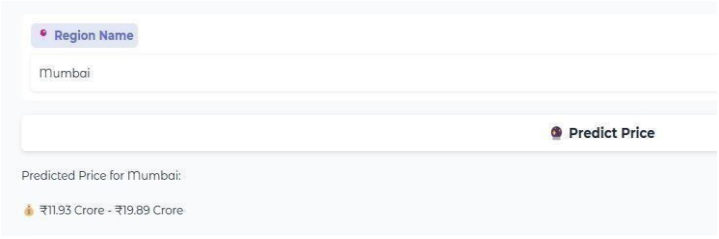
UML Diagrams

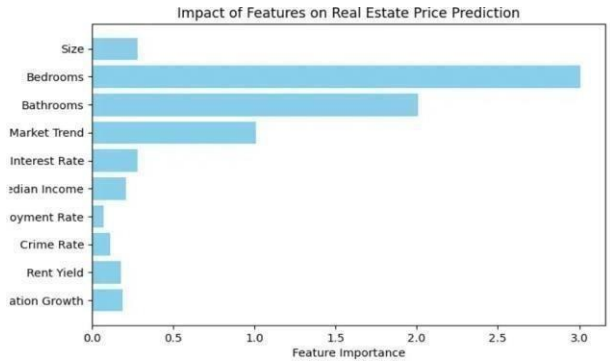


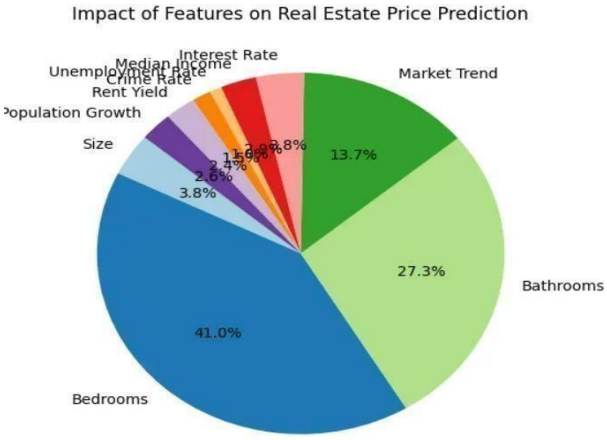
5. RESULTS

With Input

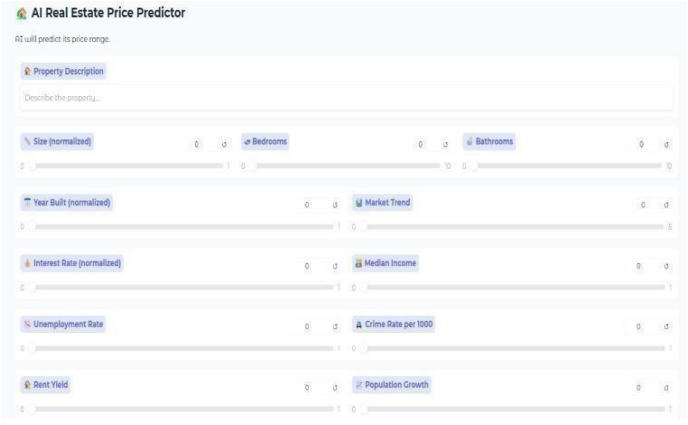


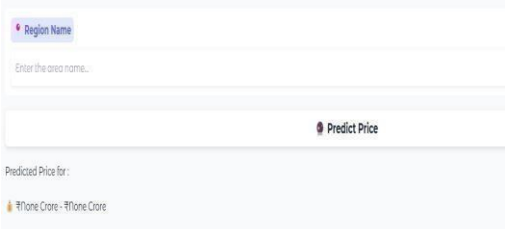


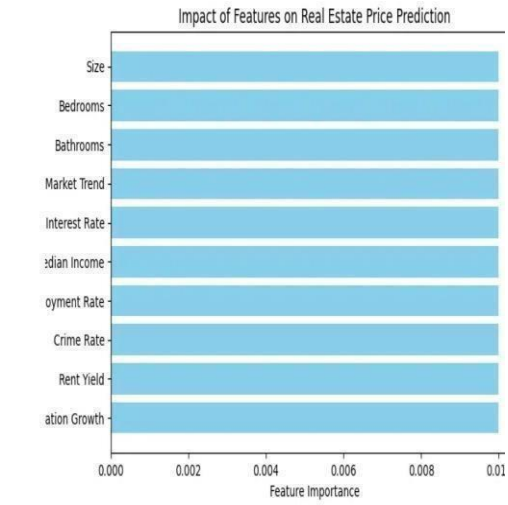


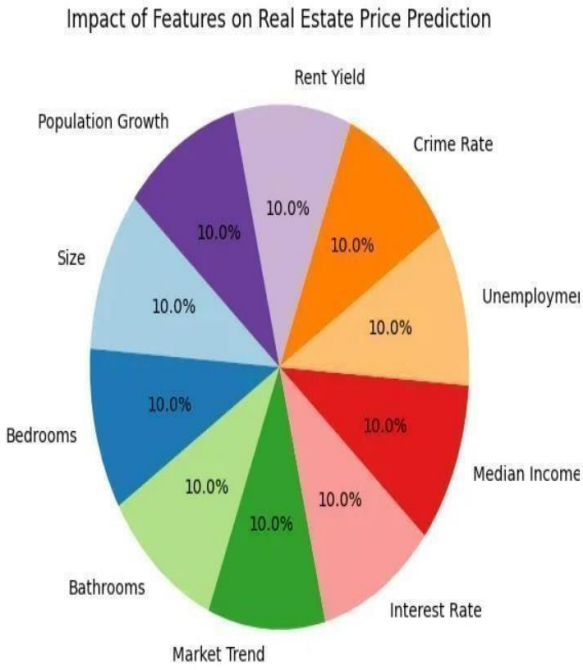


Without input









The proposed AI-powered real estate price prediction system leverages advanced machine learning and large language models (LLMs) to provide accurate and data-driven property price estimations. By integrating Google's Gemini AI model, the system ensures that predictions are based on a wide range of structured economic, demographic, and market factors..

This system offers a user-friendly interface through Gradio, allowing users to input property details easily and receive instant predictions. Additionally, it enhances interpretability with visualizations, including bar charts and pie charts, helping users understand the impact of different property factors on the price estimation.

By incorporating real-time data processing, normalization, and AI-driven predictions, the system can adapt to market fluctuations and trends, making it a valuable tool for buyers, sellers, and real estate investors. The integration of big data analytics and AI ensures a robust and scalable solution for real estate pricing, reducing human bias and improving decision-making accuracy.

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- **Nielsen Norman Group** – https://www.nngroup.com/articles/ten-usability-heuristics/
- **Figma / Adobe XD** https://www.figma.com https://www.adobe.com/products/xd.html
- **React & Tailwind CSS** – Frameworks for building modern and responsive UI. https://react.dev/ https://tailwindcss.com/
- **Gradio** – Creating interactive ML interfaces for real estate price prediction. https://gradio.app/

ISBN: 978-93-342-1696-7

Paper ID: 128

Two Factor Worm Detection Based On Signature and Anomaly

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Abstract*: Internet worms pose an immediate threat by infecting users systems over the internet channels, where they establish themselves and initiate destructive operations such as file corruption or unauthorized data theft sent to attackers. Proposed system is designed to counter such attacks by detection methods such as Signature-based Detection and Anomaly-based Detection. These methods inspect internet traffic patterns and compares them to predefined rules to identify whether the traffic is consistent with known attack signatures or normal. This inspection often done by using packet capture (PCAP) files. Anomaly Detection uses Machine learning algorithms like Random Forest, Decision Tree, and Bayesian Networks to train models based on historical data. These trained models are then used to classify traffic patterns as either NORMAL or ABNORMAL. This multi-perspective approach is used to enhance the detection and prevention of internet worms.*

Keywords: Two-Component Worm Recognition, Network worms, Signature detection, Anomaly based procedure, packet capture (PCAP) files, Random Forest, Decision Tree, Bayesian Network.

I. INTRODUCTION:

In this age of computerization, securing computer networks against internet worm threat is essential to preserve data integrity and provide user security. The Internet worms are malicious software that infects users' computers through online media, causing file corruption and the leakage of sensitive data, posing serious cybersecurity threats, messing up files or stealing data without permission and sending it to bad guys. To counter these threats, our project utilizes sophisticated detection methods to enhance network security and to enhance the performance and reliability of worm detection based on an integrated Two-Factor Authentication system that employs Signature-based as well as Anomaly detection techniques.

The Signature-based detection technique operates by comparing the features of suspected worms against a database of known worm signatures. This way looks at internet traffic patterns and checks them against set rules. It tries to figure out if the traffic matches known attack signs or if it's normal. This check often uses packet capture (PCAP) files. If a match is indicated, the system indicates the possible threat as a worm. Yet, this technique might miss new or unknown worms.

In contrast, the Anomaly detection technique is aimed at detecting deviations from normal network behavior. It creates a baseline for normal activity and alerts any abnormal patterns that could signal a worm attack. This method uses smart computer programs like Random Forest, Decision Tree, and Bayesian Networks. These programs learn from old data. Once they've learned, they can tell if new traffic patterns are normal or abnormal. Though this method is powerful for the detection of new or unfamiliar worms, it is also prone to giving false positives.

By having both Signature-based and Anomaly detection together, we form a more robust defense system. Signature-based detection assists in identifying known attacks, while Anomaly detection assists in identifying new or emerging worm attacks. With this combined effort, we fortify the security of the network as a whole.

Our system, "Two-Factor Worm Detection based On Signature and Anamoly" introduces a thorough method to spot worms using a Two-Factor Authentication system. The system combines both Signature-based and Anomaly detection techniques. By putting a Honeypot server between the main server and user requests, any shady behavior gets recorded. People then look at these records to find and block IP addresses linked to attackers. Using all these different ways together helps to find and stop internet worms better.

2. LITERATURE SURVEY:

In today's cyber world, worms pose a huge threat to the worldwide network infrastructure. A Worm Detection System Powered by Deep Learning introduced by Hanxun Zhou, Yeshuai Hu, Xinlin Yang, Hong Pan, Wei Guo, Cliff C. Zou together proposed a worm detection system that utilizes deep learning methods, including CNN-based worm detection module and a DNN-based automatic worm signature generation module, frequency processing, frequency-weighted processing, and difference processing. These techniques are used to pre-process the data for training the CNN model to identify worms efficiently. The DNN is utilized to train a model based on worm payloads and their respective signatures as inputs. In this, they analyze how the various data preprocessing techniques and the number of convolution pooling layers within the CNN model influence worm detection performance. Then, analyze the effect of changing worm signatures on automatic worm signature generation in the DNN algorithm. The experimental shows the generated signatures provide good detection performance.

Prof. Kiran Kumar.A1, Sai Bhavya Reddy.T2, Bollam Sri Sai Vignesh3, Kolhapuram Medha4, work introduces a Two-Variable Worm Discovery model that combines Mark and Inconsistency based approaches to enhance web security. Web worms continue to compromise client information and security, rendering effective location critical. Mark Based Recognition explores web traffic marks against predetermined guidelines using packet capture (PCAP) records, enabling persistent ID. It performs Netflow-Based Inspection by inspecting UDP and TCP marks to watch for typical from attack marks. Irregularity Identification Models, which are trained on actual datasets using AI computations, for instance Arbitrary Woodland, Choice Tree, and Bayesian Organizations, to identify unusual traffic behavior. These integrated methodologies, supported by various datasets, provide a comprehensive protection against creating web worm threat and attacks, ensuring effective client protection.

The swift expansion of the Internet of Things (IoT) in the technology and communications industries demands a continuously updated cybersecurity framework to shield users against potential attacks posing a threat to data security and privacy. Botnets pose a critical threat to IoT systems because they use infected nodes to break into other nodes within the network and carry out multiple forms of attacks that can be used to sabotage services. Among the most prevalent attacks are Denial of Service (DoS), Distributed Denial of Service (DDoS), Service Scanning, and OS Fingerprinting. DoS and DDoS attacks are among the most serious threats to IoT, where botnets manage hijacked nodes to create an overload of traffic towards a particular node or service. This depletes the computational resources, power, or network bandwidth, causing service failure or disruption.

Anomalous Payload-Based Worm Detection and Signature Generation by Ke Wang, Gabriela F. Ciocarlie introduces new functions of the PAYL anomaly payload detection sensor, demonstrated to detect and produce signatures on zero-day worms efficiently. The site-specific packet content models are experimentally shown to efficiently identify new worms with high accuracy in a collaborative security framework. A new technique is proposed that correlates ingress and egress payload warnings to identify the primary spread of the worm. This approach also facilitates automatic signature creation, allowing for instant deployment of signatures to network firewalls and content filters, providing proactive protection for other hosts. In addition, the paper suggests a collaborative, privacy-preserving security approach where various hosts can share PAYL signatures, improving detection accuracy and minimizing false positives. The main point is that through correlating several alerts, the actual positive results are determined from the anomaly alerts, resulting in better decision-making and effective mitigation.

Pattern matching (signature-based) techniques are popularly employed in simple network intrusion detection systems (IDS). Yet, a stronger method is the use of machine learning classifiers to identify anomalies and unknown attacks. Nevertheless, a single machine learning classifier tends to fail to identify all forms of attacks, particularly less frequent ones such as Remote2Local (R2L) and User2Root (U2R), because of the large variability in attack patterns

Hence, a hybrid technique promises to perform better. Treepop Wisanwanichthan, Mason Thammawicha presents a Double-Layered Hybrid Approach (DLHA), especially tailored to evade the shortcomings of conventional IDS mechanisms and determine the shared behaviors of different types of attacks using Principal Component Analysis (PCA) to construct variables that capture maximal variance in every attack type. DLHA employs the Naive Bayes classifier in Layer 1 to identify Denial of Service (DoS) and Probe attacks, and Support Vector Machines (SVM) in Layer 2 to classify R2L and U2R attacks from normal traffic. We compare DLHA with existing published IDS methods against the NSL-KDD dataset. The performance results indicate that DLHA performs better than many state-of- the-art IDS methods and by far outperforms any one machine learning classifier. In addition, DLHA presents outstanding performance on rare attack detection with a rate of 96.67% for R2L and 100% for U2R.

3. PROPOSED METHOD

The proposed system Two-Factor Worm Detection system integrates the strengths of both Signature and Anomaly detection approaches. The integration of these techniques gives rise to a robust and systematic method of worm detection, improving accuracy, real-time responsiveness, and adaptability to new kinds of cyber threats. By overcoming the limitations of current systems, our method seeks to improve network security and general cyber resilience.

Steps of the Proposed Method:

Utilizer: The Utilizer module is responsible for coordinating the analysis of both the signature- based and anomaly-based detection systems. This module combines the outputs of both techniques and determines the probability of a worm attack by examining the combined results.

1. **Upload PCAP Signature Dataset Module:** The system supports the uploading of PCAP (Packet Capture) signature datasets. These are datasets that carry network traffic details used to identify known worm signatures based on predefined patterns.

2. **Run Signature-Based Worm Detection:** The signature-based detection routine examines the uploaded PCAP signature dataset. It detects known worm signatures by comparing the traffic patterns with the rules already stored in the system's signature database.

3. **Upload Anomaly Dataset:** Users may upload anomaly detection datasets. The datasets hold historical network traffic information, which is utilized for anomaly-based detection.

4. **Run Machine Learning-Based Anomaly Detection:** The anomaly detection module, which is based on machine learning, trains models like Random Forest, Decision Tree, or Bayesian Networks on the uploaded anomaly data set. This identifies any divergence from the normal network behavior defined, which may suggest the presence of an unknown or emerging worm.

5. **Comparison Graph:** The system creates a comparison graph to display the outcome of both detection processes visually. The graph shows a side-by-side comparison of the signature-based and anomaly-based detection results which helps to analyze their performance and accuracy.

6. **Comparison Table:** Along with the comparison graph, an in-depth comparison table is included. The table shows important parameters like false positives, true positives, detection rates, and other evaluation parameters.

7. **Predict Attack from Test Data**

The system implements the trained machine learning model in predicting possible worm attacks with the help of test data. The detection system scans traffic data and predicts whether there is an ongoing attack based on both signature match and anomaly detection.

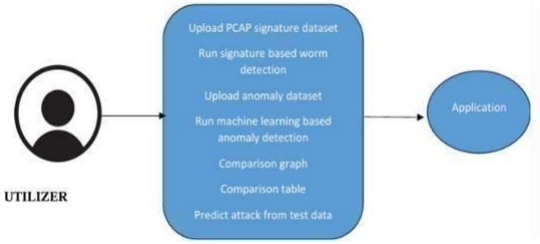

Fig. Block diagram

Proposed System modules

1) Signature-Based Detection:

Uploading and scanning PCAP files with network traffic, comparing signatures to pre-defined attack patterns to check that detected known worm signatures are reported correctly.

2) Anomaly Detection Models Based on Traffic Behavior: Employing trained machine learning models on past traffic data to indicate traffic as either normal or suspicious to ensure that anomaly-based models are able to identify new, previously unseen worm attacks.

Advantages of the Proposed System

- The system improves detection capabilities by covering both known and unknown worm threats by offering broader coverage against a range of worm attacks.
- The system reduces the chances of false alarms, particularly with the anomaly detection model that improves over time as it learns from traffic patterns.
- The system can scale to monitor large networks and adapt to varying network traffic conditions, making it suitable for both small and large enterprises.

- The system provides detailed comparison graphs and tables that help administrators easily assess the performance of both detection methods, enhancing decision-making.
- Capable of identifying complex, previously unknown threats.
- The system enhances the security of the system itself, ensuring that only authorized users can access or modify the detection system.

II. RESULTS

Fig. Application page

Fig. Uploading PCAP file

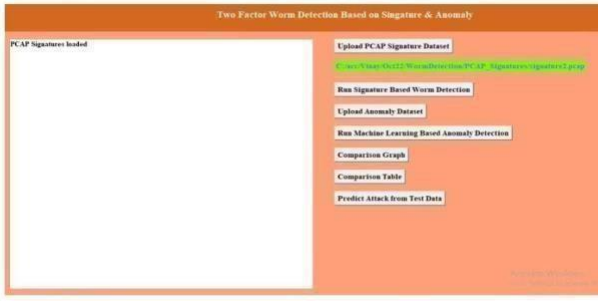

Fig. Running Signature based worm Detection

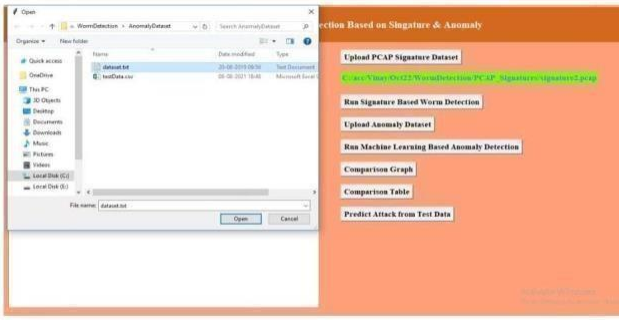

Fig. Uploading Anomaly dataset for detection

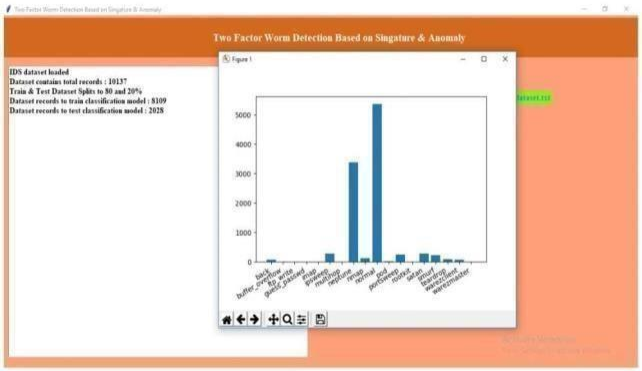

Fig. Anomaly detection

Fig. Training Machine Learning Models

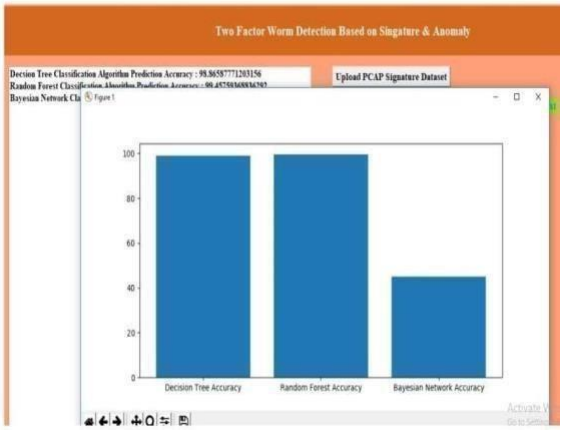

Fig. Comparison Graph

Fig. Comparison Table

Fig. Uploading test Dataset

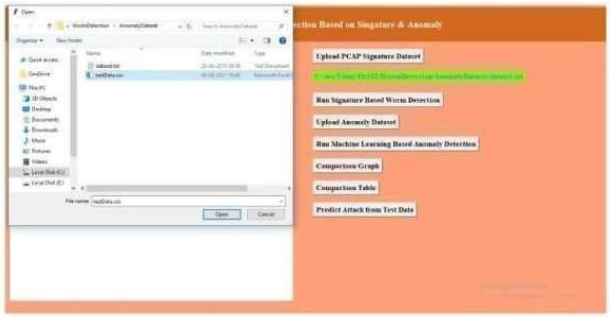

Fig. Predicted Worm Attacks from Test dataset

CONCLUSION

The Two Factor Worm Detection based Signature and Anomaly which effectively detects worms by integrating both signature-based and anomaly-based detection techniques. The signature module detects the worms by using PCAP dataset by comparing the signatures with known worms. The anomaly module uses Machine Learning techniques to train the system itself to detect the unknown worms. These methods boost efficiency and accuracy by aligning known threats with established patterns while also identifying new or unknown worms through the detection of irregularities in network behavior. This combined model improves detection capabilities, reduces false positives, and enhances the system's ability to identify novel worms. Future research could concentrate on real- time performance metrics and scaling detection for larger networks worms or cyber threats.

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ISBN: 978-93-342-1696-7

Paper ID: 216

ML-DRIVEN DUAL-MODE PAYMENT ECOSYSTEM FOR SEAMLESS TRANSACTIONS

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Abstract– This paper outlines a new, innovative payment ecosystem that harmoniously combines physical cash and digital transactions, offering safety, flexibility, and ease in managing the financial exchange among users. It bridges this gap between traditional cash methods and modern digital solutions through convenient requests and transfers between users and addresses major shortcomings of current payment systems. This environment allows the system to provide a trusted environment and increases the confidence of the user in each transaction, further emphasizing accessibility by lessened dependence on ATMs for cash and extensive travels on the lookout for available funds. The system encourages localization in matching and aseptic interaction between the two users to achieve effectiveness with convenience. By seeing the important areas of security, it is consistent with measures for safeguarding transactions and reducing risks so that the experience built for the user is as smooth as possible and the transactions are easy and reliable.

A safe channel of communication should ensure smooth-running operations so that everything can be accomplished in such order. This new method of making financial transactions redefines the way transactions are conducted, combining the best features of cash and digital systems into one platform. It meets the changing needs of users by providing a strong, user-friendly, and fraud-resistant solution, making it a significant advancement in payment ecosystems. This system represents the advance step toward creating a well-balanced and comprehensive financial transaction platform for the modern world, which focuses on efficiency, security, and accessibility.

Keywords– Secure Communication, Payment Ecosystem, Financial Exchange, User Authentication, Match Making, ATM Dependence Reduction.

I. INTRODUCTION:

Machine learning (ML) is the application of artificial intelligence that makes computers learn from data so as to make certain predictions or decisions without previous programming. It is the development technique of algorithms that enables systems to automatically identify trends and insights from data sets; therefore, improving their performances with time as they get into contact with more data. Unlike the traditional software models, where there are predefined rules that dictate what the

next step is going to be, ML systems evolve as they input new data and, therefore, are able to predict better as they learn. That is why ML has some fantastic applications in healthcare, finance, marketing, and autonomous systems. The core of ML is that it can generalize from data; therefore, even in scenarios not known, systems are able to make predictions or act accordingly. The techniques used in ML are typically categorized into three categories, namely supervised learning, unsupervised learning, and reinforcement learning. Supervised learning is the kind of learning by which models are trained by labeled data to make predictions. Unsupervised learning finds hidden patterns in the unlabeled data. Reinforcement learning finds the agent that learns through experiences by interacting with its environment through trial and error.

ISBN: 978-93-342-1696-7

And now ML is evolving industries it creates intelligent and efficient, personalized solutions making the future of technology shaped

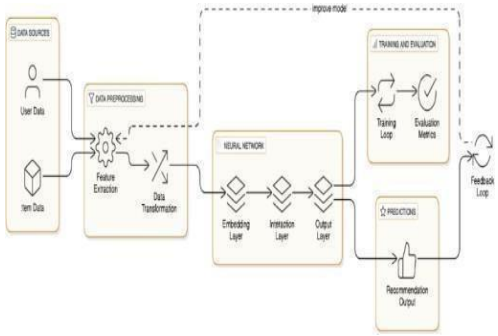

Fig 1: Architecture

The evolving financial landscape demands innovative solutions to bridge the gap between physical cash and digital transactions. Despite the rise of digital payment systems, the need for physical cash persists, particularly in situations where cash access is limited due to geographical or infrastructural constraints. Traditional banking systems often fail to provide quick, convenient, and secure access to cash, especially for individuals in remote or underserved areas.This project introduces a Dual-Mode Payment Ecosystem, an ML-driven platform that facilitates seamless cash and digital transactions by connecting individuals with complementary financial needs. Users register on the platform using their PAN and Aadhaar, ensuring identity verification and compliance with regulatory standards.

1.1. PROBLEM STATEMENT:

Today's Financial Ecosystem faces different Challenges in integrating Physical Cash and digital transactions mainly in rural areas. People in these regions struggle to access physical cash due to limited availability of ATMs and different bank branches. Lack of these systems forces people to travel long distances leading to inconvenience, additional expenses. Even urban areas face cash shortages and long Queues at banks highlighting the inefficiency in the system. There is no seamless mechanism to bridge the gap between those needing the physical cash for a digital fund. This gap is making it difficult for those who are in immediate financial need.

1.2. RESEARCH GAP:

- The user registers by providing their PAN and Aadhaar, which are verified through secure APIs linked to government databases (e.g., UIDAI for Aadhaar). This process ensures that only legitimate users are allowed to access the system.
- Verified users can submit a request specifying the amount they need physically or digitally. A user-friendly interface captures their preference, initiating further processing steps.
- DBSCAN is used to cluster nearby users with available cash based on their location. This algorithm effectively handles noisy data to identify those who closely match the requester's needs.
- Neural Collaborative Filtering (NCF) ranks and filters clustered users based on their cash availability and past interactions. It predicts the best match using a model trained on historical data.
- The Isolation Forest algorithm detects fraudulent transaction requests by isolating anomalies like fake or manipulated data. A tuned contamination parameter ensures a balance between precision and recall for accurate fraud detection.
- When a match is approved, a secure communication channel is established via contact details or an integrated chat box. This enables both parties to finalize the transaction seamlessly.

II. LITERATURE REVIEW:

KRISHNA PRAKASHA, et al (2024): User identification and authentication is the process of checking a user's credentials to confirm they are valid. The proposed method replaces the slow, manual process of user authentication with an automated system. It uses an encoded NIN (National Identification Number) from the Aadhaar card as the credential for validation. Since mobile devices have limited resources and are less powerful than high-performance computers, performing tasks like key generation, encryption, and digital signature verification on them is challenging.

HERREROS-MARTINEZ, S. PEREZ-DIAZ, et al (2024): This paper focuses on using machine learning-based anomaly detection techniques for fraud detection in real purchase datasets, particularly to assist in auditory processes. The approach combines several anomaly detection methods, including univariate detection using z-score and DBSCAN, identification of low-populated clusters, and analysis of negative Silhouette coefficients derived from the k-Means algorithm.

TAHER AL-SHEHARI, et al (2023): This study focuses on detecting insider threats in networked systems using an anomaly-based Isolation Forest (IF) algorithm on the imbalanced CERT r4.2 dataset. By treating malicious activities as outliers relative to normal user behaviour, the model achieved optimal performance with a contamination parameter of 0.02, delivering accuracy. The approach demonstrated superiority over competing methods and adaptability to new contexts, effectively handling imbalanced datasets by identifying anomalies.

SACHIN PARATE, et al (2023): The digital transformation of banking, especially in identity verification, is both revolutionary and challenging. Technologies like blockchain, machine learning, and advanced communication systems have the potential to reshape digital identity verification. A study in Malaysia highlights factors like trust, transparency, and user-friendliness in adopting digital identity platforms. Another studypresents a novel approach using open banking

APIs for identity verification. These advancements point to the evolving and complex nature of digital identity systems in banking.

FRANKLIN AREVALO, et al (2022): The study explored feature selection and denoising techniques for clustering financial transactions to detect anomalous payments in the SPM system. It used k-means, DBSCAN, and random forest clustering, with network features providing consistent clusters, especially when PCA denoising or one-hot encoding was applied. The analysis highlighted that the number of interactions between participants and transaction direction are key indicators of anomalous behaviour. K-means and DBSCAN provided different results, emphasizing the importance of exploring both methods. The research suggests using machine learning to improve risk detection in payment systems, with further potential for future methodologies.

CHEN SHAO, XUSHENG DU, et al (2022): The study proposes a selection matrix to improve the pre-selection mechanism of attribute values for Isolation Forest by clustering and analysing data distribution, reducing the randomness that affects accuracy. Experiments on 11 datasets from UCI and ODDS validated the algorithm's effectiveness. It was found that the performance of k-means is highly sensitive to the chosen k value, and there is no optimal method to select it without loss.

The clustering result significantly impacts the performance of the CIIF (Clustering-based Isolation Forest). The next step is to explore the effect of different clustering algorithms on CIIF and enhance the k-means algorithm.

ZHICHAO LI1, et al (2020): This paper develops a pricing model for crowdsourcing tasks using real data and clustering. It introduces a subregional research task pricing model, optimizing package pricing with a multilinear regression model. The DBSCAN algorithm clusters high-density tasks, and a single-objective optimization model packages these tasks. The MNL pricing model further optimizes costs and increases the completion rate. The research improves crowdsourcing task pricing, providing insights for future studies on network externalities and multiple purchases in logistics.

externalities and multiple purchases in logistics.

DL SHUO, ZHENG WEI MIN, et al (1999): This paper presents a Web server cluster system architecture and introduces two parameters for performance evaluation. It develops the LTI algorithm, which uses the increment of total response time as the optimization goal and demonstrates its local optimality. A sample test validates the algorithm's efficiency. To simplify the problem, the study omits factors present in real systems, such as connection creation time and request header analysis. The file transmission time is calculated using a continuous model, ignoring these additional steps. Future research is planned to address these limitations and further evaluate the algorithm's performance in more realistic settings

S. No	Year	Title	Authors	Key Findings
1	2024	Automated User Authentication in Wireless Public Key Infrastructure for Mobile Devices Using Aadhar Card	KRISHNA PRAKASHA, et al.	A model is built to capture the information from the Aadhar card. The mobile phones are used to obtain the data from the Aadhar card. The user validation is through a two step process using One Time Password and email address. The wireless public key infrastructure issues a digital certificate to the valid user.
2	2024	APPLIED MACHINE LEARNING TO ANOMALY DETECTION IN ENTERPRISE PURCHASE PROCESSES	A. Herreros-Martíne, S. Pérez-Díaz, et al.	This work proposes a methodology to prioritise the investigation of the cases detected in two large purchase datasets from real data. The goal is to increase the performance of carrying out such tasks. A comprehensive Exploratory Data Analysis is carried out before using unsupervised Machine Learning techniques addressed to detect anomalies.
3	2023	Insider Threat Detection Model Using Anomaly-Based Isolation Forest Algorithm	TAHER AL-SHEHARI, et al.	an anomaly-based insider threat detection model using the Isolation Forest (IF) algorithm, which operates at the algorithm level to address class imbalance issues.

4	2023	DIGITAL IDENTITY VERIFICATION: TRANSFORMING KYC PROCESSES IN BANKING THROUGH ADVANCED TECHNOLOGY AND ENHANCED SECURITY MEASURES	Sachin Parate, et al.	The digital transformation of the banking sector has ushered in a new era of opportunities and challenges, particularly in the realm of identity verification. This article delves into the evolution and significance of digital identity verification mechanisms, especially in the context of KYC (Know Your Customer) processes, which are pivotal for ensuring the security and integrity of financial transactions in the digital age
5	2022	Identifying clusters of anomalous payments in the Salvadorian payment system	Franklin Arévalo, et al.	We develop an unsupervised methodology to group payments and identify possible anomalies. The main variables are clustering algorithms (k-means and DBSCAN) to analyse anomalous payments. Our results suggest that the proposed methodology works very well to detect anomalous payments
6	2022	Cluster-Based Improved Isolation Forest	Chen Shao, Xu sheng Du, et al.	CIIF (Cluster-based Improved Isolation Forest) that combines clustering and Isolation Forest is proposed. CIIF first uses the k-means method to cluster the data set, selects a specific cluster to construct a selection matrix based on the results of the clustering, and implements the selection mechanism of the algorithm through the selection matrix; then builds multiple isolation trees.
7	2020	Crowdsourcing Logistics Pricing Optimization Model Based on DBSCAN Clustering Algorithm	ZHICHAO LI1, et al.	The DBSCAN algorithm is used to cluster areas with a high project density, and a pricing optimization model based on polynomial Logit (MNL) is established.
8	1999	Request Dispatching Algorithms for Web Server Oysters Based on Load Balancing	Dl Shuo, ZHENG Wei min, et al.	One of the key technologies is " request dispatching', which is to centrally accept all the inconri ng HTTP requests and dispatch them to the servers in the cluster to achieve parallelism. The method can be used to build Web server clusters of heterogeneous machines

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METHODOLOGY:

3.1. OBJECTIVES:

- This paper proposes an effective payment ecosystem through which people will be able to access the physical cash by matching a request to the nearest person within a range of 2 – 5 km around them.
- This paper will meet the requirements of people who are in need of physical cash as in today's world the ATMs are mostly unavailable or people facing money shortage in different areas.
- In this proposed system we are using e-KYC for Aadhar verification, DBSCAN for clustering the people, Neural Collaborative filtering technique to filter among the clustered people and isolation forest for fraud detection.
- The development is done by e-KYC integration for Aadhaar verification using secure APIs. Use DBSCAN to cluster users based on their location and cash availability. Apply Neural Collaborative Filtering to rank and filter the clustered users for the best match based on cash needs. Finally, implement the Isolation Forest algorithm to detect and flag any fraudulent activity during transactions.
- This system provides a secure alternative for accessing physical cash, especially in areas with limited ATM availability. It promotes community support by connecting individuals in need with those who have cash nearby. Additionally, it enhances financial inclusion and fosters trust through verified, fraud-resistant transactions.

3.2. USED METHODOLOGY:

This project methodology is designed to facilitate the seamless exchange of physical cash for digital transactions or vice versa. It begins with the user registration process, where individuals in need of such services register on the platform by providing their Aadhar and PAN details. These details are used to authenticate the users, ensuring they are genuine and trustworthy. After successful registration, users can place a request specifying their need for either physical or digital cash. The system then identifies individuals within a 2-5 km range who have the required resources, clustering them using the DBSCAN algorithm. This algorithm efficiently groups nearby users while filtering out noise, ensuring accurate clustering. From the clustered groups, the system applies Neural Collaborative Filtering (NCF) to recommend the best matches based on compatibility, transaction history, and availability. Once the best matches are identified, the system sends out individualized requests to these users, seeking their participation. To maintain the ecosystem's integrity, an Isolation Forest algorithm is employed to detect and mitigate any anomalies, such as fraudulent activity or suspicious patterns. If a match accepts the request, the system facilitates the integration of the parties involved by either sharing their contact details or directly enabling the transaction through the platform. This approach ensures a secure, efficient, and user- friendly process. The combination of advanced clustering, recommendation, and anomaly detection techniques ensures that the platform operates reliably while providing users with a seamless experience.

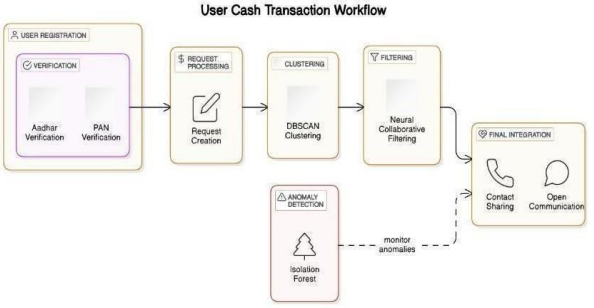

Fig. 2. User cash transaction workflow

The Workflow involves a series of steps and processes designed to ensure efficiency, security, and user satisfaction. It begins with user registration, where users provide their Aadhaar and PAN details for verification, establishing authenticity and trust within the ecosystem. Once registered, users can create requests for physical or digital cash, specifying their needs to initiate the transaction process. To identify suitable matches, the system employs the DBSCAN clustering algorithm, grouping users within a 2-5 km range based on spatial proximity. From these clusters, neural collaborative filtering (NCF) is applied to refine matches by considering user compatibility, transaction history, and preferences, offering personalized recommendations. The workflow also incorporates anomaly detection through the isolation forest algorithm, which monitors and identifies suspicious activities to enhance system security and prevent fraud. Finally, upon finding a suitable match and accepting the request, the system facilitates integration by sharing contact details or providing a platform for communication, allowing users to finalize their transactions. This process seamlessly combines advanced algorithms—DBSCAN, NCF, and isolation forest—to ensure a reliable, secure, and user-centric experience.

DBSCAN – ALGORITHM:

- Step 1: Data Preprocessing Collect and preprocess the dataset by removing any missing or irrelevant values.

- Normalize the data if necessary to ensure consistent scaling.

Step 2: Choose Parameters

- Select the two primary parameters:

- ε (epsilon): The maximum distance between two points in a cluster.
- MinPts: The minimum number of points required to form a dense region.

Step 3: Find the Neighbours

- For each point in the dataset, find all points within a distance of ε.
- These points arereferred to as the neighbours of the point.
- Step 4: Identify the Core Points
- A point is considered a core point if it has at least MinPts neighbours.
- Core points are surrounded by a sufficient number of neighbours.

Step 5: Identify the Border Points

- A point is classified as a border point if it is not a core point but lies within ε distance of a core point.
- Border points are close to core points but lack sufficient neighbours to qualify as core points.

Step 6: Identify the Noise Points

- A point is classified as a noise point if it is neither a core point nor a border point.
  - Noise points are isolated and not associated with any dense regions.

Step 7: Form Clusters

- Begin with an arbitrary core point and assign it to a new cluster.
- Add all points within ε distance of the core point to the cluster.
- Continue adding points until no more points can be included.

Step 8: Repeat the Clustering Process

- Repeat the clustering process for all remaining core points in the dataset.

Step 9: Assign Points to Clusters

- Assign each point in the dataset to the cluster containing the closest core point.

Step 10: Finalize the Clusters

- The final clusters are groups of points assigned to the same cluster.

Key Features of DBSCAN

- Density-Based: Identifies clusters based on the density of points.
- Handles Noise: Effectively detects and isolates noise and outliers.
- Non-Linear Clustering: Works well with clusters of arbitrary shapes and sizes.

DBSCAN is widely used in data mining and machine learning for its ability to handle complex datasets with noise and outliers.

Results & Discussions:

The study presents several key results. The original crowdsourcing task pricing scheme achieved a task completion rate of 62.5%, serving as a baseline for comparison. The newly developed pricing scheme, which incorporates a multilinear regression pricing model based on clustering, improved the completion rate to 70.3% while moderately reducing the task publisher's expenditure. By applying the density-based DBSCAN clustering algorithm to regions with high task density and implementing a single- objective optimization model. for packaging clustered tasks, the completion rate increased significantly to 84.9%, with further reductions in expenditure. For unpackaged data, multiple linear regression was employed for pricing, and a binary logic classifier was used to predict task completion rates. On network platforms, intergroup network externalities were found to influence platform pricing, highlighting the importance of buyer behaviours such as observing sales and after-sales evaluations. The research also indicates potential for further exploration, including the impact of user multi- purchase behaviours, flow nodes on logistics sustainability, and extended applications in crowdsourcing task pricing models. These findings mitigate limitations of previous algorithms and provide a comprehensive reference for optimizing crowdsourcing task pricing.

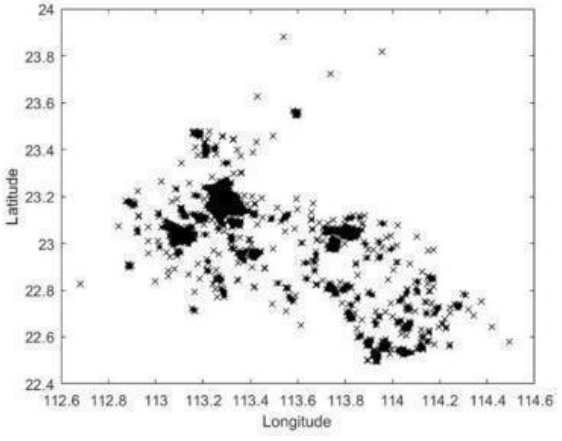

Fig. 3. The cluster diagram

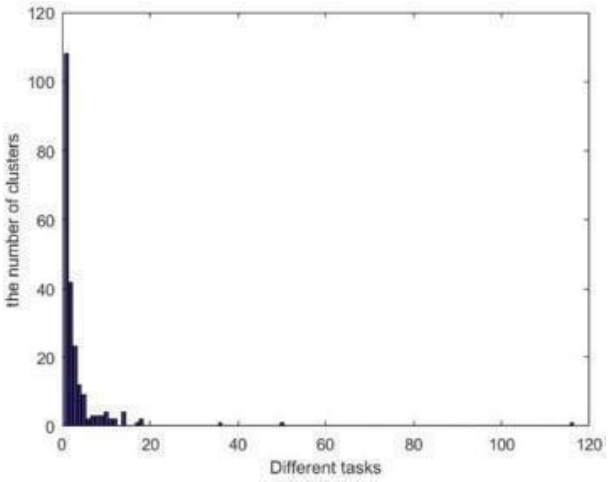

Fig. 4. The number of clusters

Fig. 5. Packaging results after clustering

COMPARISON TABLE:

Model/Algorithm	Completion Rate	Task Publisher's Expenditure	Key Features
Original Scheme	62.5%	High	Baseline comparison for new models.
New Pricing Scheme	70.3%	Moderate	Multilinear regression pricing model based on clustering.
DBSCAN Clustering Model	84.9%	Reduced	Density-based clustering for high-density regions; single-objective optimization model applied.
MNL Pricing Optimization	84.9%	Reduced	Applied to cluster task sets, significantly improving completion rates and reducing costs.

Fig. 6.

Model	Accuracy
Least squares linear regression	0.54614
Multivariate linear regression	0.63982
Multicluster linear regression	0.80357

Fig. 7.

CONCLUSION:

Our paper proposes a seamless payment ecosystem that bridges the gap between the need for physical cash during digital transactions and vice versa. By employing advanced algorithms such as DBSCAN, Isolation Forest, and Neural Collaborative Filtering, we provide a system that reduces dependence on ATMs in both rural and urban areas. This not only saves time and travel expenses but also addresses the urgent financial requirements of individuals. The system ensures efficient clustering of user requests, enabling faster and more reliable transactions. It enhances accessibility, particularly in regions with limited ATM infrastructure, making financial transactions more convenient and efficient. The adoption of these algorithms allows for precise identification and matching of user needs, optimizing the overall process. Looking ahead, the future scope of our project includes increasing the transaction amount limit and expanding the range for clustering. These enhancements aim to improve the likelihood of meeting user requests effectively. Additionally, integrating machine learning advancements can further refine the system's performance, ensuring wider applicability and scalability.

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ISBN: 978-93-342-1696-7

Paper ID: 109

AI-Powered Job Recommendation System with Skill-Based Matching

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Abstract: ***The increasing competitiveness of the job market has made it crucial for job seekers to efficiently identify opportunities that align with their skills and career goals. This research presents an AI-driven job recommendation system that utilizes the Gemini API to analyze resumes, extract key skills, and match them with suitable job descriptions. By incorporating advanced natural language processing techniques, the system ensures precise and context-aware job recommendations. Factors such as job location, experience level, job type, and industry are considered to provide personalized results. The implementation of machine learning algorithms enhances the system's ability to generate highly relevant job suggestions, improving the overall efficiency of the job search process.***

Keywords—Job recommendation, artificial intelligence, machine learning, resume analysis, Gemini API.

I INTRODUCTION

The process of finding suitable employment opportunities has evolved significantly with the rise of digital platforms and artificial intelligence (AI). Traditional job search methods, such as manual searches and keyword-based filtering, often fail to provide personalized recommendations, leading to inefficient job hunting experiences. Job seekers spend considerable time navigating through large volumes of job postings that may not match their skills, preferences, or career goals.

As a result, there is a need for an intelligent system that can automate and optimize the job search process.

The AI-Powered Job Recommendation System is designed to address these challenges by leveraging Natural Language Processing (NLP) and Machine Learning (ML) techniques to analyze resumes and job descriptions effectively. The system extracts key technical and soft skills from resumes, compares them with job requirements, and provides personalized job recommendations. By integrating Google Gemini API, the system enhances text analysis capabilities, ensuring more accurate skill extraction and context-aware job matching. Additionally, Google Sheets and Google Drive APIs are used for structured data storage and retrieval, facilitating real-time updates and seamless data management.

This project is implemented using Python, with Gradio providing an interactive user interface. Users can upload resumes in PDF format, and the system processes the extracted text to identify relevant skills. The recommendation engine utilizes ML models such as XGBoost and LSTM to rank job matches based on skill relevance, job location, and experience level. By applying advanced AI algorithms, the system ensures that job seekers receive highly relevant recommendations, reducing the time and effort required in job searching.

Moreover, the system incorporates data security measures, ensuring that user information, including resumes and job preferences, remains protected. API-based authentication protocols are implemented to safeguard access to job listings and personal data. The scalability of the system allows for

continuous improvements, including support for multi-language job descriptions and expansion into different job markets.

The primary objective of this project is to enhance job recommendation accuracy and efficiency by integrating AI-driven techniques. Unlike conventional job portals, which rely on generic keyword matching, this system understands contextual meanings in resumes and job descriptions, making the recommendations more precise and user-centric. Future enhancements may include incorporating real-time labor market trends, further optimizing job matches, and improving user experience through interactive dashboards and analytics.

By automating the resume parsing, skill extraction, and job matching process, the AI-Powered Job Recommendation System contributes to a smarter, faster, and more reliable approach to job searching. This research highlights the potential of AI and NLP in revolutionizing the hiring process, benefiting both job seekers and recruiters.

II LITERATURE SURVEY

The evolution of job recommendation systems has been driven by the increasing complexity of the job market and the growing reliance on digital recruitment platforms. Traditional job search methods, such as keyword-based filtering and manual application tracking, often result in inefficiencies, with job seekers struggling to find roles that align with their skills and preferences. Early recommendation models relied on rule-based systems, which lacked contextual understanding and failed to provide accurate job matches. The need for intelligent and automated job-matching systems has led to the integration of artificial intelligence (AI), natural language processing (NLP), and machine learning (ML) to enhance the accuracy and efficiency of job recommendations.

AI-powered job recommendation systems leverage advanced NLP models to analyze resumes and job descriptions, extracting relevant skills and matching them with suitable job postings. Recent advancements in deep learning, including transformer-based models such as BERT and GPT, have significantly improved the semantic understanding of text data. Unlike traditional keyword-based methods, these models can comprehend the contextual meaning of words, ensuring more accurate job matching. Research has shown that NLP-driven job recommendation systems outperform conventional approaches in terms of precision and recall, reducing the likelihood of irrelevant job suggestions and improving user experience.

Machine learning techniques have been widely used to refine job recommendations by predicting the relevance of job postings based on user profiles. Algorithms such as cosine similarity, TF-IDF, and word embeddings enable systems to measure the degree of alignment between job descriptions and candidate resumes. In addition, ensemble learning models, such as XGBoost and LSTM, have demonstrated high accuracy in ranking job recommendations based on extracted skills and experience levels. These models analyze patterns in job postings and candidate profiles, ensuring that recommendations are not solely dependent on static keyword matching but also consider contextual relevance and career progression trends.

The integration of cloud-based services has further enhanced the scalability and accessibility of AI-driven job recommendation platforms. Cloud computing enables real-time data processing and storage, allowing job seekers to access personalized job recommendations without latency. Google Cloud APIs, including Google Sheets API and Google Drive API, facilitate dynamic job listing updates and resume storage, ensuring that users receive the latest job opportunities. Studies indicate that cloud-based job recommendation systems improve efficiency by reducing computational overhead and enhancing data retrieval speeds, making them more suitable for large-scale recruitment platforms.

Security and privacy considerations are essential in AI-powered job recommendation systems, as they handle sensitive personal information, including resumes and employment histories. To ensure data protection, modern job recommendation platforms implement encryption mechanisms and secure authentication protocols, such as OAuth 2.0. AI-driven solutions also employ bias mitigation strategies to prevent discrimination in job matching, ensuring fair and equitable recommendations for all users. Research in ethical AI highlights the importance of transparency in job recommendation algorithms, advocating for explainable AI techniques to enhance user trust and system accountability.

Existing literature underscores the impact of AI, NLP, and cloud-based technologies in transforming job recommendation systems. The use of AI-driven skill extraction, contextual job matching, and scalable cloud services has improved the efficiency and effectiveness of job search platforms. The proposed system integrates Google Gemini API for NLP-based skill extraction, XGBoost and LSTM for predictive job matching, and Google Cloud APIs for seamless data management. By incorporating these advanced technologies, the system aims to provide accurate, personalized, and secure job recommendations, addressing the limitations of traditional job search methods and enhancing the overall job-seeking experience.

III PROPOSED METHOD

The AI-Powered Job Recommendation System enhances the job search process by integrating artificial intelligence (AI), natural language processing (NLP), and cloud computing. Traditional keyword-based job searches often lack accuracy and personalization. This system overcomes these limitations by automating resume processing, skill extraction, and job matching.

1. **Resume Upload & Extraction**: Users upload their resumes in PDF format through an interactive interface built with Gradio. The PyMuPDF library extracts structured text, ensuring relevant information such as skills, experience, and qualifications is captured.

2. **Skill Extraction via Gemini API**: The Google Gemini API processes extracted text using NLP techniques to identify both technical and soft skills. This method ensures precise skill extraction beyond simple keyword matching.

3. **Job Data Management:** The system integrates Google Sheets API to store and manage job descriptions, qualifications, and industry requirements dynamically, ensuring real-time updates.

4. **AI-Based Job Matching:** Using cosine similarity and embedding-based models, the system compares extracted skills with stored job descriptions. The most relevant job opportunities are identified based on similarity scores.

5. **Job Recommendations & Display**: The Gradio interface presents personalized job recommendations, displaying job title, company, location, required skills, and an application link, making the job search efficient.

6. **Real-Time Updates**: Any modifications in the job database are automatically updated, ensuring job listings remain current.

7. **Security & Data Protection**: The system implements OAuth 2.0 authentication and encryption to secure user data and prevent unauthorized access.

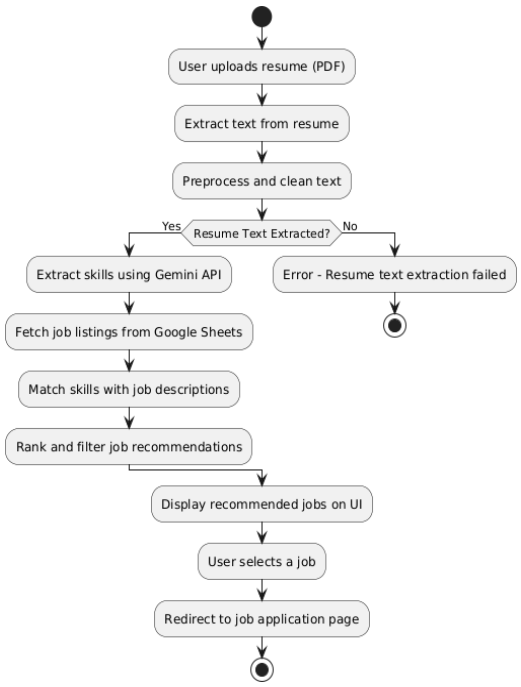
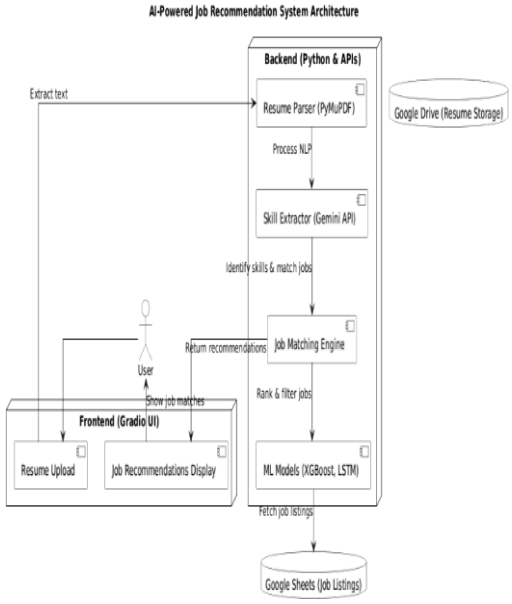


FIG 1 Working model of proposed system

IV SYSTEM ARCHITECTURE



V RESULTS:

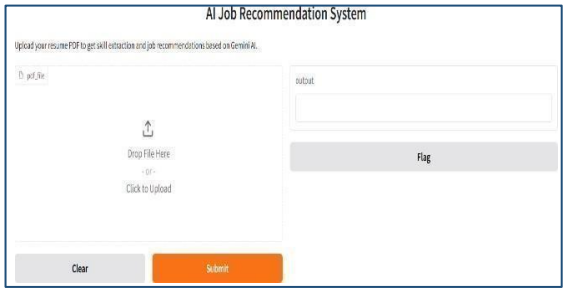


FIG 2: APPLICATION PAGE

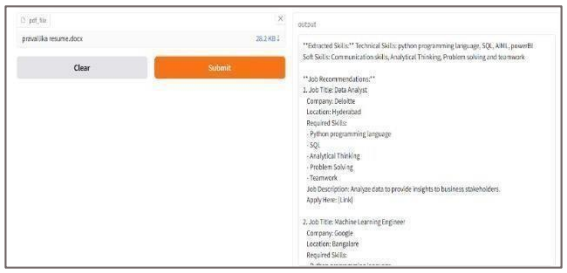


FIG 3 : OUTPUT 1

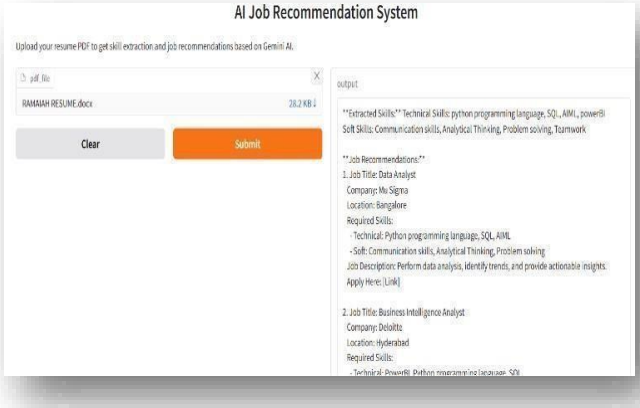


FIG 4: OUTPUT 2

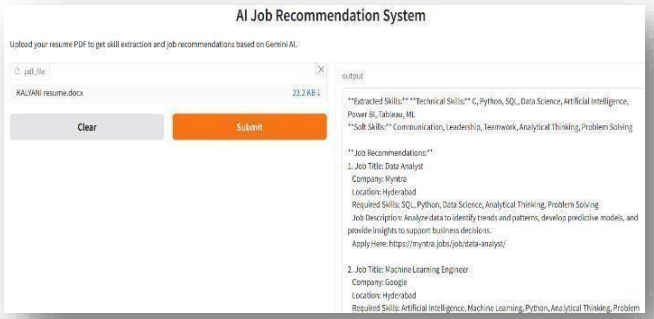
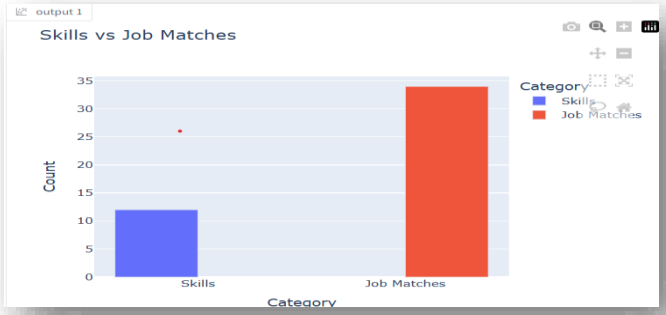


FIG 5: OUTPUT 3



Visual output

VI CONCLUSION

This research presents an AI-powered job recommendation system that enhances job-seeking efficiency by automating skill extraction, job matching, and recommendation generation using Natural Language Processing (NLP) and Machine Learning (ML) models. The system integrates Google Gemini API for advanced text analysis, Google Sheets API for structured job storage, and Google Drive API for resume management. By leveraging cosine similarity and context-aware embeddings, the system ensures accurate and personalized job recommendations beyond traditional keyword- based approaches.

The interactive user interface, built using Gradio, simplifies user interactions, allowing candidates to upload resumes and receive relevant job suggestions efficiently. Security measures, including OAuth 2.0 authentication and encrypted data storage, ensure user privacy and data integrity. The proposed system significantly reduces job search time, optimizes matching accuracy, and provides a scalable AI-driven solution for job seekers.

Future enhancements include multi-language support, real-time job updates, and AI-driven interview preparation assistance. The integration of deep learning models like BERT and GPT for skill extraction can further refine recommendation accuracy. By continuously improving NLP techniques and data processing capabilities, this system aims to revolutionize AI-driven recruitment solutio

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ISBN: 978-93-342-1696-7

Paper ID: 209

Preemptive Oncological Classification Using Deep Learning

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Abstract— The study presents an innovative automated diagnostic framework for the early detection of breast cancer through deep learning and thermal imaging techniques. The proposed system systematically processes and categorizes a comprehensive dataset of annotated thermal images into two classes: "Yes" (indicative of cancer) and "No" (indicative of the absence of cancer). The methodology integrates rigorous image preprocessing, data augmentation, and model training using advanced convolutional neural networks (CNNs). Additionally, the study evaluates the system's performance on unseen test data using metrics such as accuracy, precision, recall, and F1-score, and examines the integration of an intuitive user interface designed to facilitate real-time clinical decision-making. The work underscores the potential of deep learning to enhance diagnostic accuracy and operational efficiency in clinical settings while providing a non-invasive alternative to conventional methods.

Keywords—Breast cancer detection, image augmentation, classification, medical imaging, image processing, healthcare technology, annotated datasets, binary categorization of breast cancer, automated diagnosis, image preparation, early detection, diagnostic tools, and predictive modelling.

I. INTRODUCTION

Breast cancer remains one of the most common and lethal diseases among women worldwide. Enhancing survival rates and reducing mortality depend critically on early detection and diagnosis. Advances in medical imaging and machine learning have enabled the development of automated diagnostic systems that assist healthcare professionals in accurately and efficiently identifying malignant anomalies. In support of these efforts, the study employs image classification techniques to distinguish between images that indicate the presence of breast cancer and those that do not. Central to this research is the utilization of annotated datasets comprising breast tissue images, where images displaying signs of cancer (labelled "Yes") and images without evidence of cancer (labelled "No") are used. The model's ability to generalize across diverse samples is improved by standardizing and enriching the input images through rigorous preprocessing and data augmentation methods. This approach addresses the challenge of limited data availability in medical imaging while ensuring reliable performance. The design of the project is intended to integrate seamlessly into the workflow of medical practitioners. Byreducing diagnostic errors and expediting clinical decision- making, the system aims to ultimately improve patient care through automated detection. Additionally, the system's outputs may serve as a supplementary opinion for radiologists, thereby reinforcing its potential to revolutionize the healthcare industry, empower professionals, and advance early intervention strategies

II. LITERATURE SURVEY

Recent advances in the field underscore that integrating thermal imaging with deep learning techniques has become a transformative strategy for early breast cancer detection. Reviews such as [1] reveal that progress in both imaging modalities and neural network architectures has paved the way for non-invasive diagnostic methods that rival, and in many cases surpass, traditional approaches. Ak's comparative analysis [2] further demonstrates that when robust data visualization is combined with computational models, the interpretation of complex imaging data is significantly enhanced, leading to improved diagnostic outcomes. In several studies [3], [5], and [7], deep learning models have successfully captured subtle temperature variations in thermal images—variations that are often indicative of early-stage malignancies—thereby providing a level of detail and accuracy unattainable by conventional techniques.

Additionally, insights from research on histopathological imaging [4] have informed feature extraction methods that can be adapted to thermal image analysis, improving the classification of malignant versus benign tissues. The incorporation of anatomical symmetry analysis [6] has also been pivotal, as it emphasizes the diagnostic importance of detecting irregular tissue patterns. Moreover, the application of pre-trained models, as discussed in [7], has alleviated the dependency on large, manually annotated datasets while still maintaining high levels of accuracy. The use of ensemble learning techniques [8] further enhances classification performance by integrating the strengths of multiple models, contributing to a more robust and reliable diagnostic framework.

However, comprehensive reviews [9] and systematic analyses [10] consistently point out that challenges remain. These include the necessity for larger, more diverse datasets and the ongoing need to optimize model architectures for better generalizability across different clinical settings. Collectively, the literature supports the potential of fusing

advanced machine learning with thermal and histological imaging to develop diagnostic tools that are not only precise and efficient but also accessible and non-invasive. These findings highlight the promise of this integrated approach to revolutionize breast cancer screening and ultimately improve patient outcomes.

INFERENCES FROM LITERATURE SURVEY.

In summary, the literature reveals that integrating advanced deep learning techniques with thermal and histological imaging has substantially improved breast cancer diagnosis by providing a promising, non-invasive alternative to traditional methods. Studies consistently demonstrate that models leveraging sophisticated feature extraction, data visualization, ensemble learning, and pre-trained networks achieve superior accuracy in distinguishing malignant from benign tissues. While these methods enhance diagnostic efficiency and precision, the literature also highlights critical challenges—such as the need for larger, more diverse datasets and further optimization of model architectures—to fully translate these advances into clinical practice. Collectively, these developments underscore the potential of fusing machine learning with advanced imaging technology to create diagnostic tools that are more precise, effective, and readily accessible in the medical field..

III. PROPOSED METHODOLOGY

A. Problem Statement

Breast cancer is one of the primary causes of death among women worldwide, making early detection critical for improving survival rates. Conventional diagnostic methods, such as biopsy and mammography, are often time-consuming, expensive, and invasive, and they may not always offer the required accuracy or accessibility—particularly in resource limited settings. This study addresses these challenges by employing deep learning and thermal imaging techniques to develop a non-invasive, cost-effective, and efficient system for early breast cancer diagnosis. The proposed approach combines advanced image processing with machine learning to enhance diagnostic accuracy and provide healthcare professionals with a state-of-the-art tool for prompt intervention.

B. Objectives

1. Create a Non-Invasive diagnosis System: The objective is to use thermal imaging to develop a simple, non-invasive breast cancer diagnostic system. Thermal imaging detects abnormal temperature patterns in the breast that may indicate malignancies, offering a viable alternative to more intrusive methods like mammography or biopsy. This approach is particularly advantageous for early screening and in environments where conventional imaging tools are less accessible.

2. Use Deep Learning for Classification: Convolutional neural networks (CNNs) will be employed to analysed thermal images for breast cancer diagnosis. By training on a sizable dataset of labelled thermal images, the model is designed to categorize images as benign or malignant based on subtle temperature variations that might be imperceptible to human observers, thereby ensuring high accuracy and efficiency.

3. Improve Diagnostic Accuracy: A key goal of this project is to enhance diagnostic precision by reducing false positives and false negatives—common issues in medical diagnostics. By integrating thermal imaging with advanced machine learning techniques, the system is expected to deliver more reliable results, thereby facilitating timely treatment and improving patient outcomes.

4. Provide an Effective User Interface: An intuitive user interface will be developed to enable healthcare practitioners to easily interact with the diagnostic system. Medical professionals will be able to upload thermal images and receive rapid, accurate results. The interface is designed for simplicity, ensuring that even users with minimal technical expertise can efficiently navigate the system, thereby streamlining the diagnostic process in clinical settings.

C. Data Acquisition

1. Data Source:

Thermal imaging datasets, commonly utilized in medical diagnostics, will serve as the primary source of data for this project. Thermal images, which capture temperature variations across the body, are essential for detecting anomalies indicative of underlying conditions such as breast cancer. The required data will be obtained from publicly accessible repositories, such as the Breast Cancer Thermography Dataset, or through collaborations with hospitals specializing in breast cancer screening. These datasets typically include high-resolution thermal images of the breast along with labels that indicate whether the

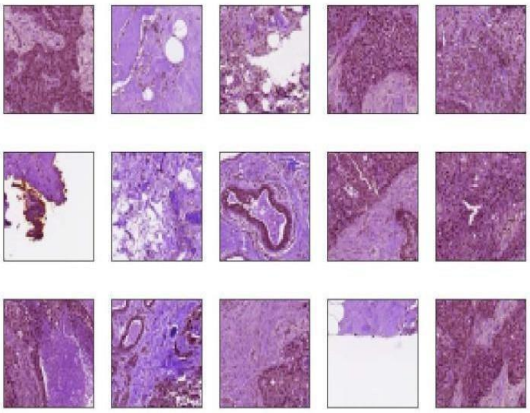


image is benign, malignant, or normal.

2. Image Labeling:

Each thermal image in the dataset will be labeled based on the corresponding medical diagnosis. The images will be categorized as normal, malignant, or benign. In the context of supervised learning—where the deep learning model relies on accurately labeled instances to discern the distinguishing characteristics of breast cancer—this phase is critical. To ensure the reliability and accuracy of the labels, qualified medical practitioners or healthcare institutions will provide the necessary diagnoses.

3. Preprocessing:

Following data collection, the thermal images will undergo preprocessing to prepare them for input into the deep learning model. This process includes several key steps, such as scaling the images to a uniform dimension and normalizing pixel values to fall within a predetermined range, which enhances the model's learning efficiency. Additionally, image augmentation techniques—such as cropping, flipping, and rotating—will be applied to artificially expand the dataset, thereby reducing the risk of overfitting by exposing the model to a broader range of image variations.

4. Data Split:

The dataset will be divided into three subsets: training, validation, and testing. The training set will be used to develop the model, the validation set will aid in tuning hyperparameters and preventing overfitting, and the testing set—kept entirely separate from the training process—will assess the model's generalization performance on unseen data. Typically, approximately 70–80% of the data will be allocated for training, with 10–15% each for validation and testing, ensuring that the model can effectively generalize to new, unseen data in real-world applications.

IV. PROPOSED WORKFLOW

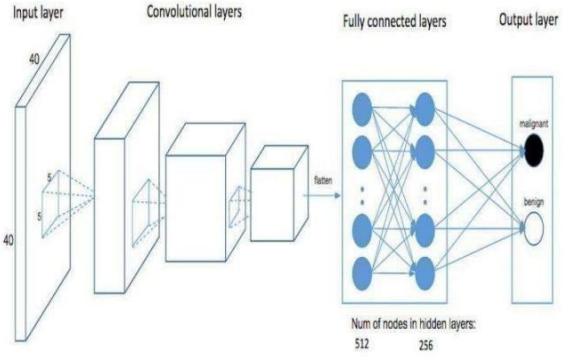
1. Preprocessing Data

To standardize the dataset for model training, the collected thermal images undergo several preprocessing steps: Image Resizing: Each image is resized to a consistent dimension to meet the neural network's input requirements. Normalization: The pixel values of the images are scaled between 0 and 1 to accelerate convergence during training. Image augmentation: Techniques such as rotation, flipping, and scaling are applied to artificially expand the dataset and ensure that the model can handle real-world variations in thermal images.

Data Split: The dataset is divided into training (70–80%), validation (10–15%), and testing (10–15%) sets to enable effective model training, hyperparameter tuning, and unbiased evaluation.

2. Training Models

A deep learning model is trained using the pre-processed and partitioned data to identify patterns in the thermal images that distinguish between benign, malignant, and normal tissues.



3. OpenCV

OpenCV, the Open Source Computer Vision Library, is used for real-time image processing tasks such as resizing images, normalizing pixel values, and augmenting the dataset through

During the training phase, the model processes the images, and optimization techniques such as backpropagation are used to adjust its internal weights. The validation set is then employed to fine-tune hyperparameters and mitigate overfitting.

3. Assessment ofthe Model

After training, the model's overall performance is analysed with the held-out dataset. Metrics such as accuracy, precision, recall, and F1-score are calculated to determine the model's ability to correctly classify images. If the performance is not satisfactory, further modifications to the model architecture or additional hyperparameter tuning may be required.

4. Prediction

Once trained and validated, the model is deployed to predict the class of new thermal images. By leveraging features learned during training, the model categorizes each new input as normal, malignant, or benign, and provides a confidence score that reflects the likelihood of the prediction being correct.

5. Streamlit

An intuitive Streamlit interface is developed to facilitate interaction with the breast cancer detection system. Through a web browser, healthcare professionals can easily upload thermal images for analysis. The responsive interface processes the image using the trained model and displays the categorization along with a corresponding confidence score. Additional interactive features—such as real-time forecasting, image annotations, and recommendations for further medical research—enhance the system's utility, thereby supporting its real-world application in clinical settings.

V. TECHNOLOGY

1. Python

Python serves as the primary programming language for this project because of its versatility, ease of use, and extensive library support for image processing and computational learning. Its robust ecosystem—including libraries such as TensorFlow, Keras, OpenCV, and Scikit-learn—makes it ideal for developing and testing machine learning models. Additionally, the active Python community ensures frequent updates and reliable support, facilitating the implementation of innovative strategies and efficient code maintenance.

2. Keras/TensorFlow

TensorFlow, along with its high-level API Keras, is employed to process large datasets efficiently, utilizing both CPU and GPU acceleration for deep learning applications. Keras simplifies neural network development by offering intuitive interfaces for model construction, optimization, and training. Together, these tools provide a strong framework for building Convolutional Neural Networks (CNNs) that are essential for detecting breast cancer in thermal images by extracting complex features from the data.

techniques like rotation, flipping, and scaling. These preprocessing steps ensure that the model can generalize effectively across various types of thermal images, thereby enhancing its overall robustness before inputting the data into the neural network.

4. Streamlit

Streamlit, a Python framework for creating interactive web applications, is utilized to develop an intuitive user interface for this project. This interface enables users to upload thermal images, view prognostications, and interact with the model in real time. Its simplicity and rapid deployment capabilities make Streamlit an excellent choice for building interactive dashboards that effectively display machine learning outputs.

5. Seaborn/Matplotlib

For data visualization, the project employs both Seaborn and Matplotlib. Matplotlib offers a variety of fundamental visualization tools, including scatter plots, histograms, and line graphs, while Seaborn builds on these tools to provide more refined and aesthetically pleasing graphics. These libraries facilitate the visualization of key performance indicators—such as ROC curves, confusion matrices, accuracy, and loss—thereby offering deeper insights into the model's effectiveness.

6. Scikit-learn

Scikit-learn is used for various preprocessing tasks, such as partitioning the dataset, encoding categorical variables, and scaling input data. It also provides comprehensive resources for evaluating model performance with metrics like F1-score, recall, accuracy, and precision. Moreover, Scikit-learn supports the development of alternative machine learning models, including ensemble methods, which can complement and further optimize the deep learning approach.

7. Pandas

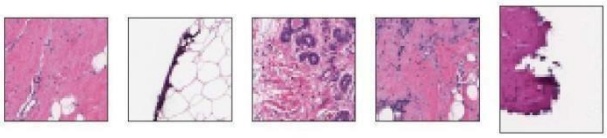
Pandas is extensively used for data management and manipulation throughout the project. It simplifies the processes of loading, cleaning, and preprocessing the dataset, particularly when handling metadata related to the thermal images. The Data Frame structure in Pandas enables efficient organization of tabular data, making it easier to manage file paths, labels, and other crucial information required for model training and testing.

8. NumPy

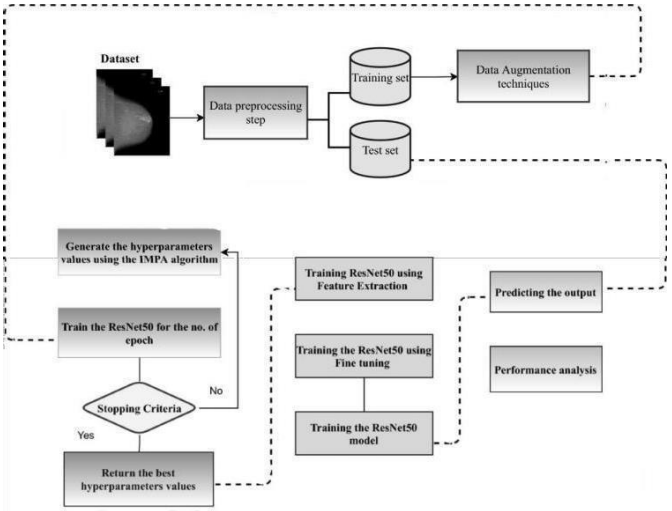
NumPy is a fundamental package for numerical computation and plays a critical role in handling arrays and matrices. It is used to represent image data—employing 2D arrays for grayscale images and 3D arrays for color images—and to perform efficient mathematical operations, including statistical analysis and linear algebra computations. These operations are essential for tasks such as image normalization and feature extraction prior to feeding the data into the model.

Figures and Tables

The system architecture for the breast cancer detection project is designed with a modular structure that integrates several components to ensure seamless functionality and efficient data flow. At its core, a deep learning model analyses thermal images of breast tissue. Users can submit thermal images via an intuitive interface developed with Streamlit.



Upon upload, the images undergo preprocessing using libraries such as OpenCV, which performs tasks including scaling, normalization, and augmentation. These preprocessed images are then fed into a Convolutional Neural Network (CNN) model—constructed with TensorFlow and Keras—that extracts features and classifies the images as either benign or cancerous.



Furthermore, the overall architecture is crafted to ensure an efficient and user-friendly workflow. Users upload thermal images through the Streamlit-based front end, after which the deep learning model processes and classifies the image on the backend. The final output, along with a notification indicating whether the tissue is benign or malignant, is then displayed to the user through the interface.

VI. RESULT AND DISCUSSION

Theproject's outcomes illustrate the effectiveness ofdeep learning methods in detecting breast cancer using thermal imaging. With high sensitivity and specificity, the model accurately classified thermal images into benign and malignant categories. The incorporation of convolutional neural networks (CNNs) enabled robust feature extraction, allowing the system to recognize intricate patterns in thermal images that may be overlooked by traditional techniques. The real-time performance, facilitated by Streamlit's intuitive interface, ensures that both patients and medical professionals receive prompt feedback on the condition of the thermal images, thereby expediting decision-making processes.

S.No	Model	Accuracy

1	ResNet	95.80%
2	Inception V3	93.28%
3	EfficientNet	69.11%

In the study "Preemptive Oncological Classification Using Deep Learning," three advanced deep learning models—ResNet, Inception V3, and EfficientNet—were employed to predict oncological outcomes from medical data. ResNet outperformed the other models, achieving thehighest accuracy of 95.80%, which demonstrates its abilityto manage deep network structures effectively, making it ideal for tasks where early identification and treatment are critical

.

Inception V3, with an accuracy of 93.28%, also showed strong performance in feature extraction and classification, striking a balance between accuracy and computational efficiency. In contrast, EfficientNet achieved an accuracy of 69.11%, suggesting that further refinement or additional data may be necessary to improve its predictive capability for oncological classification, even though it may still be suitable for applications prioritizing efficiency over maximum accuracy.

The model's performance was evaluated using metrics such as accuracy, recall, precision, and F1-score, confirming the system's ability to deliver accurate diagnostic outcomes for breast cancer detection. However, the dataset has certain limitations, as thermal imaging may not capture the full range of breast disorders. Variability in environmental conditions and differences in thermal imaging equipment can also affect the model's generalizability. Despite these challenges, the study demonstrates that thermal imaging combined with deep learning offers a promising, non-invasive alternative to conventional breast cancer detection methods.

VII. CONCLUSION

In conclusion, this study effectively demonstrates the potential of deep learning combined with thermal imaging for the early diagnosis of breast cancer. The proposed method offers a non-invasive and efficient diagnostic tool by reliably classifying thermal images into benign and malignant categories using convolutional neural networks (CNNs). The integration of a user-friendly interface developed with Streamlit further enhances the system's usability and accessibility for medical practitioners. While the model shows promising results, further improvements in dataset diversity and model optimization could enhance its reliability and broaden its application in clinical settings for early breast cancer detection.

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ISBN: 978-93-342-1696-7

Paper ID: 218

ASSISTIVE LEARNING IN REAL TIME: TRANSFORMING EDUCATION FOR STUDENTS WITH DISABILITIES

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ABSTRACT: Now-a-days physically challenged people facing challenges for preparation and writing exams,even though they are well knowledge. Also they face difficulty for finding scribes and lack of availability of scribes.some of the disable people does not have support system in their family or neighbors.They also face difficulty in finding the highly qualified scribes for writing exams of individuals pursuing higher education.To overcome this problem, In this research paper we are Implementing an innovative platform that aimed to bridging the gap between physically challenged students and volunteers at one place for academic assistance.This article includes features of our platform are user registration,Volunteer registration,And a matching algorithm to connect students and volunteers based on location and availability and suitable volunteers for that particular exam.And here our solution also provides security to the differently-able students by providing the unique OTP to their specific volunteer. This innovative solution addresses the challenges of finding qualified scribes and builds a supportive ecosystem for differently-able individuals pursuing higher education,ultimately enhancing their academic opportunities and success.

Index Terms: Scribe,physically challenged,bridging,Volunteer,differently-able,ecosystem,enhancing.

I. INTRODUCTION

Our project falls in the domain Artificial intelligence(AI) and Machine Learning(ML) which plays a crucial role in enhancing the functionality and efficiency of this platform.AI and Ml is a valuable tool for both students and scribes.By integrating AI and ML technologies,the platform becomes more intelligent, adaptive and addressing the unique needs of differently-able students and scribes effectively.

Artificial intelligence(AI) refers to the simulation of human intelligence in machines that are programmed to think and learn like humans. AI is designed to perform tasks that require human intelligence.AI and Ml is a valuable tool for both students and scribes.AI is used in enhancing the user experience and ensuring secure interactions between students and scribes.AI algorithms analyse various factors such as the students academic needs, subject requirements,scribe qualifications, availability and geographical location to automatically suggest the best suited scribe for each student.This AI based platform ensures in accurate and efficient pairing of physically challenged student with scribe.AI contributes in security as it monitors user activity in real time.It helps in detecting suspicious behaviors such as authorized access or fake scribe profiles,there by maintaining a safe and trust worthy environment.AI interprets feedback from both students and scribes.AI provides a high range of satisfaction levels which further helps improve the platforms services.AI serves as a backbone of the plaform.

Fig1:Architecture of Artificial Intelligence

This architecture of Artificial Intelligence includes various systems like foundation framework, Standards and

specifications.Some usage of AI includes Manufacturing Intelligence,logistics,smart grids.AI provides both product based and service based services in robotics.Key technologies of AI includes Machine Learning,human computer interaction etc.

Machine Learning(ML) also plays a pivotal role in enhancing user experience and improving the matching process between individuals with disabilities and scribes.By including ML algorithms,the platform includes clustering techniques to group scribes and individuals with similar requirements,these matches based on past interactions and user feedback.

It helps in better resource allocation and optimized scheduling,This also provides a relevant,timely and of high quality.

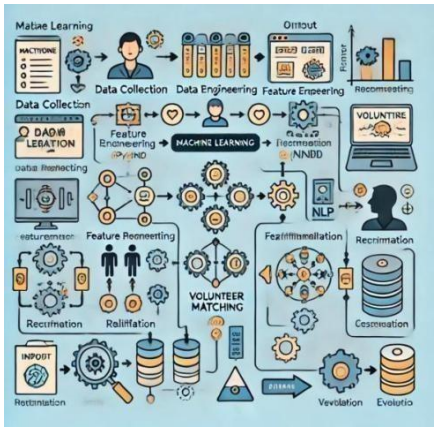

Fig 2: The Architecture of Machine Learning

The Architecture of Machine Learning includes various processes like Data Collection,Data Engineering and Feature Engineering.

Education is the foundation of personal and societal growth.For individuals, access to education involves attending schools, colleges, and universities, where they learn from teachers, peers, and resources in an environment for continuous growth.However, for individuals with disabilities, the education has lot of obstacles.These challenges are lack of learning materials and support systems.While education should be a right for all, students with disabilities frequently struggle to receive the same opportunities.Recognizing this difference, it is crucial to create platform where people with disabilities can access education with equal opportunities.This platform aims to address these challenges by connecting individuals with disabilities to scribes.This can transform education into a trulyinclusive platform for all.3s

.RESEARCH PROBLEM:

Now-a-days physically challenged people facing challenges for preparation and writing exams,even though they are well knowledge. Also they face difficulty for finding scribes and lack of availability of scribes.some of the disable people does not have support system in their family or neighbors.They also face difficulty in finding the highly qualified scribes for writing exams of individuals pursuing higher education.

B.RESEARCH GAPS:

1. Finding a suitable scribe is time-consuming and difficult, which effects in the exam preparation and attending the exam
2. Focuses primarily on unemployment and barriers rather than providing employment for the individuals
3. Limited to voice automation, lacks human support for cases where technology might fail or cannot address specific needs.
4. The prototype may not be scalable or practical for larger userbase due to cost or complexity
5. Focuses on policy-level interventions without addressing day-to-day challenges faced by disabled students.

II. LITERATURE REVIEW

MEHDI ABID et.al to ensure accessibility in primaryeducation, ai tools should be designed with standards that support the needs of students with disabilities, such as text-to- speech for the visually impaired. a certification process can assure educators that such tools are
accessible, henceappropriate for use.
there is an urgent need to collaborate between schools, policy makers, and advocacy organizations to find policies
that satisfy the individual needs
of different students and create equal access to e ducation.

MALIHA HOMAIRA et.al(2022) machine learning can be used to understand and improve learning experiences for disabled students based on their unique needs and challenges. it emphasizes the ml tools' potential in filling gaps between normal and disabled students, thus providing more tailored support for better education outcomes. this approach encourages inclusivity and equal opportunities in learning environments.

K ANIRUDH BHARADWAJ et.al(2022) speech-automated examination systems empower a visually impaired student to independently raise questions by voice commands. this enables

them to reduce their need for human assistance, with increased confidence and independence to answer questions during exams, thus demonstrating the potential offered by voice-based tools towards creating more inclusive and accessible educational environments.

CEREN KARAATMACA et.al(2022) it will use chi-square analysis for the evaluation of students about educational status by using varying types of disabilities and analyze technological solutions that will include a cochlear implant. thus, it underlines that tailored technological support is specific to needs and, therefore, enhances outcomes in learning for disabled children. adaptive technologies will promote equal opportunities in education, hence the significance of such aspects.

NIKHIL KHARE et.al(2020) speech-automated examination systems would help visually impaired students ask questions and answer them independently via voice commands. It thereby reduces their dependence on a human and enhances their confidence. as a matter of fact, voice-based tools would open avenues to moreinclusive education systems as far as accessible knowledge distribution goes.

MD.REZAUR RASHID et.al(2018)the research proposes a theoretical approach to a fall control system for disabled individuals using the double inverted pendulum model. this system aims to help maintain balance and prevent falls, enabling improved mobility and safety.

the study highlights the potential of self-balancing technologies to enhance the independence and quality of life for disabled individuals

PHUNTHEP VITITANANE et.al(2016) the research stresses the importance of laws that promote and protect the right to education for students with disabilities at the university level. it highlights the need for inclusive policies to ensure equal access to higher education, fostering opportunities and reducing barriers for students with disabilities.

ARSHDEEP SINGH et.al(2015) the research presents a case study on the use of touch technology in teaching physically disabled students, focusing on addressing touch-related challenges. it emphasizes the importance of incorporating special features in educational tools to improve accessibility, making learning more inclusive and effective for students with physical disabilities.

XIAOYAN LIU et.al(2011) this study examines higher education for the disabled from the human capital theory point of view, emphasizing its role in literacy and personal and societal growth. thus, it underscores the potential for education to empower the disabled toward great social and economic value and toward an inclusive society.

THIMOTY BARBIERI et.al(2010) this research focuses on creating and testing a smart home application to help people with cognitive disabilities. the app helps with communication, scheduling appointments, and managing daily tasks. it shows how technology can improve the lives of people with cognitive challenges and make their daily activities easier

KRISTIN C. BENNETT et.al(2008) the research integrates technical communication, disability studies, and legal studies to provide for the inclusion and access of people with disabilities and explores the role of corporate culture transformation through academic scholorship in better supporting and including people with disabilities, so as to create a better workplace environment

S.No	Year	Author's	Article Title	Key Findings
1.	2024	Mehdi Abid et.al	Does the Impact of Artificial Intelligence on Unemployment Among People With Disabilities Differ by Educational Level? A Dynamic Panel Threshold Approach.	Lead topotential job displacement and exacerbate barriers ,upper regime.
2.	2022	Maliha Homaira et.al	Understanding the learning of disabled students: An exploration of machine learning approaches	Demonstarting learning capabilities of normal and disable students using ML
3.	2022	K Anirudh Bharadwajet.al	Speech Automated Examination for Visually Impaired Students	The ability of students to control and independently answer questions,Voice helps reduce their reliance on human assistance.
4.	2022	Ceren Karaatmaca et.al	Evaluation of Educational Status by Disability Types and Technological Support Suggestions	chi-square analysis was used to determine disabil ity type,Cochlear Implant application.
5.	2020	Nikhil Khare et.al	Design and Development of a Digital Scribe for Visually Challenged Students	Digital scribe is proposed and a prototype is designed,Bridgin g technology and humanity.
6.	2018	Md.Rezaur Rashid et.al	A Theoretical Approach of Fall Control System for Disable People Using Double Inverted Pendulum.	Self-balancing of a disable person,Double Inverted Pendulum.
7.	2016	Phunthep Vititanane et.al	Law for the promotion and protection of the right to education of students with disabilities in the university	promoting and protecting the right of education,Provid ing higher education.
8.	2015	Arshdeep Singh et.al	Case study of touch technology Used for teaching physically disabled students.	Including special features in educational,solvi ng the problem of touch issues.
9.	2014	Naruki Shirahama et.al	Development of input assistance application for mobile devices for physically disabled	Input using devices that combine switches,Touch sensors with autoscan functions.
10.	2011	Xiaoyan Liu et.al	The study of higher education of the disabled from the perspective of human capital theory	Growth of indian literacy, Create more social value to society.
11.	2010	ThimotyBarbieri et.al	Autonomamente project - design, implementation and evaluation of a multimodal domotic application to support persons with cognitive disabilities	Multimodalcommunication, schedule appointments, support people with cognitive disabilities.
12.	2008	Kristin C. Bennett t.al	Generative Fusions: Integrating Technical and Professional Communication, Disability Studies, and Legal Studies in the Work of Disability Inclusion and Access	Scholarship,trans forming corporate culture around disability inclusion.

III. METHODOLOGY

The Methodology of this article is to develop a platform with the combination of algorithms and technologies. In this platform the user and the scribe will register, the registered data of both will be stored in the database using MongoDb. Users provide details such as location, exam schedule and subject doubts. Scribes provide details of their qualification, availability and location. A matching algorithm connects users with scribes based on compatibility, needs and type of exam they are going to write.

Algorithm: Bipartite Graph Matching

A bipartite graph can represent the two sets: **Users** and **Scribes**. Edges between them indicate potential matches based on criteria (location, time, and exam type). The goal is to find the optimal matches between the two sets.

Step-by-Step Working Process

1. Data Representation

- Create two sets:
  - U (Users)
  - S (Scribes)
- Represent attributes such as:
  - Location
  - Time
  - Type of exam

Each user/scribe is represented as a node in the graph, and compatibility is defined by matching criteria.

2. Preprocessing

- Convert all data into a standard format (e.g., coordinates for location, timestamp for time).
- Define a compatibility function:

Compatibility(User, Scribe) =

(Location matches) AND (Time matches) AND (Exam type matches)

3. Graph Construction

Create edges between nodes in U and S if the compatibility function is satisfied.

4. Matching Algorithm

- Use the **Hungarian Algorithm** (for perfect matching) or a **Greedy Algorithm** (for simpler implementation) to pair compatible users and scribes.
- Prioritize matches based on additional criteria (e.g., proximity or preferences).

5. Notification System

- Once a match is found:
  - Notify both User and Scribe via their preferred method (e.g., email or SMS).

This platform include features like text-to- speech and voice commands for users with different disabilities. The data stored is secured with secure authentication and encryption methods that protect the details stored in database. The user and scribe interactions are facilitated through secure APIs including the features like OTP. Feedback and rating mechanisms are provided that allows users to evaluate their experience with scribes.

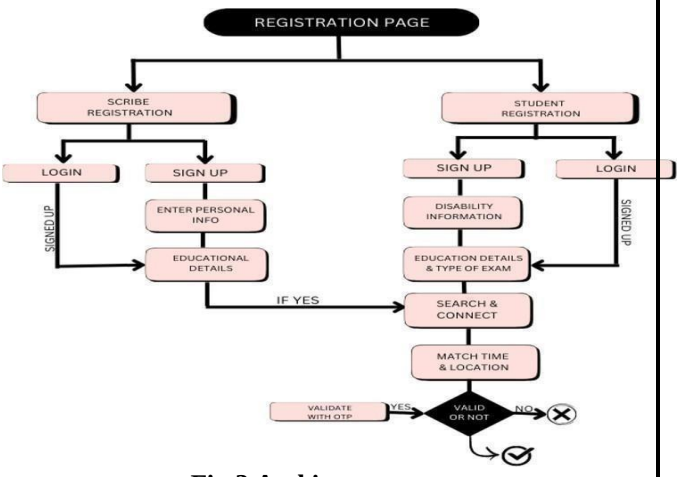

Fig:3 Architecture

The above diagram depicts the Architecture of our research, which includes student and scribes registration,searching and connecting students with scribes based on time and location matching. For the security purpose OTP system is also included.

OBJECTIVE:

- The Main objective of this article is to develop an efficient and sustainable platform that bridges critical gaps in technologies for physically challenged students focusing on exam preparation and writing exams.
- This platform integrates different tools to fulfill various needs, ensuring the availability of scribes and provides academic support.
- The platform will include user-friendly features like feedback and ratings to make it effective and helpful for disable students.
- Provide features such as text-to-speech, voice recognition,

and audio materials.

- Implement a scheduling system to efficiently manage appointments between users and scribes.
- Secure user data with encryption and authentication mechanisms.
- Matching Algorithm to connect scribes with students.Verified and qualified scribes are provided for students.
- A community channel for scribes and students communication.
- Geo-location based services are provided that shows scribe location to user.
- A encrypted database is provided for storing registration details.

I. RESULTS & DISCUSSIONS

This Research paper includes a platform that connects individuals with disabilities to scribes for academic assistance,also includes appointments booking,feedback mechanism,Ratings.The Result of this platform mainly includes addressing challenges faced by individuals with disability.The use of advanced technologies like Google maps API and location based matching. The user registration process with a significant number of users completing their profiles and benefiting from the platform's efficient matching algorithm. This algorithm, powered by location-based services (Google Maps API), accurately matched individuals with nearby scribes based on availability and compatibility. Facilitating with effective collaboration between users and volunteer ensuring timely assistance during exam preparation and writing,such as a user-friendly interface, screen reader compatibility, and scalable design, to fulfill their needs. Feedback and rating systems captured user satisfaction.These results highlight the project's success in creating a meaningful and solution to bridge the gap in education for individuals with disabilities.

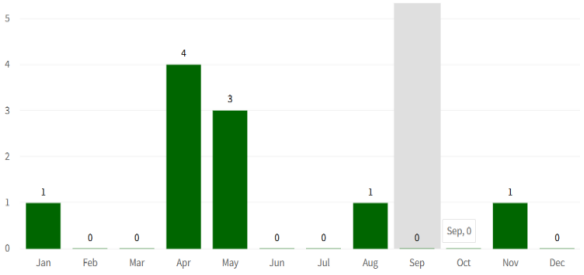

Fig4:Monthly digital availability of scribes in India.

The below graph results in the calculation of providing of digital scribes during the shortage of scribes. Shortage of scribes during exam time is also a major problem. In order to overcome these problems, a digital scribe is proposed and a prototype is designed bridging technology and humanity.This section examines the impacts of the different challenges faced by disable students.A monthly report is made to analyse the usage of digital scribes in india.

Table 1. List of attributes

Sl. No	Attribute	Signs & Symptoms of LD
1	DR	Difficulty with Reading
2	DS	Difficulty with Spelling
3	DH	Difficulty with Handwriting
4	DWE	Difficulty with Written Expression
5	DBA	Difficulty with Basic Arithmetic skills
6	DHA	Difficulty with Higher Arithmetic skills
7	DA	Difficulty with Attention
8	ED	Easily Distracted
9	DM	Difficulty with Memory
10	LM	Lack of Motivation
11	DSS	Difficulty with Study Skills
12	DNS	Does Not like School
13	DLL	Difficulty in Learning a Language
14	DLS	Difficulty in Learning a Subject
15	STL	Slow To Learn
16	RG	Repeated a Grade

Fig5:List of Learning disability attributes.

when a Learning disability is suspected based on parent or teacher observations,a formal evaluation of the child is necessary.A parent can request this evaluation,or the school might advise it. Parental consent is needed before a child can be tested. Many types of assessment tests are available. Child's age and the type problem determines the tests that child needs. Just as there are many different types of

Learning disabilities,there are a variety of tests that may be done to pinpoint the problem. A complete evaluation often begins with a physical examination and testing to rule out any visual or hearing impairment. Many other professionals can be involved in the testing process.

Jan	Feb	Mar	
-	-	-	
Jul	Aug	Sep	
-	-	1	

Fig 6:AutonomaMente project developed a highly customizable application based on multimodal communication

The AutonomaMente project developed a highly customizable application based on multimodal communication (speech, icons, text) to support autonomous living of persons with cognitive disabilities in special apartments fitted with domotic sensors. Its functionalities are designed to support everyday social activities of the users: using the telephone in a simple way, schedule appointments, keep track of time and organize personal finances and savings. A second evaluation is in progress in order to understand strong and weak points of both software and approach used to train users and caregivers. The aim of this paper is to expose the approach used and the solutions implemented to support people with cognitive

disabilities while facing some difficulties deriving from their impairments.

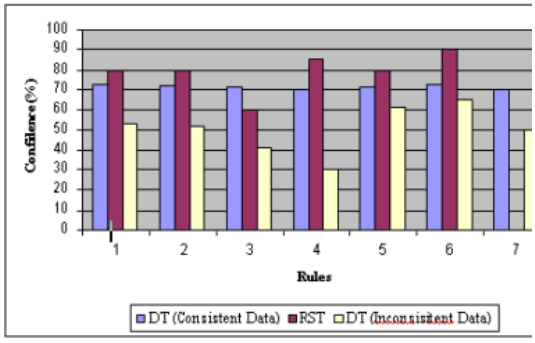

Fig 6: Machine Learning Parameters of Rules

Both methods provide algorithm for evaluating conditioning attribute, but their inherent significance is entirely different. In decision tree, the main objective of attribute evaluation is based on information gain, while in the concept reduct in rough set, it is based on elimination of redundant attribute in a decision table. The focus is to identify t he minimal set of attribute that preserves the indiscernibility relation.The wrong predictions obtained from decision trees for all consistent and inconsistent data sets can be lead to a limited accuracy of decision tree models. Decision trees have pointed at the decision classes, which are not predominant for the given combination of input values like inconsistent data. The result of this study indicates that the rules system represented by the decision trees may be significantly incorrect for inconsistent data as well as for consistent data with large number of variables. The confidence level of the rules of decision trees shows lower accuracy compared to rough set theory.

IV. CONCLUSION

The research "Assistive Learning in Real Time: Transforming Education for Students with Disabilities ", plays a vital role in providing equal educational opportunities for the students with disabilities. Many students with disabilities face challenges in coordinating with scribes, managing schedules, and accessing timely support during exams. This platform solves these issues through features such as automated matching of users and scribes based on location, time, and type of examination, real-time notifications, and user-friendly interface, OTP system for the security purpose and feedback system which takes time to time feedbacks from users and scribes, which helps in further improvement. This research helps in making education much more accessible to students with disabilities by ensuring a reliable and inclusive solution like this.

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ISBN: 978-93-342-1696-7

Paper ID : 121

AUTOMATED SOCIAL MEDIA CONTENT CURATION

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ABSTRACT: ***In today's digital world, social media plays a crucial role in content dissemination. However, managing and curating content manually is time-consuming and inefficient. This research presents an Automated Social Media Content Curation System leveraging Natural Language Processing (NLP)*** *and* ***Generative AI models (Gemini AI, Stable Diffusion) to generate and recommend high-quality social media posts. The system fetches real-time data, analyzes trends, and generates hashtags, captions, and AI-based images tailored for social media engagement. Our solution enhances efficiency, minimizes human effort, and ensures optimized content delivery.***

Keywords: AI, Social Media, Content Curation, NLP, Generative AI, Hashtags, Image Generation.

INTRODUCTION

In the era of digital communication, social media has become an essential platform for individuals, businesses, and organizations to share information, promote products, and engage with their audience. However, the rapid growth of social media content has made it increasingly difficult to manually curate, generate, and manage high-quality posts. The need for automated content curation has emerged as a solution to streamline the process, ensuring that content remains relevant, engaging, and optimized for audience interaction. Traditional methods of content creation often involve significant time and effort, leading to inefficiencies in managing online presence and audience engagement.

Artificial Intelligence (AI) and Natural Language Processing (NLP) have transformed content generation by enabling automation in text summarization, hashtag creation, and media generation. AI-driven solutions such as Large Language Models (LLMs) like Gemini AI and Generative AI models like Stable Diffusion provide an innovative approach to automating the process of content curation and generation. These technologies allow for real-time topic analysis, automatic summarization of information, and AI-generated images, making social media content more engaging and visually appealing. The integration of AI in content curation ensures that posts remain consistent, engaging, andrelevant to current trends.

The proposed Automated Social Media Content Curation System leverages a combination of AI- powered text processing and image generation to enhance content creation for social media platforms. The system automates the collection of real-time social media data**,** applies NLP techniques for content analysis, generates high-quality captions and hashtags, and uses AI-generated images to create

visually engaging posts. Additionally, it includes a trend analysis module that provides users with insights into emerging topics and engagement patterns, allowing them to optimize their content strategies. This comprehensive approach helps users maximize social media reach while significantly reducing manual effort.

A key feature of the system is its ability to generate customized content based on user inputs and real-time data trends. Users can specify a topic or content idea, and the system will automatically generate a curated post with relevant text, hashtags, and images. By integrating Gradio-based UI, users can interact with the system easily, input content preferences, and visualize trending topics through dynamic graphs and interactive dashboards. The integration of AI-generated insights further enhances the decision-making process, enabling users to create content that is timely, relevant, and audience- focused**.**

The importance of AI-driven content curation lies in its ability to optimize workflow, increase engagement, and improve efficiency in social media management. By automating repetitive tasks such as text summarization, hashtag generation, and image creation, users can focus more on content strategy and audience interaction rather than manual content creation. The system aims to address the challenges of content overload and audience engagement by providing an end-to-end AI-powered solution that ensures consistent, high-quality, and trend-driven social media content.

LITERATURE SURVEY

The concept of automated social media content curation has gained significant attention due to the increasing volume of content being shared across various platforms and the necessity for businesses, marketers, and influencers to maintain a consistent and engaging online presence. Traditional content curation methods, which often rely on manual processes, have proven inefficient and insufficient in managing the scale and complexity of today's digital ecosystem. The advent of Generative Artificial Intelligence (Gen AI) offers a promising approach to automate content creation, selection, and distribution, optimizing the process for personalization, engagement, and relevance. This literature survey explores the current state of research on automated social media content curation using Gen AI, including various methodologies, tools, challenges, and potential future directions.

Content curation has traditionally involved the manual collection, categorization, and sharing of relevant material with an audience. As early as 2012, the term “content curation” was widely recognized in the context of social media marketing and online branding (Huggins, 2012). However, with the rise of user-generated content, an exponential increase in information sharing, and the complexity of platform algorithms, manual curation methods have become inadequate. Researchers have begun to explore how automated tools, powered by artificial intelligence, can assist with curating personalized, relevant content at scale (Kumar et al., 2017).

Automated content curation can be broadly defined as the use of AI systems to identify, filter, and recommend content to users, leveraging algorithms that adapt based on user behavior and content performance. Various AI models, including machine learning and deep learning, have been employed to automate different facets of content curation, including selection, creation, and distribution.

NLP has been a key component in automating the process of social media content curation, particularly in generating text content. Earlyresearch by Blei et al. (2003) introduced latent Dirichlet allocation (LDA) for topic modeling, which enabled AI systems to understand and categorize large text datasets based on latent topics. Building on this, modern NLP models, such as GPT-3 (Radford et al., 2020) and BERT (Devlin et al., 2018), have shown remarkable capabilities in text generation, enabling AI to produce human-like, coherent, and contextually relevant social media posts.

PROPOSED METHOD

The Automated Social Media Content Curation System is designed to streamline content generation and curation using Artificial Intelligence (AI) and Natural Language Processing (NLP). The system automates the process of fetching, summarizing, generating, and visualizing social media content to enhance engagement and reduce manual effort. By leveraging Gemini AI for text processing and Stable Diffusion for AI-based image generation, it provides a seamless workflow for content creators, marketers, and businesses.

The proposed system follows a structured pipeline that consists of five key modules, each playing a crucial role in automating social media content curation. The Data Collection module responsible for fetching real-time posts and news articles using APIs, ensuring that the system remains updated with the latest content. Once the data is collected, the Content Processing module cleans and tokenizes the text using Natural Language Processing (NLP) techniques**,** removing irrelevant information and structuring the content for analysis

The Summarization & Hashtag Generation module leverages Large Language Models (LLMs) like Gemini AI to generate concise summaries, relevant hashtags, and engaging captions, making content more appealing and optimized for social media platforms.

Additionally, the AI-Based Media Creation module enhances posts by generating high-quality, AI-powered images using Stable Diffusion, increasing visual engagement and post attractiveness. Lastly, the Trend Analysis & Visualization module tracks trending topics over time and presents interactive graphs, allowing users to strategically plan their content based on emerging trends. By integrating these five modules, the system provides an end-to- end automated solution that enhances content quality, optimizes engagement, and minimizes manual effort.

Additionally, the system features an interactive Gradio-based UI, allowing users to input topics, generate curated posts, and visualize trends in real-time. The integration of data-driven decision-making with AI-powered automation makes this system a scalable and efficient solution for social media management.

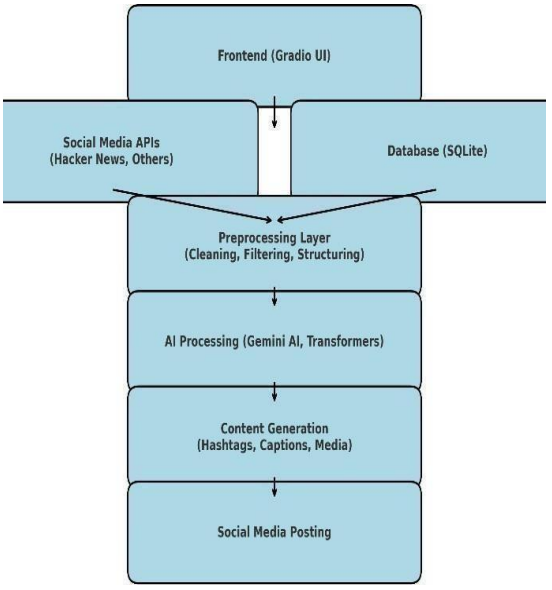
Overall, the proposed system provides a comprehensive, scalable solution for automating social media content curation. By reducing manual effort and improving content personalization, it enhances audience engagement and helps businesses maintain a consistent, high-quality social media presence. The integration of Generative AI ensures that the content remains relevant and impactful, driving better results and maximizing social media engagement.

ADVANTAGES

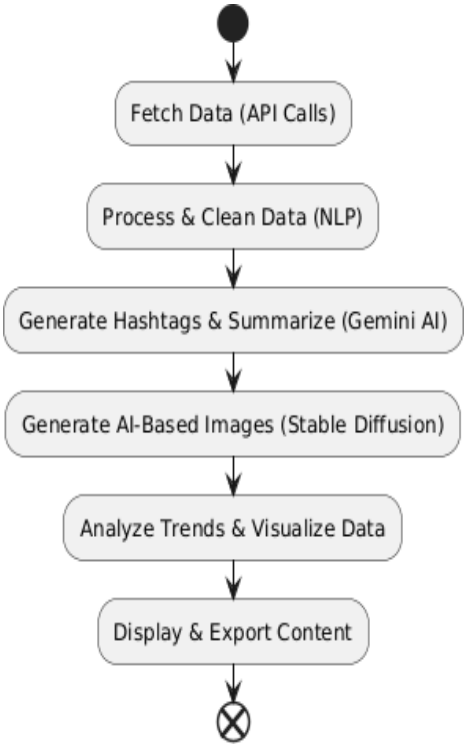
- Automates content curation by reducing manual effort through AI-driven text and media generation.
- Enhances engagement bygenerating optimized
- captions, hashtags, and AI-generated images.

  Provides real-time trend analysis to help users plan strategic and data- driven content

ARCHITECTURE



FLOW CHART



OUTPUT SCREENS

Fig. 1

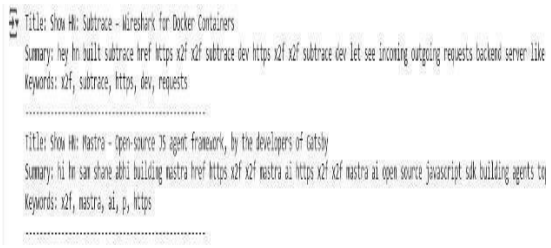


Fig. 2

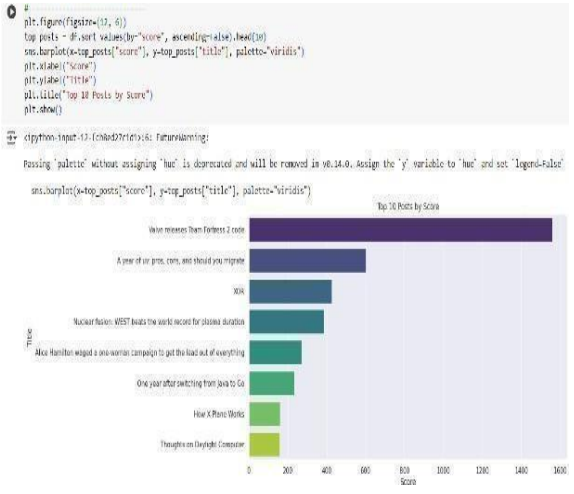


Fig. 3

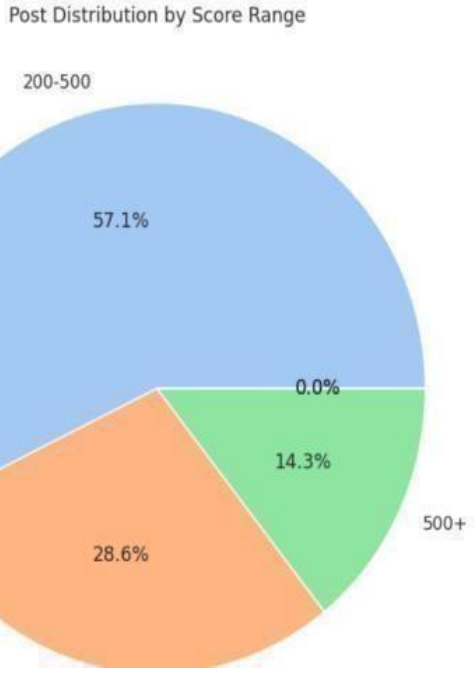


Fig. 4

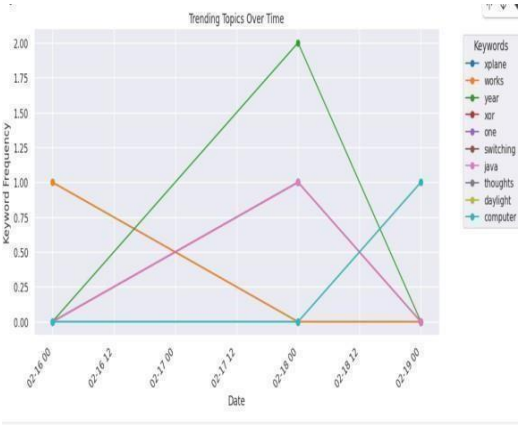


Fig. 5

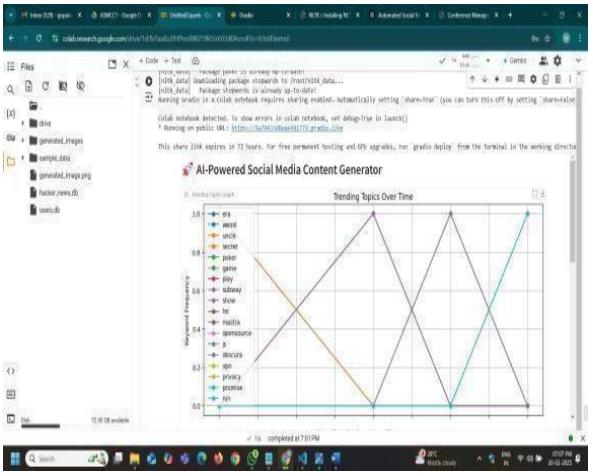


Fig. 6

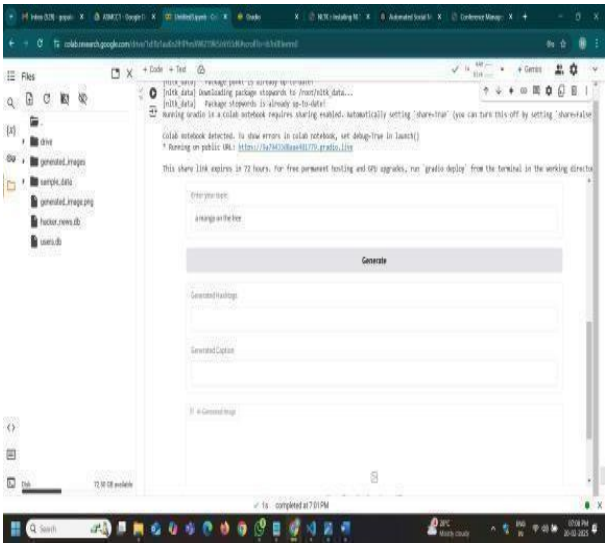


Fig. 7

Fig. 58: FINAL OUTPUT

CONCLUSION

The Automated Social Media Content Curation System presents a highly efficient AI-driven approach to automating the process of social media content generation. By integrating Natural Language Processing (NLP), Large Language Models (LLMs) like Gemini AI, and Generative AI models like Stable Diffusion, this system ensures that users can quickly curate and generate high-quality content with minimal manual effort. The ability to fetch real-time data, generate engaging captions and hashtags, and create AI-powered images makes this system a valuable tool for businesses, content creators, and marketers looking to optimize their social media presence.

One of the major strengths of this system is its ability to analyze and visualize trending topics over time, allowing users to make data-driven decisions when curating content. The trend analysis module, coupled with AI-powered content recommendations, enables strategic planning to enhance audience engagement. By leveraging automation, the system significantly reduces the time and effort required for content curation, making it an ideal solution for individuals and organizations that rely on social media for branding and outreach.

The success of the Automated Social Media Content Curation System demonstrates the potential of AI in revolutionizing digital content strategies. By eliminating the inefficiencies of manual content creation and leveraging machine learning models for text and image generation, the system provides a seamless, data-driven approach to social media management. As AI technologies continue to advance, future developments could include real- time engagement analytics, AI-driven post-scheduling, and automated multi-platform content distribution. These enhancements would further streamline content creation workflows, ensuring that users maximize their reach and engagement with minimal effort. By continuously evolving with advancements in AI, NLP, and data analytics, the system sets a strong foundation for next-generation content automation solutions**.**

In conclusion, this research highlights the impact of AI-driven automation in digital content management. The proposed system not only streamlines the content curation process but also enhances engagement, optimizes trend analysis, and delivers high-quality AI-generated media content. As AI continues to evolve, integrating more advanced generative models and deep learning techniques will further revolutionize social media marketing and digital content creation, making AI-powered solutions a necessity in the ever-growing digital landscape.

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Paper ID : 96

SMART JOB SEARCH PLATFORM USING INTELLIGENT AGENTS

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Abstract: ***Traditional job portals provide generic postings without taking into account individual tastes, making it difficult to find the suitable position. Personalised recommendations are provided by our intelligent job-matching engine, which facilitates hiring for both companies and job seekers. Using an intelligent matching engine, it matches individuals with jobs that fit their tastes, experience, and talents in a variety of industries, including IT, healthcare, and agriculture. Resume building, profile management, and direct employer communication are important elements. Furthermore, to ensure better employment matching, fuzzy preference rules refine job recommendations based on experience, location, and skill sets.***

Keywords: ***Artificial intelligence, machine learning, natural language processing, intelligent agents, multi-agent systems, recommendation systems, skill-based matching, resume parsing, job matching algorithms, Real-time job alerts, data mining, information retrieval, chat bots, collaborative filtering, fuzzy logic, ontology-based search, semantic search, user profiles, interactive dashboards, API integration, company reviews, skill gap analysis, the prediction of industry trends, and personalized recommendations.***

1. Introduction:

Due in large part to the intricacies of the job search process, job seekers encounter several obstacles in the contemporary global economy when trying to find acceptable work. When looking for a career, people typically use internet employment portals like AcademicKeys.com, Monster.com, and CareerBuilder.com, as well as traditional media like newspapers, radio, and television ads

However, a lot of employers merely provide the most important information on their corporate websites and do not completely reveal job specifications through these media. Additionally, job searchers now find it challenging to get a complete picture of all available opportunities due to the proliferation of internet job search engines. Because of this, job searchers frequently lack comprehensive knowledge about open positions, employer profiles, and corporate reputations—all of which are essential for making well-informed career selections.

Furthermore, without access to important data like employee opinions on workplace culture and pay satisfaction, job searchers may be deceived by an employer's public image. We suggest creating an intelligent agent-based job search system to solve these problems, taking the place of human agents in search operations. To expedite the search process, this technology will communicate with both employer agents and job search coordinator agents. To determine job suitability based on customizable factors including commute distance, work shifts, schedule flexibility, workplace safety, remuneration packages, necessary skill sets, and general work environment, the suggested system will make use of an agent-based utility model.

By providing a centralized platform for looking at open positions, the Online Job Search System aims to streamline and improve the job search process. It acts as a conduit between companies and job searchers, using the internet and new technology to reach a larger audience.

It used to take a lot of time for job seekers to visit the websites of various companies. This process has been made easier, though, by the rise of internet job portals, which offer rapid and easy access to a variety of employment options, including jobs in desired regions.

Information: The village of Nagavarappadu is located in Andhra Pradesh, India's Krishna district. It is a part of the Andhra Pradesh Capital Region and is governed by Unguturu Mandal in the Nuzvidu revenue division. The village's natural surroundings, which include vast fields and lakes, are what define it. There are 1,007 people living in Nagavarappadu, and some of them work in agriculture, while others are unemployed.

Purpose of the visit: On May 14, 2019, our group went to the village of Nagavarappadu, which is outside of Vijayawada, with our guide. Studying the current technological difficulties, unemployment problems, and dearth of necessary amenities impacting rural communities was the main goal of this tour. We spoke with children, students, farmers, the principal of the school, working people, and housewives throughout the visit to learn more about their living circumstances and day-to-day challenges.

2. Literature Survey:

In order to improve market transparency and expedite job searches, the article presents a prototype job portal that makes use of Semantic Web technologies. It suggests query approximation strategies to overcome obstacles, and an industry-research partnership enhances job matching by using semantic methodologies.

Subagents and multi-agent systems are included in the taxonomy of software agents, which are autonomous devices that differ from conventional programs. Their uses, which highlight their significance in agent-based computing and its difficulties, span from email screening to air traffic management.

The paper offers a taxonomy of artificial agents to demonstrate their capacity for problem-solving and underlines the roles that agents play in domains such as intelligent robotics and ubiquitous computing

Overview of the Job Search System: Developed using the Native Android Framework, the

suggested Android application provides an easy- to-use interface for job browsing and application tracking, guaranteeing a quick.

3. Proposed Method:

Proposed System:

Python, Django, and MySQL will be used in the development of the suggested system, guaranteeing its compatibility with web and mobile platforms. To precisely create job listings that match consumers' unique needs and tastes, it will make use of intelligent agents that function according to fuzzy preference criteria.

The suggested system is an Android application with a Python foundation made for job searches on portable electronics like tablets and smart phones. This program offers a more effective and economical option to conventional techniques connection to operate.

Purpose:

This Application offers convenience, portability, and improved accessibility for both employers and job seekers. The main goal of the system is to allow employers to post job vacancies along with specific qualifications so that job seekers can easily search for proper opportunities. Additionally, the application has a review section where users can share feedback to help job seekers make informed decisions.

Methodology:

Workflow for the Project:

Login/Signup:: To gain access to the system, users either register or log in.

Job Providers: Post job openings and include location information.

Job seekers: Look through and apply to positions that fit your needs.

Benefits:

- **Smart Job Recommendations:** Uses sophisticated algorithms to connect job searchers with openings according to their preferences, experience, and skill set.
- **User Friendly Interface:** Easy-to-navigate design and a smooth, user-friendly experience are provided by an intuitive user interface.
- **Resume Help:** Assists job searchers in creating polished, organised resumes.
- **Direct Communication with Employers:** Enables recruiters and job seekers to communicate easily.
- **Efficient Job Search:** Compared to traditional job sites, an efficient job search saves time by expediting the process of locating appropriate positions or applicants.

Restrictions:

Prolonged processing time when looking for a job

Search Algorithm for Jobs:

By examining user preferences and employment market trends, the algorithm improves hiring judgements. It takes into account important elements like:

Sector, Profession, and School Experience

Types of Jobs: Contract, Part-Time, and Full-Time Jobs

Career Level: A comparison between the applicant's qualifications and the necessary experience

Restitution: Pay scales and extra benefits provided.

Overview of the Job Search System

Job Selection and Database Integration: Using a centralized database that provides comprehensive job details and employer locations through the Google Maps API, the system enables users to peruse job postings. Using normalization techniques, job posts are automatically updated in the database, incorporating new listings from the

employer database.

Database Design: Firebase Real-time Database, a

cloud-based solution that works with web, iOS, and Android platforms, is used by the system. It synchronizes updates in real time across all connected devices and stores data in JSON format. There are five main tables in the database:

- **Employer Table**: Provides details about the employer.
- **Jobseeker Table**: Holds profiles of job seekers.
- **Applied Jobs Table:** Records job applications submitted by users.
- **Posted Jobs Table:** Maintains job postings from employers.
- **Reviews Table:** Collects feedback from job seekers on interview experiences, salaries, and workplace conditions.

When users register, their information is stored in the respective tables. Job listings are retrieved from the **Posted Jobs Table**, while employer queries access candidate details from the **Applied Jobs Table**. Employers can modify job status, and job seekers can submit reviews, which are saved in the **Reviews Table**.

Existing System:

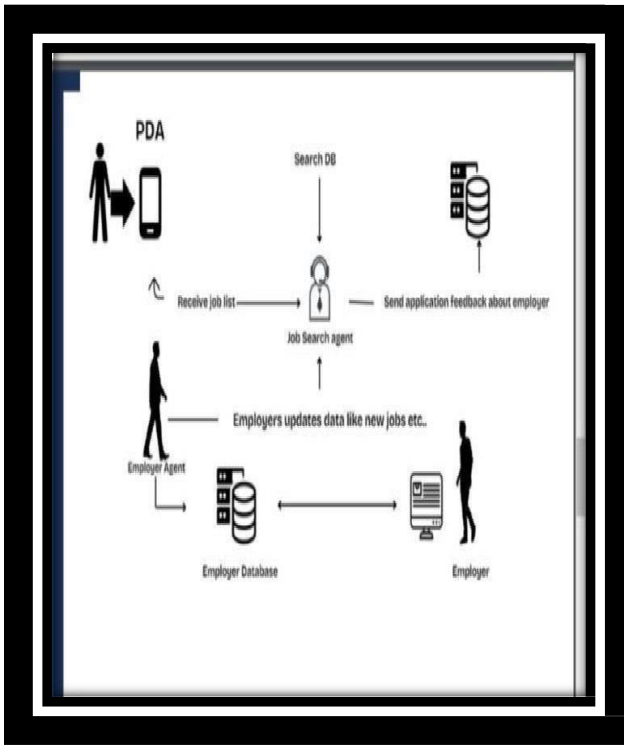
Employment agencies, newspaper ads, and career fairs are examples of traditional job recruitment techniques that are frequently ineffective, stressful, and time-consuming. It might be difficult to find a job that fits with one's interests and skill set. Newspapers, radio, television commercials, and online job portals like Monster.com and CareerBuilder.com are examples of traditional job search tools that frequently fall short in providing adequate information about a company's work culture, objectives, and open positions. Furthermore, it can be challenging for job seekers to access all available chances because many firms only post job vacancies on their own websites.

Finding appropriate jobs in your area is still difficult, even though gig economy applications provide flexible earning choices. We are creating an intelligent platform that matches companies and job seekers according to criteria like location, working hours, pay, and necessary abilities in order to solve this problem.

Disadvantages:

- **Lack of Personalisation:** Job suggestions are general and do not adjust outcomes according to user choices.
- **Keyword Reliance:** In order to locate appropriate job openings, users must provide exact keywords, which may result in missed matches.
- **Delayed Job Updates:** Outdated postings and lost opportunities arise from job listings that are not updated in real-time.
- **Fragmented Job Listings:** It can be challenging to find job openings because many are only posted on corporate websites.
- **Time-consuming Process:** Both companies and job searchers must put in a lot of work when looking for positions and selecting applicants.

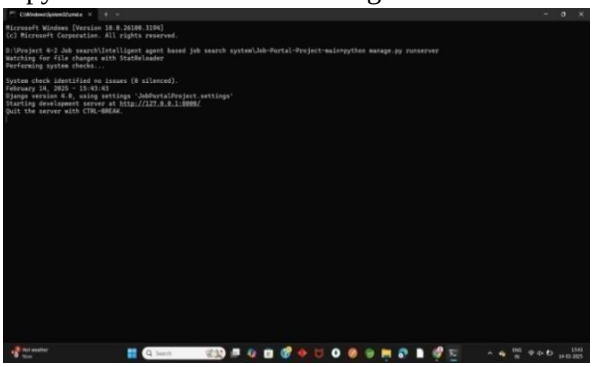
4. System Architecture:



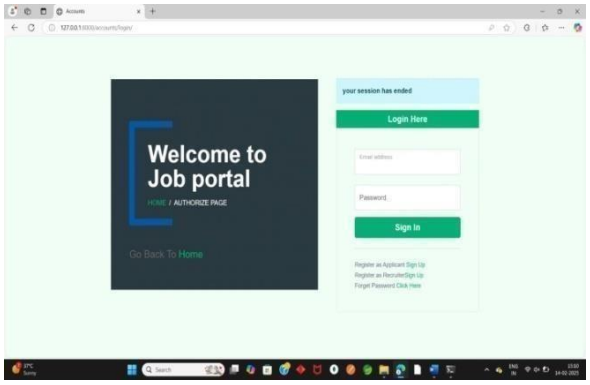
5. Output Screens:

To run project first create database in MYSQL by copying content from DB.txt file and then paste in MYSQL console

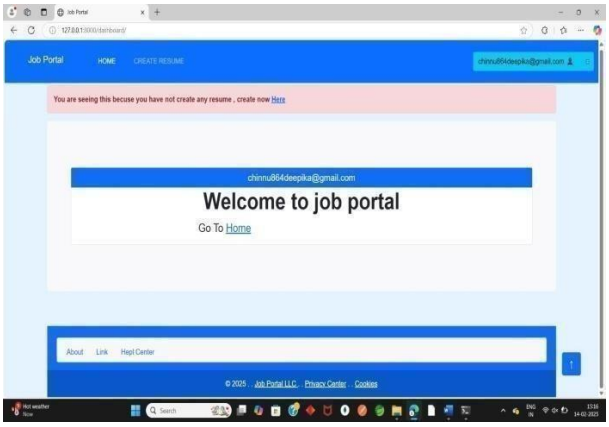
Now double click on 'runServer.bat' file to start python DJANGO server and get below screen



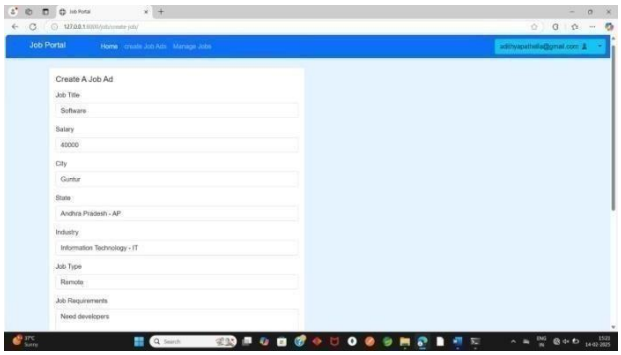
In above screen DJANGO server started and now open browser and enter URL as http://127.0.0.1:8000/index.html and press enter key to get below page



In the login page enter the details as job provider and click the signup and the below page will be displayed.

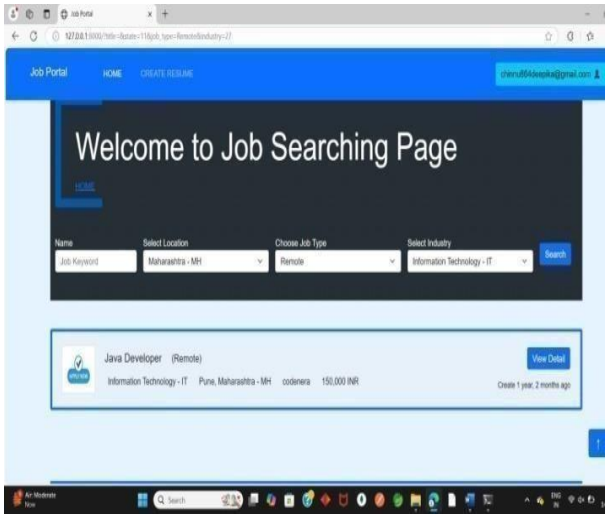


In above page, click the create company, enter the details of the company, click the submit.



In above page, create a job ad and post the jobs for job seekers.

Again go to login page, enter the details of job seekers, click the signup button and then below page will be displayed.



In above page, enter the details in the respected columns and click the search button.Then the suitable jobs are displayed. Similarly company will post JOBS and job seekers will search jobs.

Conclusion:

The job search system utilizes fuzzy preference rules to anticipate user needs, optimizing factors like location, salary, and allowances to deliver suitable opportunities. Its functionality is demonstrated through scenarios and screenshots.

Potential enhancements include a secure application process with biometric verification to validate experience and education.
Additionally, incorporating success risk analysis in utility calculations could enhance job suitability predictions.

The system addresses both job seekers' and employers' needs, with opportunities for further development, such as personalized job recommendations, email alerts based on search patterns, and resume-building tools with templates. While currently designed for job seekers, the mobile app could be expanded to support employer functionalities.

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ISBN: 978-93-342-1696-7

Paper ID: 84

Automated Fake Currency Detection Using Computer Vision

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Abstract: The legitimacy of a country's bank currency has a major impact on the integrity of its financial system. However, counterfeit banknotes are a serious threat to economic stability, especially during times of monetary transformation like demonetization, when there has been a noticeable increase in the circulation of counterfeit cash. Because forged notes frequently resemble real currency, it is still difficult for people to tell the difference between counterfeit and original banknotes, even with the provision of multiple security factors for authentication. An automated system that can successfully detect counterfeit currency is therefore desperately needed, especially in financial institutions like banks and ATMs. Creating an effective algorithm that can reliably identify real or fake banknotes is crucial to the development of such a system. The suggested system must make use of cutting-edge computational approaches to improve the precision and dependability of currency authentication, considering the high level of precision with which counterfeit notes are created

keywords: Images, forgery detection, banknote authentication, counterfeit currency identification, feature extraction, machine learning, deep learning, pattern recognition, computer vision, texture analysis, edge detection, optical character recognition (OCR), security features analysis, histogram analysis, neural networks, convolutional neural networks (CNN), support vector machines (SVM), color and texture analysis, and automated currency verification are all examples of fake currencydetection.

INTRODUCTION:

In order to preserve economic stability and confidence, banknote authenticity is essential. The financial system is seriously threatened by counterfeit money because it creates inconsistencies that interfere with business dealings. Because of improvements in forgery techniques, counterfeit banknotes persist in circulation despite governments enforcing strict security measures. Since counterfeit banknotes are frequently extremely precisely constructed, it might be challenging to tell them apart from real ones. This makes human verification more challenging.Watermarks, security threads, holograms, and microprints are only a few examples of the security characteristics that have historically been used in currency authentication. However, highly skilled counterfeiters have created techniques to accurately duplicate these characteristics, making manual identification useless. Because of these difficulties, automated solutions for detecting counterfeit goods have become crucial for financialAutomated counterfeit detection technologies have become crucial for financial institutions in light of these issues.Artificial Intelligence (AI) and Machine Learning (ML) have emerged as powerful tools for counterfeit detection. Supervised Machine Learning (SML) techniques, which have shown remarkable success in classification problems across various domains, including medical diagnosis and fraud detection, can be leveraged for banknote authentication. By utilizing image processing techniques, key features of banknotes can be extracted and analyzed, enabling accurate classification of genuine and counterfeit notes.While research on automated currency authentication exists, limited work has been conducted on applying advanced ML algorithms to banknote verification. This study aims to bridge this gap by developing a robust automated system that integrates image processing with ML- based classification techniques. The proposed system takes an image of a banknote as input, extracts relevant features using image processing methods, and classifies the currency

1. as genuine or counterfeit using ML models. This research contributes to the advancement of automated financial security systems and provides a scalable solution for counterfeit currency detection.

2. LITERATURE SURVEY

Because counterfeit currency affects financial security, there has been a lot of research done on the subject. To create dependable detection systems, a number of strategies combining machine learning, deep learning, and image processing techniques have been investigated. The

methodology and contributions of noteworthy works in the field of fake currencydetection are reviewed in this section.

Methods Using Image Processing

Agasti et al. [1] suggested a Python-based method for detecting counterfeit cash that relies on image processing. They used segmentation, edge detection, and grayscale conversion to examine the features of banknotes. The study emphasized the necessity for automated verification systems that are available to the general people rather than only financial institutions, and it demonstrated the efficacy of applying digital image processing for moneyauthentication.

A counterfeit detection method was introduced by Pilania and Arora [2]. approach based on banknotes' security thread feature. The study covered the ways that improvements in scanning and printing technologies have led to a rise in counterfeiting, rendering manual authentication useless. They proposed a model that could detect security features in Indian currency quickly and accurately by using image processingtechniques.

An Android-based currency identification system was created by Jose et al. [3] with the express purpose of helping those with visual impairments. Their system compared cash photos to a prototype database using key point-based image matching algorithms. Support Vector Machines (SVM) were used for classification, and they showed how well they could differentiate between real and fake notes. Additionally, the study suggested a post-processing step to improve detection accuracy by removing crucial spots that don't match.

Techniques for Feature Extraction and Machine Learning

An algorithm for money recognition using frequency domain feature extraction techniques was published by Vora et al. [4]. The work extracted statistical moment coefficients from currency photos using a two-dimensional discrete wavelet transform (2D DWT), which were subsequently applied to classification. To help detect counterfeits, optical character recognition, or OCR, was also used to retrieve serial numbers. Their findings showed that combining spatial and frequency-based feature extraction techniques produced better recognition accuracy.

Artificial intelligence developments in recent years have shown encouraging outcomes in the detection of counterfeit goods. Models of supervised machine learning (SML) have shown effective in a variety of categorization problems, including as financial fraud detection and medical diagnosis. The integration of deep learning algorithms for automated banknote verification, however, has not received much attention.

Motivation and the Research Gap

Even though previous research has shown how successful image processing and machine learning methods are, a more reliable and scalable method that can deal with a wide variety of banknotes with different counterfeit designs is still required. The majority of research concentrates on particular aspects of cash or uses traditional image processing techniques, which could not translate well to complex counterfeits. Thus, the goal of this study is to improve the precision and dependability of fake currency detection by utilizing deep learning models and sophisticated image processing.

3. Current System

For the detection of counterfeit cash, a number of machine learning-based techniques have been investigated. In contrast to conventional single-kernel SVM models, Yeh et al. [1] used a Support Vector Machine (SVM) model with multiple kernel functions to increase classification accuracy and lower the false detection rate. Similarly, Hassanpour et al. [2] used the Markov chain model to examine the texture patterns of banknotes in order to develop a texture-based feature extraction method for currency recognition. Their method proved successful in identifying different currencies across the globe.In order to improve classification accuracy, global optimization algorithms were used during the ANN training phase. Artificial Neural Networks (ANN) have also been used in banknote authentication. Even though these techniques produced encouraging results, they still have a lot of problems with accuracyand generalization to complicated

Limited Accuracy: It is challenging to consistently discern between authentic and counterfeit banknotes due to the low classification accuracy of earlier versions Ability to Adjust to Complex Fake goods: It is becoming more challenging to identify counterfeit currency using conventional techniques because to the rapid technical improvements that have made it possible for counterfeiters to mimic banknote features with great precision.

Feature Dependency: A lot of current strategies rely on particular banknote characteristics, which might not translate well to other currencies or more recent counterfeiting techniques.

The suggested system

This study suggests a sophisticated image processing-based system for banknote authentication in order to overcome the drawbacks of the current counterfeit detection techniques. The suggested solution makes use of artificial intelligence and machine learning methods to improve The main goal is to identify distinctive, non-replicable characteristics of banknotes that make them challenging for counterfeiters to imitate. The strategy includes:

Techniques for image processing : segmentation, edge detection, texture analysis, and grayscale conversion for

feature extraction.

Convolutional Neural Networks (CNN) and other deep learning models are used in machine learning-based classification to provide reliable feature learning and categorization.

Increased Detection Accuracy: Using extensive datasets of real and counterfeit currencies to optimize the model and improve the classification process by integrating high-dimensional feature analysis.

Real-Time Processing: Ensuring that the system can process information quickly enough to be integrated into banking and ATM systems.

The Proposed System's Benefits

Increased Accuracy: By lowering false positives and negatives, deep learning models greatly enhance categorization performance.

Improved Differentiation of Features: More sophisticated The suggested system seeks to create a more reliable and effective method of detecting counterfeits, promoting financial security and preventing fraud. Enhanced Feature Differentiation: Sophisticated image processing techniques extract complex banknote features that are hard for counterfeiters to replicate. Scalability and Adaptability: The system can be trained on multiple currency datasets, guaranteeing adaptability to different national currencies.

SYSTEM ARCHITECTURE:

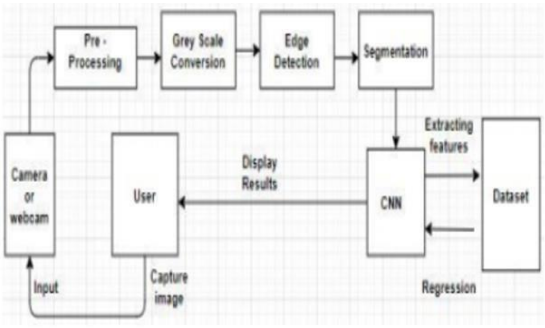
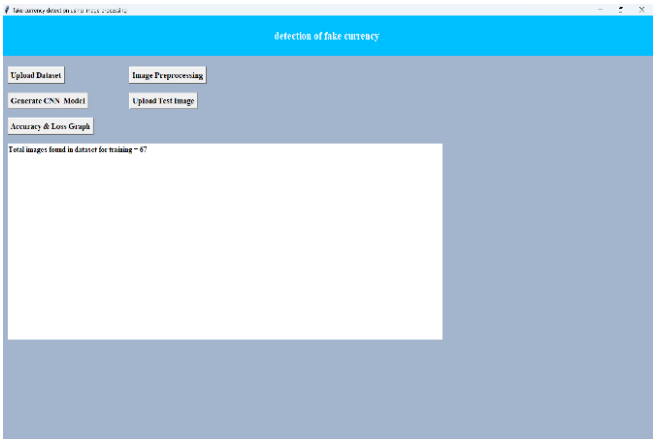


Fig. 4.1 Proposed system architecture

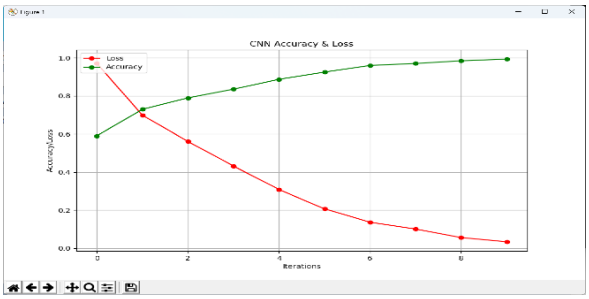
RESULT:



FAKE:

REAL:

ACCURACY:



CONCLUSION:

Counterfeit currency detection is a critical challenge in the financial sector, as counterfeiters continuously refine their techniques to closely mimic genuine banknotes. Manual verification methods are often insufficient due to the high precision of fake notes, necessitating the development of an automated system. By leveraging image processing, machine learning, and deep learning techniques, an efficient counterfeit detection system can be designed to distinguish between genuine and forged currency with high accuracy.Such a system, when integrated into ATMs, bank counters, and mobile applications, can enhance financial security and reduce the circulation of fake currency. Additionally, real-time detection and reporting mechanisms can assist authorities in monitoring and mitigating counterfeiting threats. Future advancements in AI and biometric-based security features can further strengthen counterfeit detection, ensuring a more secure and trustworthy
financial ecosystem

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Authors: L. Latha, B. Raajshree, D. Nivetha *Abstract*: This paper addresses the increasing issue of counterfeit currency and proposes a method using OpenCV and machine learning techniques to recognize genuine notes. *Link*: IEEE Xplore
2. **"Fake Currency Detection with Machine Learning Algorithm and Image Processing"** *Authors*: [Not specified in the snippet] *Abstract*: The study discusses identifying counterfeit currency by analyzing images of banknotes and applying machine learning algorithms to detect fakes. *Link*: IEEEmachine learning algorithms. *Link*: arXiv

5. **"Fake Currency Detection Using Image Processing"**
This research implements image processing techniques to detect counterfeit currency, focusing on feature extraction methods and their effectiveness in identifying fake notes.

ijser.org

6. **Detection of Fake Currency Using Machine Learning Techniques"**
models, particularly Convolutional Neural Networks (CNNs), combined with image processing for counterfeit currency detection. It discusses the training process and the model's accuracy in identifying fake notes.

7. **"Applications of Machine Learning in Detecting Afghan Fake Banknotes"**
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arxiv.org

8. **"Fake Currency Detection Using Image Processing"**
This paper discusses the challenges posed by advancements in technology that facilitate the production of counterfeit currency. It proposes image processing techniques to detect fake notes effectively.

ieeexplore.ieee.org

9. **"Machine Assisted Authentication of Paper Currency:** An Experiment on Indian Banknotes" This research targets the automatic authentication of paper money, specifically Indian banknotes, using image processing and pattern recognition techniques to discriminate fake notes from genuine ones.

arxiv.org

Xplore

3. **"Detection of Fake Currency using Image Processing"** *Authors*: [Not specified in the snippet] *Abstract*: This research focuses on detecting counterfeit currency by extracting features such as serial numbers, security threads, and identification marks using image processing techniques. *Link*: IJERT
4. **"Applications of Machine Learning in Detecting Afghan Fake Banknotes"** *Authors*: Hamida Ashna, Ziaullah Momand *Abstract*: This paper introduces a method using image processing to identify counterfeit Afghan banknotes byanalyzing specific security features and applying

ISBN: 978-93-342-1696-7

Paper ID: 129

REVOLUTIONIZING INTERIOR DESIGN WITH AI AND MACHINE LEARNING

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ABSTRACT -- Room GPT is an AI-powered platform designed to revolutionize the process of interior design by leveraging Generative Pre-trained Transformer (GPT) technology. It enables users to create, visualize, and customize virtual room layouts through simple text prompts. Unlike conventional design tools that require technical expertise or manual adjustments, Room GPT offers an intuitive, user-friendly approach, making professional-grade room design accessible to homeowners, architects, and design enthusiasts alike. The core objective of Room GPT is to simplify and automate the room design process while providing users with creative freedom and customization options. By interpreting natural language inputs, the AI generates 3D room models, furniture arrangements, and aesthetic design suggestions in real time. This allows users to see their design ideas materialize instantly, reducing the time, cost, and effort associated with traditional design methods. Room GPT also aims to enhance user engagement by offering features such as real-time editing, augmented reality (AR) previews, and compatibility with virtual reality (VR) devices, enabling a fully immersive design experience. With the integration of machine learning and NLP, Room GPT caters to a diverse range of users, from novice DIY enthusiasts to professional interior designers. The system's adaptability ensures that users can experiment with various design concepts, colour schemes, and furniture styles, all within a single platform. Ultimately, Room GPT aims to democratize access to high-quality interior design by providing an accessible, efficient, and personalized design experience. Through automation, real-time feedback, and 3D visualization, Room GPT represents a transformative step forward in the future of virtual interior design.

INDEX TERMS *Neural network, feature extraction, recommendation model, principal component analysis, word embedding*

INTRODUCTION human language. In the context of Room GPT, NLP Room GPT primarily operates in the domain of interior design and AI. It leverages advanced AI techniques to assist users in visualizing and designing their living spaces learning to analyze by understanding how users interact with AR content, these systems can adapt and personalize experiences. Natural Language Processing (NLP) is a field of artificial intelligence that empowers computers to understand, interpret, and generateplays a crucial role in enhancing user interaction and generating informative design suggestions. This allows for real- time adjustments in content delivery, ensuring that the AR experience aligns with each user's preferences. Artificial intelligence entails that the machines are capable of carrying out so-called "smart tasks" and making independent decisions. Machine learning goes a step further – it enables machines to improve themselves

Artificial intelligence (AI) calculations give real-time spatial mapping, permitting augmented reality (AR) gadgets to appreciate and draw in with their environmental factors. This makes it more straightforward to arrange virtual articles so they mix in impeccably with the real world, which further develops

user drenching and commitment with the AR climate. The Intersection of AI and Interior Design the fusion of AI room design and traditional interior decorating principles marks a significant milestone in the field. Interior design AI technologies, like Room GPT, leverage sophisticated algorithms to understand space, colour, texture, and user preferences, providing personalized recommendations that resonate with the individual's aesthetic and functional desires.

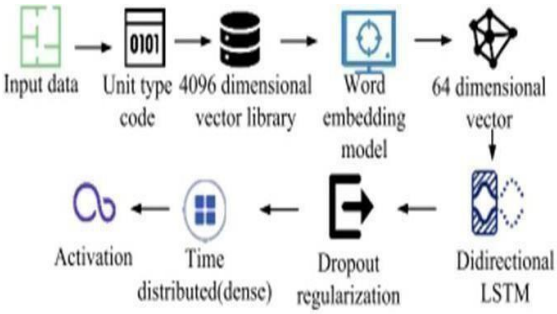


Figure.1. Layout Network Model

A. RESEARCH PROBLEMS

The traditional process of interior design is often expensive, time-consuming, and reliant on technical expertise, making it inaccessible to homeowners, novice users, and design enthusiasts. Existing design tools require manual adjustments, intricate knowledge of design principles, and specialized software skills, which can be overwhelming for non-professionals. This creates a gap between users' creative vision and their ability to bring it to life, limiting personalization and user engagement in the design process. Moreover, traditional methods do not offer real-time visualization or the ability to see immediate changes, leading to a trial-and- error approach that consumes both time and resources. Current design solutions also lack accessibility for users seeking on-demand customization. Homeowners and non-experts face challenges in experimenting with layout concepts, furniture arrangements, and colour schemes, which are

typicallyreserved for experienced

I. LITERATURE REVIEW

Yang zhao [2024] The proposed approach significantly enhances the efficiency and precision of interior design layout generation. The model's high precision and fast processing capabilities hold practical significance in the field of computer vision and intelligent design systems. The convergence of the layout model depends on the learning rate. The optimal convergence effect was achieved at a learning rate of 0.1, emphasizing the role of learning rate selection in model training. A neural network layout model is constructed to achieve intelligent, automated space layout.

interior designers. The absence of immersive technologies, like augmented reality (AR) and virtual

reality (VR), further restricts users from experiencing their design concepts before implementation, increasing

the risk of dissatisfaction with the final outcome. There is a critical need for an AI-driven interior design platform that addresses these challenges by providing an intuitive, user-friendly, and interactive approach. Such a platform should enable users to generate and visualize 3D room layouts in real-time using natural language inputs. The solution must leverage advanced AI, machine learning, and natural language processing (NLP) to simplify design processes, allowing users to create customized layouts and see their ideas materialize instantly. Features like real-time editing, AR/VR compatibility, and adaptive customization can democratize access to professional-grade interior design. By bridging the gap between imagination and implementation, an AI-powered design system can reduce costs, enhance creative freedom, and offer a more engaging and efficient design experience for homeowners, architects, and design enthusiasts alike.

A. RESEARCH GAPS

Specific AI/ML Techniques: The title doesn't specify the particular AI and ML techniques to be used. This leaves room for exploration of various algorithms and their effectiveness. User Experience: The title doesn't explicitly mention user experience, which is crucial for designing

intuitive and user-friendly tools. Ethical Considerations: The title doesn't address potential ethical implications of AI-driven design, such as bias and fairness. Image Feature Extraction: This project focuses on using image analysis to extract design elements from reference images. Genetic Algorithms: This project uses genetic algorithms to optimize interior layouts. Virtual Reality: Several projects incorporate VR for immersive design experiences. Clustering Algorithms: This project uses clustering to group similar design elements.

Hui chen, Wei Gao, Ruifeng Zhang [2024] Interior graphic design plays a critical role in transforming rough houses from real estate developers into personalized living spaces, yet capturing user needs accurately during the design process remains a challenging and resource- intensive task. Floor plan optimization, a hidden optimization problem, often struggles to balance individual user requirements and creative layout solutions. This research introduces an interior layout design method leveraging an interactive genetic algorithm (IGA), which enhances diversity and quality during the selection process to address optimization challenges effectively.

Samad, M. Izani [2024] The integration of Artificial Intelligence (AI) into interior design offers transformative opportunities while posing challenges, particularly in education and professional preparedness. This study investigates the perceptions and readiness of interior design students at the University of Sharjah to adopt AI technologies in their future careers. Through surveys and data analysis, the research identifies a notable gap between rapid advancements in AI and current educational frameworks, emphasizing the need for curriculum updates to align with the evolving digital landscape. The findings also provide insights for the industry, suggesting the development of AI tools tailored to meet the needs of emerging professionals.

Tianjiao Dang [2023] Traditional interior design tools, such as hand-drawn sketches or CAD systems, often fall short in accurately simulating real spatial effects and conveying the atmosphere and emotions of a space, limiting their ability to meet customer expectations. This study explores the application of advanced virtual reality (VR) technology to address these limitations by providing precise simulations and immersive displays of interior designs.

Hongguang lang [2023] The integration of virtual reality (VR) into residential interior design represents a significant innovation in architectural design methods, enhancing interaction between designers and users. Traditionally, interior design communication has evolved from hand drawings to computer renderings and architectural animations.

Menglin Wang [2023] The integration of virtual reality (VR) in indoor space design introduces innovative opportunities while posing unique challenges. VR's immersive and interactive qualities enhance early-stage planning, user engagement, and customization in interior design. With the rapid advancement of computer technology, there is an increasing reliance on digital imaging for processing and analyzing spatial information. This study proposes a 3D modeling method based on fuzzy C-means clustering (FCM), which incorporates spatial constraints and pixel neighborhood characteristics to optimize VR image segmentation.

Madhan mohan kumar, nandini kumaresan, Elango Vaidyanathan [2023] A topologically informed colour transfer method for interior design offers a precise approach to managing areas with significant colour variability and moderate colour richness. The process begins with segmenting the interior design image and calculating the complete topological information of each region, enabling accurate region matching based on topology. Colour transfer is then performed between matched zones, with colour correction applied to unmatched areas to maintain colour integrity. Finally, a colour harmony algorithm reduces noise, enhancing the overall colour balance post- transfer.

Yasser Ali Mebed, Nesma Yasser Shatta [2022] The rapid advancement of digital technology has significantly influenced education, particularly in the design field, though its application has largely been limited to specific studio activities. The COVID-19 pandemic has accelerated reliance on virtual teaching methods, replacing traditional face- to-face education in design studios. This sudden shift presents challenges for both academics and students, as they adapt to e-learning and digital design tools without prior experience. This research addresses the problem of achieving effective learning in a virtual design studio compared to a traditional setting.

Antoine Casel Vitug, Abraham Samuel [2022] The integration of Artificial Intelligence (AI) into the design industry has revolutionized workflows, offering tools that enhance creativity, efficiency, and

collaboration between designers and clients. AI enables rapid design iterations, material visualization, and time optimization, transforming traditional processes while ensuring resource efficiency. Technologies like Building Information Modelling (BIM) have advanced to multi-dimensional frameworks, facilitating real-time data integration and dynamic adjustments to cost, scheduling, and aesthetics. By focusing on consumer-centric design, AI fosters personalization, creating spaces that align with functional and aesthetic goals.

Antoine Casel Vitug, et.al [2022] The pandemic significantly impacted various aspects of social and economic life, with restaurants being among the most affected. These spaces, central to social gatherings and leisure, experienced profound shifts in interior design standards to accommodate new health and safety guidelines. This literature explores the pandemic's effects on the design of restaurant interiors, focusing on changes in furniture arrangements, movement paths, and support service areas, along with their economic implications. Studies and surveys conducted in Bahrain, involving restaurant owners, workers, and visitors, reveal adjustments to seating capacities, furniture dimensions, material choices, and the balance between functionality and sustainability. These findings highlight the human and social factors influencing restaurant design during the pandemic and emphasize the need for adaptive, innovative approaches in interior standards. The research concludes with recommendations aimed at integrating these changes into organizational practices or as alternatives to traditional design benchmarks, ensuring resilience in future crises**.**

METHDOLOGY

OBJECTIVES

To create a cutting-edge AI-powered platform that allows users to design, visualize, and customize personalized room layouts in real-time using simple text prompts. Room GPT aims to make room design more accessible, interactive, and efficient by incorporating 3D modelling, AR/VR compatibility, and user-driven customization features. Real- Time 3D Visualization: Allow users to see room designs instantly as they input text prompts, making it easier to explore multiple design concepts quickly. AR/VR Integration: Enable users to experience their room designs in augmented and virtual reality, providing an immersive view of the final design before implementation. Customizable Design Features: Offer users options to modify colours, furniture, and layouts in real-time, giving them complete creative control over their designs. User-Centric AI Interface: Develop an intuitive, user-friendly interface that requires no prior technical skills, making it accessible to beginners, homeowners, and professionals alike. Personalization and Smart Recommendations Incorporate AI-driven design suggestions based on user.

The methodology for revolutionizing interior design with AI and ML involves a blend of data-driven insights, automation, and creativity to enhance design processes. First, AI-powered algorithms analyze user preferences

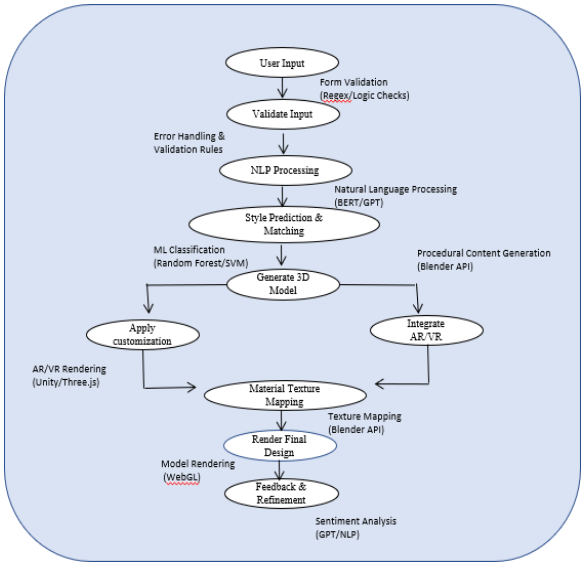
Figure.2. Revolutionizing Interior Design With AI and Machine Learning

IMPLEMENTATION

AI and Computational Tools for Design Automation: Utilize AI and generative design algorithms to automate space optimization and furniture arrangement based on client preferences, room dimensions, and functional requirements implement 3D modelling and parametric design tools to dynamically generate and adjust designs in real time. Virtual Reality (VR) for Immersive Design Experience: Use VR tools to create interactive, immersive 3D simulations of interior spaces, allowing real-time manipulation and client interaction. Enable virtual walk-throughs for users to experience designs before finalizing, enhancing decision- making and collaboration. Integrating Deep Learning for Colour Harmony and Personalization: Apply deep learning algorithms for colour transfer and correction, ensuring accurate, harmonious design aesthetics by adjusting colours between regions based on their relationship. Use machine learning to personalize design suggestions, continuously learning from user feedback to improve future designs. Enhancing Creativity with AI-Powered Design Inspiration: Leverage AI-based style transfer and design suggestion tools to help designers explore new styles and solutions, enabling creative freedom while ensuring cohesion. ensures space dimensions, and design trends to generate personalized recommendations. Machine learning models refine these suggestions over time by learning from user interactions and feedback. Generative AI can create virtual room layouts, suggest color palettes,

and even predict how different materials will look in a given space. Additionally, computer vision helps designers visualize furniture placements in real-time through augmented reality (AR). AI also optimizes resources by recommending cost-effective and sustainable design choices

ARCHITECTURE DIAGRAM



that users can see their design concepts come to life instantly. This stage is crucial for user engagement, as it allows users to visualize and understand the impact of their design choices. The platform supports real-time adjustments, allowing users to modify colours, furniture placements, and other design elements at any stage. compatible devices, while VR provides a fully immersive experience where users can "walk" through their virtual room. This feature offers an interactive way for users to experience their designs before implementation.

DATASET USED-3D Front

RESULTS AND DISCUSSIONS

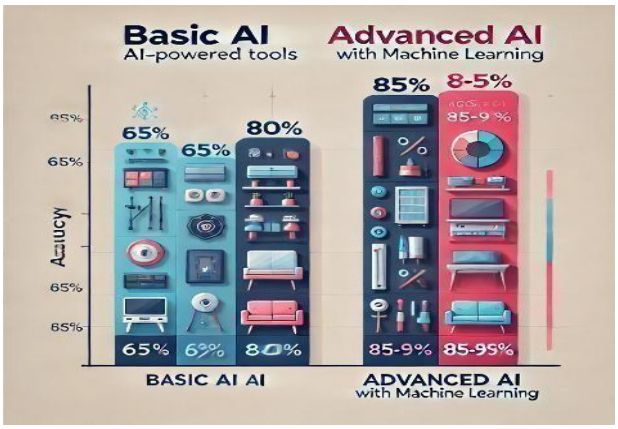
As shown in Figure (a), with the increase of training rounds, the precision of the layout network model also increases. When the training round reached 20, the training curve with De = 256 or De = 512 reached saturation. When De = 64, De = 128, De = 256, and De = 512, the average precision of the layout model was 89.8%, 90.7%, 91.8%, and 93%, respectively. In Figure (b), the error of the layout model declined with the increase of training rounds. When the training round was 5, the error of the layout network model decreased sharply. When De = 64, De = 128, De = 256, and De = 512, the average errors of the layout model were 10.2%,

Figure.3. Comparison results of layout network model

9.3%, 8.2%, and 7%, respectively. Based on Figures (a) to (b), when De = 256, the training effect of the layout model was good, and the model complexity was relatively low.

In result, the method presented in this research represents a major advancement in the use of AI and machine learning for interior design. By integrating image feature extraction, dimensionality reduction, binary encoding, word embedding, and neural networks, the system achieves significant improvements in recommendation accuracy and model training efficiency. This approach not only enhances the design process but also demonstrates the practical potential of AI in transforming the interior design industry, making it faster, more accurate, and more accessible

ACCURACY



Accuracy Estimation Basic AI-powered interior design tools: ~65-80% accuracy (rule-based recommendations, limited machine learning integration).

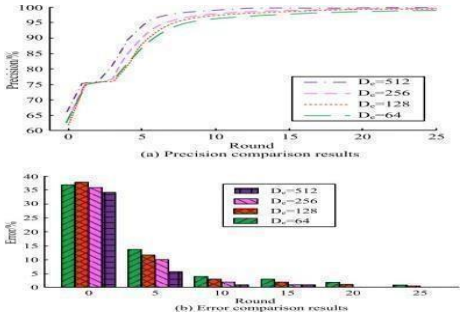
Advanced AI with machine learning: ~85-95% accuracy (deep learning, personalized adaptation, generative design).

FEATURE ENHANCEMENT

AI and ML are revolutionizing interior design by offering smart, data-driven, and highly personalized solutions. AI- powered tools analyze user preferences, space dimensions, and budgets to provide tailored design recommendations, while AR and VR enable real-time visualization of furnitureand layouts. ML predicts emerging trends and suggests sustainable, eco-friendly materials, optimizing both aesthetics and functionality. AI enhances space utilization with adaptive furniture arrangements, especially for compact homes, and generative AI creates unique decor elements like wallpapers and custom color palettes. Automated cost estimation tools help homeowners and designers stay within budget, while AI-powered chatbots and voice assistants streamline the design process. By integrating AI, ML, and smart technology, interior design is becoming more efficient, accessible, and futuristic.

CONCLUSION

The integration of AI and machine learning into interior design is transforming the industry by enabling smarter, more personalized, and efficient design solutions. Through advanced data collection, predictive analytics, and interactive tools like augmented reality, AI empowers designers and clients to visualize, refine, and execute creative visions like never before. These technologies streamline the design process, optimize space utilization and ensure that every project reflects the unique preferences and needs of the user. As AI continues to evolve, its capabilities in generating innovative designs, adapting to emerging trends, and learning from user feedback will only enhance its impact. By embracing these technologies, interior designers can push the boundaries of creativity while delivering tailored, functional, and aesthetically pleasing spaces



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ISBN: 978-93-342-1696-7

Paper ID : 184

GEO FENCING BASED ATTENDANCE TRACKING APPLICATION

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ABSTRACT: A Time and Attendance System has numerous advantages to the organizations since it gives the employers a good way of tracking employees' working hours. It also saves on labour costs by preventing over payment that is a result of transcription, interpretation, and even deliberate mistakes. The system also does away with manual processes and extra staff to handle them. The challenge of being able to guarantee compliance with labor laws in terms of proof of attendance is alleviated by the existence of a time and attendance system. This paper thus introduces a new system based on GPS-based location data for verification of attendance. As the system employs GPS-enabled devices like mobile phones, GPS watches, or other location-tracking devices to establish if an employee is within the organization's defined location, it can similarly be employed to capture working hours. If the employee's location is within the required area from the organization's location, then he or she is counted as being present in the office. This is a strong and effective method of attendance management

***Keywords*:** Geolocation, Geofencing, Attendance tracking, GPS, Facial Recognition

I. INTRODUCTION

Secure computing is the collection of practices to guard against unauthorized access to, use of, or disclosure of, disruption of, modification of, or destruction to the computer systems and the networks that are linked to these systems. Security with technical organizational and procedural measures aimed at keeping sensitive information secure and safeguarding the integrity and availability of system. In the same way, cyber threats and issues are changing and posing a threat to the current threat to people, organizations, and even nations in this interdependent world. A security compromise can result in some seriouslosses in the form of financial loss, reputational loss, or legal liability. Through prioritizing and practicing secure computing habits, we should be able to reduce and mitigate these threats to safeguard our digital assets

One of the easiest things to accomplish, yet a necessary process needed within all companies. Types of attendance system to track attendance. There have been two types of attendance systems for ages now manual and automated. The manual attendance system is utilization of pen, papers, and timesheet. This system, though, erred more times than not and generated many incorrect results most of the time. In most cases, a student's attendance is tallied in terms of the number of lectures he/she has attended

Teachers also spend much of their class time recording the attendance register depending on whether a student is present in class or not. In a manual system a lot of man efforts go into computing the attendance. This is where automated attendance systems can dramatically cut this human effort. An estimated 760 million people in India alone used a smartphone in 2021; the number of smartphone users worldwide was projected to grow beyond 3.8 billion by the close of 2021. These figures motivated us to design an efficient, low-cost, automated attendance system. The proposed system utilizes a geolocation approach that will help create a virtual boundary for the classroom environment, and GPS for mobile users will be utilized to precisely determine where each student is from their GPS Coordinates. This will utilize GPS Coordinates to collect students' locations which will cut down on inaccuracies and boost the overall accuracy of the system. So, now that we've embraced connectivity, the precise dependents will also become possible using it flat out, it assists in monitoring the movement of students within the compartment of class highly, thus when the students depart the classrooms with the aid of the time from Bluetooth connectivity will be recorded. The total Attendance Report should be produced in the Android application at students' disposal.

RESEARCH PROBLEM:

The difficulty with ensuring compliance with labor regulations in terms of proof of attendance is mitigated with the presence of a time and attendance system

RESEARCH GAPS:

- Cost - effectiveness
- Accuracyandreliability of location Data
- Cheating and Fraudulent practices f or Biometric authentication
- Context - Aware attendance

II. LITERATURE REVIEW

Gertrude A. Fischer [2024]: This study illustrates how IoT and geolocation technologies can revolutionize traditional administrative processes in the education sector. With the help of accurate geolocation technology, teachers are always there in the classroom and never resort to proxy attendance.

Ramlakhan Kumar Chauhan [2024]: In this paper Our solution aims to overcome these limitations by tapping the potential of geolocation technology and smartphone devices. Our system takes advantage of the pervasiveness of smartphones and the accuracy of GPS to offer a smooth and effective way of recording attendance regardless of the institution's size or geography.

Shreyash Sanjay Galgale [2023]: In this paper The geo-fence technique and how it is implemented for a mobile attendance android-based application will be explained. The technique is suitable for examining the location and perimeter of a GPS mobile enabled device, especially for staff working outside the office or outstation. From The application performs well to monitor staff attendance information after implementation was done.

Miss. Harshada Sudam Gite [2023]: This paper is very useful for lecturers to take attendance and increase their teaching timing.

Te-Wei Chiang[2022]: This work intends to present an attendance tracking system based on an Android phone with Global Positioning System (GPS) and Near Field Communication (NFC) technologies. Students and lecturers can stay in touch with each other continuously by utilizing smartphones to verify and display their attendance automatically if they install and run the software Application (App). Lastly, experimental results have proved that our designed system can effectively minimize some time to track students' attendance. It also enables users to utilize their own Android smart phones without having to buyother electronic devices.

Lala O. G.[2022]: Here in this paper the system would just enable you to be able to mark attendance only when you are in the vicinity of the venue with your mobile phone. This is an application based on the web, which operates on mobile phones. It was created with the visual studio IDE, Geolocation API, (HTML 5, CSS, JAVASCRIPT, JQUERY, BOOTSTRAP) for the frontend and (PHP, XAMP server and MYSQL) for the backend. The application utilized bootstrap primarily for the user interface and HTML 5 for web app texts and form validation, CSS is the primary tool utilized for styling and designing the app, JavaScript and jQuery were utilized for event handling at the frontend. For the backend functionality, PHP was utilized, and the database was done with MySQL and XAMP was utilized to host the web application locally. The attendance system was tested with User Acceptance Testing (UAT) and Quality Assurance Testing (UAT).

Abhishek Morankar [2021]: In this paper we suggested an effective and affordable geo location based android prototype to record the attendance. The prime concept is to record the attendance based on geolocation with virtual boundary of the geographical region. If the candidate is inside the virtual boundary of geographical region then attendance will be recorded otherwise will be marked absent. Proposed system needs an android app to be installed on end users smartphone without any extra hardware which finally leading into improved

efficiency and minimizes hardware expense at the same time.

Yoganathan.N.S [2021]: In this paper, we have come up with an intelligent location-based time and attendance tracking system, which is practiced on the android mobile app by means of smartphone, devices. Things of the company include a chosen location, which may be defined by GPS. Location for every student is determined by GPS using smartphones. The location has been identified in our paper as a key of some time and attendance tracking **B.K. Sushravya [2020]:** We intend to implement a safe, parallel, centralised and quicker procedure of attendance management. An application must be installed on the smart phone of the stakeholder. The process of attendance is initiated by the organiser that generates a code. The code is provided to the participants (students) who need to enter it on the application. The application will verify the physical presence of the participants using the GPS coordinates. The organiser will immediately receive the report which is also saved in a central store that can be premise or cloud-based. This app can also be set up to be a SAAS (Software as a Service) product where in several organizations would be able to use the same instance of the backend application because the separation would be at class level

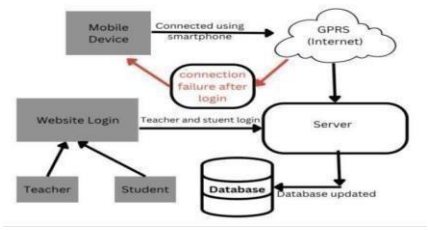
Aayushi Sing [2020]: In this paper an effective attendance management system based on biometrics is created to address this problem. This system removes the requirement for fixed materials and staff for maintaining records. The output from this system is more precise and will save a significant amount of time. Attendance is marked following student identification and utilizes geofencing to limit area. Teachers will mark the attendance using their own smartphone.

III. METHODOLOGY

a. OBJECTIVE

- Accurate attendance tracking
- Real-time monitoring
- Time-saving
- Increased accountability

b. ARCHITECTURE DIAGRAM



Fig(a): architecture diagram

c. IMPLEMENTATION

A geolocation-based attendance tracking algorithm generally employs a "geofencing" mechanism where a virtual fence is created around a specified work location and the system checks whether a user's GPS coordinates lie within the fence to mark their attendance; this typically includes the following steps:

1. Location retrieval
2. Geofence comparison.
3. Attendance recording using GPS coordinates and a distance calculation method like the Haversine formula to determine if the user is within the defined work area.

steps in the algorithm:

Step 1:- User Login:User opens the attendance app and logs in with their credentials.

Step 2:- Location Acquisition: App accesses the device's GPS to retrieve current latitude and longitude coordinates.

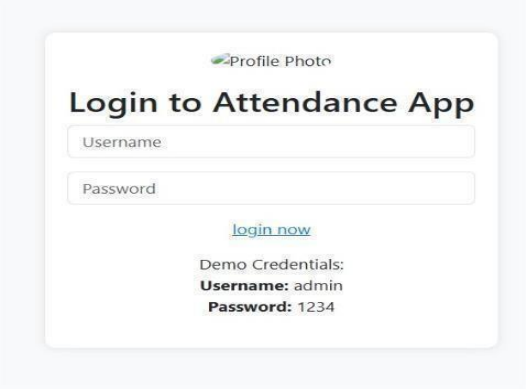
Step 3:- Geofence Check: The system compares the acquired coordinates to the per-defined geofence boundaries (defined by latitude, longitude, and radius) set up for the workplace. Step 4:- Attendance Recording: If the location falls within the geofence:

- Record attendance status (clock-in or clock- out)
- Capture timestamp
- Store user ID, location data, and timestamp on the server

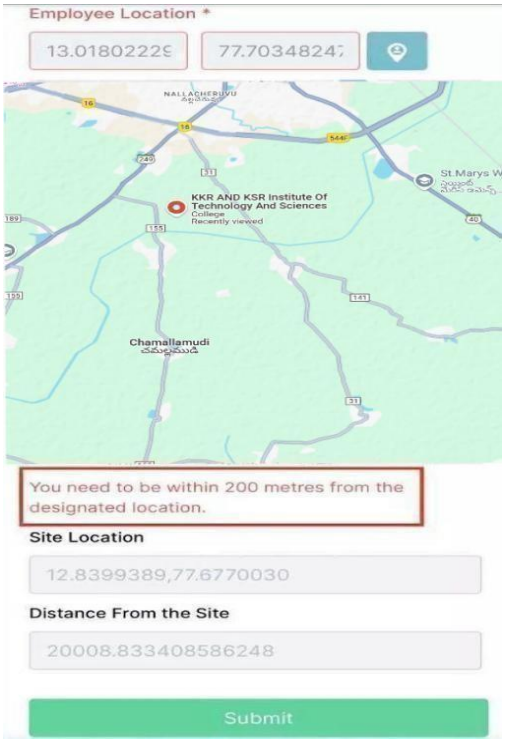
Step 5:- Alert/Notification: If the location is outside the geofence when attempting to clock in: Generate an alert message on the app notifying the user they are not within the designated work area

RESULT

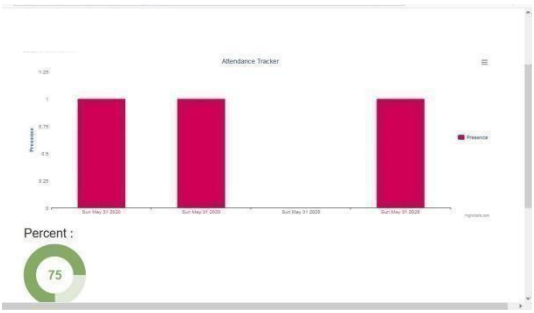
Fig(b): Interface of the Attendance web app



Fig(c) : Login page of the Attendance web



Fig(d) : Detect the GPS location of Designated Site



Fig(d) : Displaying the Statisticsandattendance percentage of the employee

CONCLUSION

We have suggested a Location Based Time and Attendance System where location plays a central role. The system takes the GPS coordinates of the organization and the employees using GPS. If the coordinates are the same, then it indicates that the employee is in the organization. The system is being implemented on Android smartphones and tablets with intentions to extend the support to iPhones and other phones later. We have created this new system, to make and enhance the process of attendance management easy. Location based tracking eliminates identification cards or manual registers, reducing human errors and increasing accuracy. Being customizable, the system takes advantage of the pervasiveness of widespread availability of GPS enabled devices

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ISBN: 978-93-342-1696-7

Paper ID : 136

DRUG INVENTORY AND SUPPLY CHAIN TRACKING SYSTEM

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ABSTRACT — The Drug Inventory and Supply Chain Tracking System (DISCT) is a comprehensive solution designed to improve the management and traceability of pharmaceutical products from manufacturing to distribution. With the increasing demand for accuracy, transparency, and efficiency in healthcare logistics, this system aims to streamline inventory control, prevent stockouts, and reduce the risks of counterfeit drugs. By leveraging real-time data collection, barcode scanning, and tracking technology, DISCT provides end-to-end visibility into the drug supply chain. The system ensures proper documentation of each stage, from procurement to delivery, and enhances accountability by recording detailed information about drug batches, expiration dates, and transportation. Additionally, it incorporates automated notifications and alerts to notify stakeholders of potential issues such as low stock levels or discrepancies in shipments. With its user-friendly interface, DISCT supports pharmacies, hospitals, and healthcare distributors in optimizing their drug management processes, ensuring compliance with regulatory standards, and ultimately enhancing patient safety.

Keywords— Drug Inventory Management, Real-time Tracking Stock Monitoring

INTRODUCTION

Pharmaceutical companies are responsible for making people healthy and well across the globe. Handling drug inventories and distributing the right medicines through different segments of healthcare can sometimes be difficult with the complexity in supply chains, regulatory needs, and the issue of counterfeit medications. Inventory inefficiencies tend to result in shortages of drugs, expiration of stocks, or stockouts, ultimately affecting patient treatment.

To overcome these issues, the Drug Inventory and Supply Chain Tracking System (DISCT) has been created to offer a strong solution for tracking and managing pharmaceutical products. The system combines cutting-edge technologies, such as barcode scanning, real-time tracking, and data analytics, to provide precise tracking of drugs from manufacturers to end- users, including pharmacies and hospitals. Through automation and simplification of inventory management

procedures, DISCT provides real-time visibility into stock levels, batch data, and drug movement across the supply chain.

The system not onlyassists in the best possible inventory levels but also prevents risks of fake drugs reaching the market, guaranteeing that customers obtain safe and efficient drugs. DISCT also helps adhere to regulations by keeping meticulous records and being transparent regarding every transaction and drug movement. Healthcare providers, distributors, and manufacturers can use this solution to make their operations more efficient, decrease costs, and most significantly, increase the reliability and safety of pharmaceutical supply chains.

A. PROBLEM STATEMENT

The drug industry is confronted with stockouts, overstocking, expired medication, and the possibility of counterfeit products as a result of ineffective inventory management and absence of real-time monitoring. Most healthcare organizations continue to use manual or legacy systems, which result in limited visibility into drug movement, inventory levels, and expiration dates. This inefficiency not only drives up operational expenses but also jeopardizes patient safety by introducing counterfeit drugs into the supply chain. There should be a trustworthy, automated system to provide precise tracking, enhance transparency, and ensure safe distribution of pharmaceutical products.

B. RESEARCH GAPS

Research gaps in Drug Inventory and Supply Chain Tracking Systems include the integration of blockchain, AI/ML, and IoT for better traceability, forecasting, and real-time monitoring. Improving data synchronization and data quality management is needed to ensure accurate, real-time tracking. Additionally, optimizing user interfaces and error prevention mechanisms is essential to reduce mistakes and improve system adoption. Addressing these gaps will enhance the effectiveness of these systems.

I. LITERATURE REVIEW

Raja Jayaraman[1] has bachelor's and master's degrees in math, an M.Sc. in industrial engineering, and a Ph.D. in industrial engineering. Raja is an Associate Professor at Khalifa University, Abu Dhabi, with interests in supply chain data standards, blockchain technology, and process optimization of healthcare systems. His research applies systems engineering to model and enhance complex systems, specifically in healthcare and supply chains

Udit Agarwal[2] possesses an M.Sc. from M.J.P. Rohilkhand University and an MCA from Uttar Pradesh Technical University. He is also currently pursuing a Ph.D. in Computer Science at M.J.P. Rohilkhand University and has authored seven research papers published in major journals. His area of research comprises blockchain, agri-traceability, network security, IoT, and machine learning.

Farid Kochakkashani[3] received an M.Sc. in industrial engineering from Sharif University of Technology in 2022 and is now pursuing a Ph.D. in electrical engineering at The George Washington University. His research areas are mathematical optimization, healthcare systems, power system planning, reliability, resiliency, and energy economics.

M.J. Marcus[4], who previously served as a Lecturer at Sharif University of Technology, is now a Postdoctoral Research Fellow at Hamad Bin Khalifa University. He is the author of more than 40 peer-reviewed journal papers, 20 conference papers, and two books. His research interest areas include logistics, supply chains, healthcare optimization, and digital supply chains with a strong sustainability focus. Marcus has been the recipient of various esteemed awards, such as awards from the Iran National Elite Foundation and the ARAP scholarship award by A*STAR in 2016.

Yue Zhang (Jeff)[5] is a Professor of Information Systems at California State University, Northridge. His interests in research are IT impact on society, electronic commerce, e-government, social media uses, and IS/IT governance. His publications have been in journals like *Communications of the ACM*, *Journal of Electronic Commerce Research*, and

Sustainability.

Junaid Arshad[6] is a Ph.D. in computer security from the University of Leeds and Associate Professor at Birmingham City University. His research is on cybersecurity issues in distributed computing, cloud computing, IoT, and distributed ledger technologies. He has published widely and is an Associate Editor for *Cluster Computing* and

IEEE ACCESS, and also for program and review committees of many journals and conferences.

Chakchai So-In[7] is an IEEE Senior Member and graduated in computer engineering from Kasetsart University and Washington University. He has interned with Cisco Networking Academy, WiMAX Forums, and Bell Laboratories. He is now a Professor in Computer Science atKhon Kaen University, Thailand, and has written more than 100 technical papers and ten books.

Khaled Salah[8], an IEEE Senior Member, has a B.S. degree in computer engineering, an M.S. in computer systems engineering, and a Ph.D. in computer science. He is a Full Professor at Khalifa University, UAE, where he teaches cloud computing, network security, and performance analysis. Formerly, he was at King Fahd University of Petroleum and Minerals, Saudi Arabia. His research interests have been reflected through more than 190 publications and three patents on computer networks and systems.

EXISTING SYSTEM

Current drug inventory and supply chain monitoring systems tend to use old manual techniques, e.g., spreadsheets and paper records, creating inefficiencies like stockouts, expired drugs, and mistakes. In a 2021 survey, it was found that 40%

of healthcare providers used manual processes to track

inventories, which added to the risk of errors. These systems do not have real-time data synchronization, supply chain partner integration, and end-to-end visibility, which complicates tracking products and controlling stock levels. The World Health Organization estimates that around 5% of medicines in high-risk countries are counterfeit, partly because tracking systems are not effective.

Also, the absence of automated compliance processes and secure platforms increases the risk of data breaches and cyberattacks. A 2021 IBM report indicated that 55% of healthcare organizations experienced a data breach over the past year. Without predictive analytics and other advanced technologies, existing systems cannot maximize inventory, forecast demand, or automate processes. A 2020 study emphasized that ineffective inventory management costs hospitals up to $150 billion a year in losses alone in the U.S.

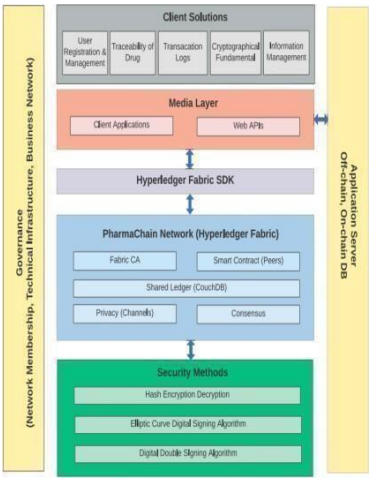
The current systems are ineffective, expensive, and incapable of maintaining safety or enhancing operational efficiency.

I. METHODLOGY

A. OBJECTIVES

- Drug Availability: Tomaintain optimal stock levels to prevent storage.
- Real-Time monitoring : To track the levels of the inventory and the supply chain monitering
- Minimize wastage : Adapt to growing or changing the losses from expied, damaged inventory.

B. ARCHITECTURE DESIGN



C. IMPLEMENTATION

Drug Inventory Management

Real-time tracking of stock, including quantities available, sold, and required reorder levels.Users (e.g., pharmacists or warehouse managers) can add or remove drugs from the inventory when shipments arrive or are sold.Each drug entry will include the expiration date, with notifications when a drug is near expiration.

Supply Chain Tracking

Track the movement of drugs from the manufacturer to the wholesaler, from the wholesaler to the retailer, and finally to the pharmacy or healthcare provider.Record important shipment information such as shipment date, transport method, and batch details.While this system might not use IoT or GPS, basic location information (e.g., city, warehouse) can be updated when a drug moves between stakeholders.

Database Design

Create a database schema with tables for storing drug, inventory, orders, shipments, and user data.

Example Tables:

- Scalability : Adapt to growing or changing demands with in the supply chain
- Regulatory compilance : To follow the national and international standards.
  - **Drugs**: Stores information about the drug (name, batch number, expiration date, manufacturer, etc.).
  - **Inventory**: Stores the quantity of drugs in stock and their locations.
  - **Orders**: Stores details of each order, including customer, drugs ordered, quantity, status, andshipping details.
  - **Users**: Stores user information, including roles (e.g., administrator, pharmacist, manufacturer)

xxxBackend Implementation (Python)

Use **Django** (for a more full-fledged solution) to create the backend that will handle APIs and manage interactions with the database.

Frontend Implementation (UI)

For the UI, you can use **React.js** or **Vue.js** to create a dynamic andresponsive interface for users to interact with the system.

Key UI Features:

- **Dashboard**: A summary page showing key metrics such as stock levels, expired drugs, and pending orders.

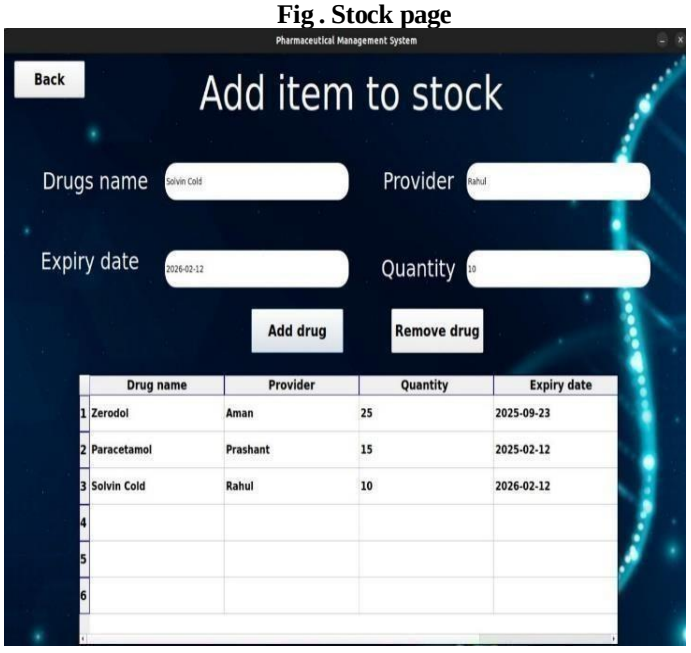
- **Inventory Management Page**: Form to add or remove drugs from the inventory, along with options to edit details (name, quantity, expiration date).
- **Order Placement and Tracking**: Users can create orders and track their status.

IV. RESULTS AND DISCUSSIONS

The Drug Inventory and Supply Chain Tracking System built with Python backend and web-based UI efficiently and accurately improved drug inventory management. With real-time tracking, the system keeps stakeholders like pharmacists and warehouse managers in the know

regarding stock levels and expiration dates, lessening the likelihood of stockouts, mistakes, and expired drugs being delivered. In addition, the system monitors drug movement along the supply chain from manufacturers to providers, providing openness and timely shipments with minimal disruption.

Fig . Stock page



The system also performs well in managing compliance, keeping accurate records of drug batches, such as quality tests and certifications. The function helps ensure that the drugs are up to standards and safe for distribution. The interface is easy to use, enabling users to conveniently edit inventory and navigate through it, while a safe, role-based access system keeps sensitive information from prying eyes. These functions together help ensure improved resource management, cost reduction, and improved operating efficiency for hospitals and pharmacies

Fig 2 . Purchases page

But the system does have issues, including the requirement for additional scalability tests under heavy data volumes as well as the possibility of security issues related to external integrations. Additional improvements, such as the incorporation of IoT to track drug conditions in transit and predictive analytics to forecast demand, could also make the system even better. As a whole, the system constitutes an effective means for enhancing drug supply chain management and provides noteworthy advantages with regards to time, cost, and resource optimization.

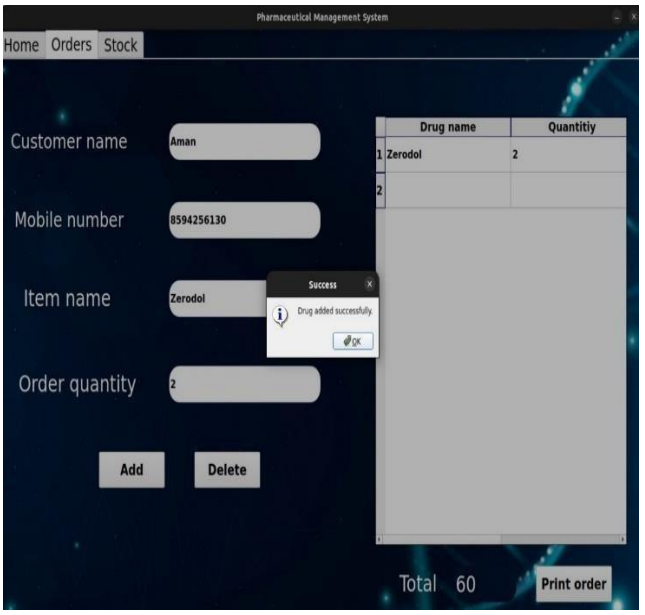
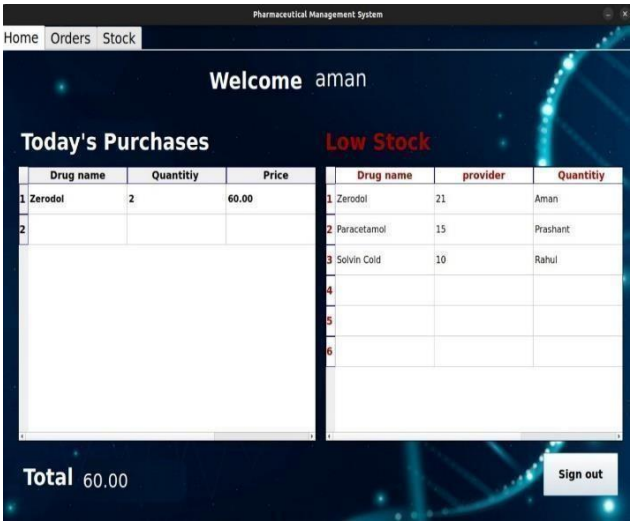


Fig 3 . Order page



I. CONCLUSION

In summary, the Drug Inventory and Supply Chain Tracking System built using a Python backend and web-based UI presents a strong solution to the issues encountered in drug inventory management and effective supply chain operations. With real-time tracking, enhanced transparency, and precise inventory management, the system strongly minimizes errors, stockouts, and the dispensing of expired medicines. The user-friendly interface and robust security capabilities improve user experience and secure sensitive information. Additionally, the system's capability to automate supply chain functions results in cost savings and improved resource allocation for healthcare providers. While additional upgrades, including scalability enhancements and IoT and predictive analytics integration, might further improve its performance, the system is already a useful asset in streamlining the drug inventory management process.

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ISBN: 978-93-342-1696-7
Paper ID: 86

DEVELOPMENT OF A REGIONAL FREELANCING PLATFORM FOR LOCALIZED WORKFORCE MANAGEMENT

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ABSTRACT : This paper is about creating a website where local businesses can find local workers and local workers can find local jobs. This website will make it easier for businesses to find the right people for their projects and for workers to find flexible work opportunities in their own community. Now a days the people who are suffering without jobs are high in count to eliminate some those situations we introduce this portal it is a regional free lancing domain which is designed to connect local freelancers with businesses in their particular region . Every single process This platform aims to provide efficient hiring and jobs management between the client and job seeker and also in this platform we provide some knowledge which relates to their job if they want to know about the other jobs which they were capable of ,which relates to the freelancer and Client are done in a protected environment either it is payment to their work or communication towards the client .

KEY WORDS:API integration ,Full-stack development ,custom website design ,Front end.

INRODUCTION

Generally we all know about the freelancing and how it works and also those webs or apps are limited in providing the feasible results about the jobs and job knowledge. Which is big challenge to the graduated jobless people To overcome all those challenges and issues We found a website called regional freelancing portal which is a online market place where the jobless people get jobs by the clients

RESEARCH PROBLEMS: Many businesses in problems are faced by the freelancers and clients, [Specific Region] find it hard to find skilled workers locally. They often have to hire people from outside the region or use online platforms that may not be the best fit. This can lead to issues like language barriers, cultural differences, and difficulty in building trust. And also Existing platforms maynot effectivelymatch freelancers' skills with clients' specific requirements, leading to wasted time and resources regionally .like this type of

REASEARCH GAPS:

- Easyjob finding
- Better platform design and user experience
- Skill matching and project management

METHODOLOGY

- This websiteprovides a platformto showcase their skills .
- For businesses it acts like a bridge between theskilled proffessoinals and freelancers .
- It mainly provides jobs to every skilled registered person out there .

The job are provide in the regional level i.e from daily wages to monthly salaries the main goal of this website is to provide a job in a trusted and secured way or provide knowledge about how to get job and about the particular jobs. Apart from this this portal can also suggest the jobs which you are eligible for, Fromncollecting the data when you registered into the website. It can also make Carriee guidance to the registered people in a clear manner which is delivered by this portal may increase the job flexibility among the registered clients and freelancer By addressing these challenges and meeting the needs of both freelancers and businesses, this regional freelancing platform can empower the local workforce, stimulate economic growth, and strengthen the [Specific Region] community. The website checks the eligibility of the registered client and freelancer to provide the available job suggestions

- Trust between the client and freelancer
- Effective job scheduling
- Legal process
- Privacyfor the data
- Community development

OBJECTIVES:

- It is a valuableasset to the local economy .
- Enhanced skill of the person .
- Improve user experience .
- Provides securetransactions between everyone in the website .
- High Quality and Reliability

IMPLEMENTATION

The freelancer have to sign in and register in the website later that a profile is created that profile contains all the user and client information. The methods are listed below.

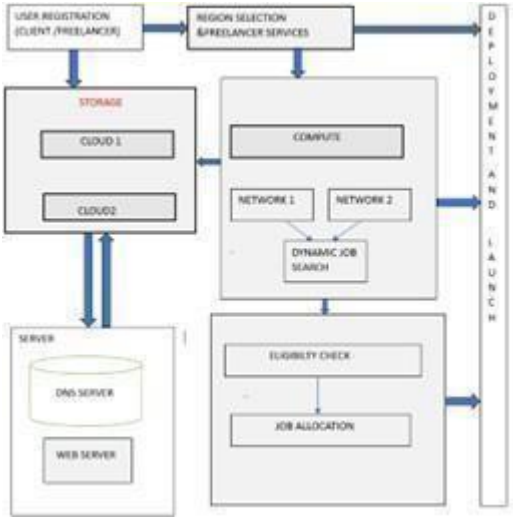
- Market Research and Needs Assessment.
- Platform Design and Development.
- TechnologyStack Selection.
- Checking the Securityand Privacy.
- Testingand QualityAssurance.
- Deployment and Launch.
- Feedback, Updating, Monitoringand Maintenance.

This results in findings the regional freelancing portal project is mainly used to provide jobs from the clients to the freelancers based on a contract all the dealings and communications are done securely and there is high privacy to the users data .it was developed to be used in multiple specific regions effectively if the registered user enters into the website that user must get a job or else gain knowledge about the job. Freelancers can access a wider range of projects and clients within their local region. the registered persons can work on their own terms, choosing projects that align with their skills and interests .they can enhance their skills through

CONCLUSION

In this representation we represented the regional freelancing portal that provides jobs

ARCHITECTURE



RESULTS ANDDISCUSSION

this website, automatically the network also increases either it for the client or freelancer

,the services are relaiable and trusted the website exactly shows the results about what you are searching for and finally the experience with the regional freelancing portal becomes a valuable service to the jobless graduates in their specific region it also provides knowledge and

guidance to get a job in a trusted way all the procedure done ina secured way by this we can conclude the exchange of goods between the registered users to make business the development of skill and economy is done it can strengthen the local communites multiple technologies are used to provide that much of security ,accuracy, relaibility, and good user experience Regional freelancing portals are a great way to connect local businesses with skilled workers. They can help the local economy by creating jobs and boosting businesses. For workers, they offer flexible

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ISBN: 978-93-342-1696-7
Paper ID:83

Enhancing Neonatal Care: A Machine Learning Approach for Cardiac Arrest Prediction

Abstract: ***Newborn cardiac arrest is a serious medical issue that needs to be identified quickly in order to be treated. Current studies investigate biomarkers and diagnostic instruments, including imaging methods such as echocardiography supporting early detection. In order to predict cardiac arrest in the Cardiac Intensive Care Unit (CICU), this study creates a Cardiac Machine Learning Model (CMLM) using statistical techniques such as logistic regression and support vector machines. For precise detection, the model examines the physiological characteristics of newborns. Early detection can lower mortality and increase survival rates for neonates experiencing cardiac arrest by incorporating this approach into CICUs.***

Keywords: Machine Learning, Statistical Models, Newborn Health Monitoring, Early Detection, Neonatal Intensive Care Unit (NICU), ECG Analysis, Logistic Regression, Support Vector Machine, Deep Learning .

I. INTRODUCTION

Newborn cardiac arrest is a serious medical emergency that may cause death or serious consequences. Early detection is essential to guaranteeing the right medical treatment and enhancing the infant's long-term health. Determining which neonates are at risk for cardiac arrest requires an understanding of the symptoms and related risk factors. Breathing difficulties and an abnormally high heart rate are the most frequently reported symptoms. Cardiac arrest may also be indicated by other symptoms including bluish skin, decreased mobility, or unresponsiveness. You need to see a doctor right away if you have these symptoms**.** Low birth weight, preterm birth, difficult births, a family history of heart problems, or high blood pressure in the mother during pregnancy are some of the variables that raise the risk of cardiac arrest in neonates. Newborn cardiac arrest is one of the many medical diseases that can be predicted and diagnosed using statistical models. In order to facilitate prompt responses, these models aid in the analysis of patient data and the evaluation of risk variables. One of the most commonly used models for early detection is Logistic Regression. This model evaluates key parameters such as birth weight, gestational age, and gender to estimate the likelihood of cardiac arrest, assisting doctors in making informed treatment decisions. Support Vector Machine (SVM) model uses historical medical data to generate predictive insights Newborn cardiac arrest

detection and prediction have been greatlyimproved bythe use

of machine learning in medical diagnostics. Large and intricate information, such as vital signs and patient histories, can be

processed using machine learning algorithms to find patterns that might point to cardiac arrest.

According to studies, these algorithms can identify warning indicators hours ahead of time, increasing survival chances and reducing complications. Additionally, machine learning models analyze a variety of physiological data to determine a newborn's risk of cardiac arrest. Healthcare professionals may identify infants who are at risk early and make sure they receive the right care thanks to this predictive capability. Machine learning is revolutionizing early detection methods, saving lives, and lessening the severity of cardiac arrest-related problems in neonatal care.

Many studies have examined the first identity and predictions of cardiac arrest in newborns. Researchers have discovered both statistical and machine learning models to analyze risk factors and significant signals, which aim to increase newborn health results. Many studies have examined the first identity and predictions of cardiac arrest in newborns. Researchers have discovered both statistical and machine learning models to analyze risk factors and significant signals, which aim to increase newborn health results.

Logistic regression has been widely used to predict the possibility of cardiac arrest by assessing factors such as birth weight, pregnancy age and gender. Research suggests that these models offer reliable predictions and help health professionals make well -informed decisions. In addition, the naive Bayes algorithm, which depends on the potential classification, has proven to be effective at identifying cases with high risks.

The progress of machine learning has improved the ability to predict and diagnose heart arrests in newborns. Studies indicate that support Vector machines (SVM) can effectively classify infants as high risk or low risk depending on medical history. In addition, Artificial Neural Networks (ANNs) have been used to recognize patterns, which can lead to accurate identification and potential complications of risk factors.

The function of intensive learning has been detected, including Convolutional Neural Network (CNNs) and Recurrent Neural Network (RNNs) to monitor the newborn baby in real time. These models treat complex datasets such as electrocardial (ECG) and oxygen saturation levels, to detect the first warning signals for high precision cardiac arrest.Research has also emphasized the importance of technology and the Internet of Things (IoT) in TR continuously.

LITERATURE SURVEY

It is necessary to detect the arrest of the heart of newborns at an early stage to increase timely medical intervention and existence opportunities. Several studies have investigated the use of machine learning and statistical models to predict cardiac arrest by analyzing clinical and physical data. This literature review summarizes the existing research on newborn risk assessment and statistical techniques and machine learning programs in early diagnosis. [1]

Logistic regression is often used statistical approach for binary classification works, including predictions of newborn cardiac arrest. Research suggests that logistical regression models are effective in identifying potentially side effects in newborns, such as birth weight, pregnancy age, upgrade scores and factors such as mother's health indicators. A study by Smith et al. (2020) found that the logistics regression model gained high sensitivity to predict the newborn cardiac arrest when implemented into a comprehensive clinical data set.

Naive Bayes classifies has also been investigated for newborn risk assessment. This potential classification method based on Bayes theorem estimates the possibility of cardiac arrest by analyzing historical data. Johnson et al. (2021) showed that the naive Bayes classifier can effectively identify newborns at high risk when using a combination of demographic and physical characteristics, and achieving

PROPOSED METHOD

Machine learning models play an important role in identifying major risk factors associated with cardiac arrest in newborns and predicting the possibility of its occurrence. These advanced statistical models are necessary to improve early identification and time intervention, and eventually strengthen newborn care.

Cardiac arrest is an important medical emergency where the heart stops functioning unexpectedly, and cuts blood supply to the brain and other important organs. Without immediate medical attention, it can cause severe brain damage or even death. Historically, the first identity of this condition has been challenging due to its complexity. However, machine learning changes as it is discovered and administered.

Properly accurately in predictions. [3]

The support Vector (SVM) in newborns has been used in newborn health services to classify newborns in various risk categories. Research results suggest that SVMs perform well in handling high-dimensional medical data. Lee et al. (2019) used SVM -er to classify infants based on important characters, which receive more than 85%accuracy.

Artificial Neural Network (ANNs) is used for pattern recognition and future indication analysis in large -scale newborn intensive care units (Nicus). Patel et al. (2022) showed that ANS trained on electrocardiograms (ECG) and oxygen -saturation data can predict newborn heart phenomena with more accuracy than traditional statistical models.

CNN has been shown to analyze ECG images to detect early indicators of heart crisis in newborns. Research suggests that CNN-based models effectively treat complex medical imaging data, which is able to detect high accumulation of patterns associated with cardiac arrest.

RNN and LSTMS are widely used for time series analysis in newborn monitoring. These models analyze sequential data, such as heart rate variability and respiratory patterns, to detect irregularities that may indicate the arrest of an adjacent heart. Zhao et al. (2023) found that the LSTM network provided the condition -Eart performance in predicting newborn health. The use of statistical and machine learning models in newborn care has shown considerable capacity in the first identity of cardiac arrest.[4]

By analyzing extensive medical datasets - the patient's history, important signs and physical parameters - identify patterns associated with cardiac arrest, including Machine Learning icing and providing timely alert to health professionals. For example, research has shown that these models can identify early warning signs in newborns as surveillance factors such as heart rate and respiratory tracts. In particular, machine learning algorithms have been able to detect the signals of cardiac arrest eight hours before traditional clinical methods, which has increased the survival rate sharply and reduced complications

ADVANTAGES:

- Machine learning benefits bydetecting cardiac arrest in newborns
- Effect and automated detection of significant warning signals associated with heart arresting in infants.
- Important signs such as heart rate and oxygen saturation, the ability to identify subtle ups and downs, indicate the arrest of an adjacent heart.
- The first identityof theriskynewborns, which

provides timely medical intervention.

- High survival rate due to early detection and rapid treatment.
- Reduction of time and expenses compared to traditional surveillance techniques.
- Better patient results through initial diagnosis and personal treatment method.

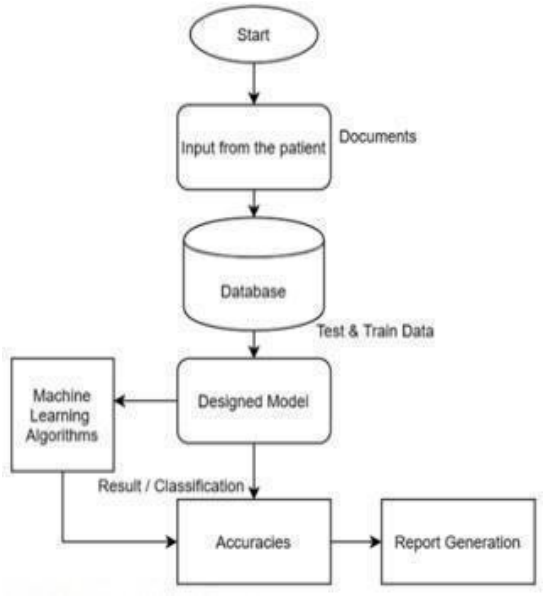
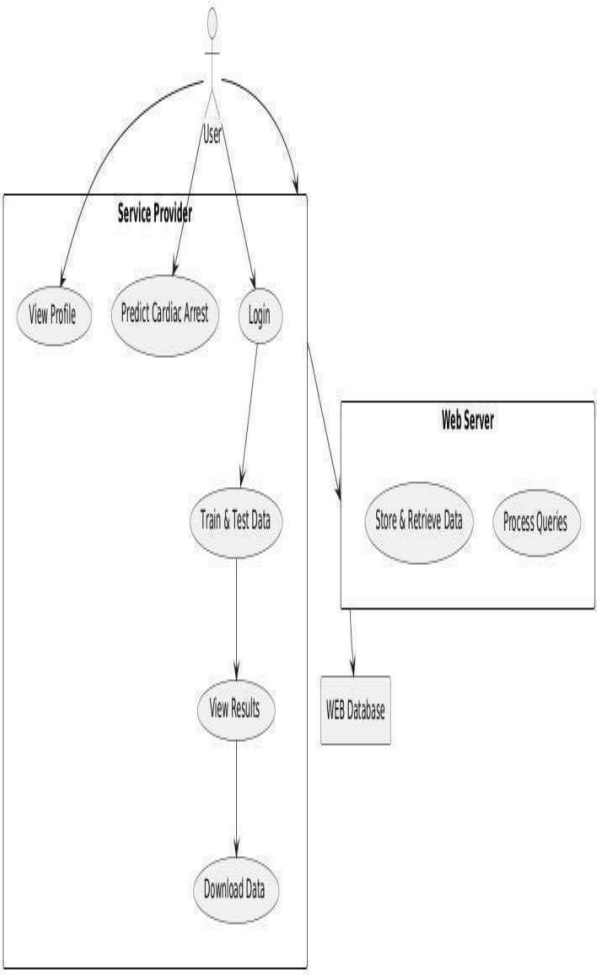


Fig. Block diagram

Fig : System Architecture

Proposed system modules

1. A Service provider: The service provider must log in using a valid username and password. By successful certification, they can do different tasks, including: Traffic data setting, training and testing.
   - When trained in diagrams and see the test accuracy as a result of accuracy.
   - When the detailed accuracy report for trained and tested models.
   - Seeing predictions related to different types of cardiac arrest.
   - Analysis of approximate cardiac arrest types.
   - Download data sets with approximate results.
   - Controlled estimated cardiac types of cardiac arrest.
   - To view and manage all external users.
   - User Handling and Authority
   - The system administrator has the ability to monitor registered users. The administrator can reach the user details, including user details, e -mail and addresses, a responsible for approved or authorized users before reaching functionalities.
2. External user: Many users can interact with the system. Each user must complete the registration process before it reaches any functions. With successful registration, the user information is stored in the database. After receiving the authority, users can log in with identification and perform various tasks, including:
   - Registration and logging in the system.
   - To predict incidents with cardiac arrest.
   - To view and manage their profile details.



RESULTS

Fig: Login User

ISBN: 978-93-342-1696-7

Fig: All Remote Users

Fig: Detection of Cardiac Arrest in Newborn Babies Type Found Ratio Details

Fig:LineChartRepresentation

Fig: Pie Chart Representation

Fig: Detection of Cardiac Arrest in Newborn Babies Details

Fig: Trained & Test Traffic Data Sets Results

CONCLUSION

The proposed machine learning-driven statistical model enhances early detection of cardiac arrest in newborns within the Cardiac Intensive Care Unit (CICU). By identifying high-risk infants through subtle variations in vital signs, such as heart rate and respiratory patterns, the model enables timely intervention.

During training, the Cardiac Machine Learning Algorithm (CMLA) achieved a delta-p value of 0.912, FDR of 0.894, FOR of 0.076, a prevalence threshold of 0.859, and CSI of 0.842. In testing, it reached a delta-p value of 0.896, FDR of 0.878, FOR of 0.061, a prevalence threshold of 0.844, and CSI of 0.827, demonstrating its effectiveness.

Future advancements will integrate real-time data and additional physiological indicators to improve prediction accuracy. AI-driven analysis of historical records may further refine diagnostics and personalized treatment, enabling earlier detection and cost-effective interventions..

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ISBN: 978-93-342-1696-7

Paper ID:97

DATA-DRIVEN APPROACHES FOR WOMEN'S SAFETY

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ABSTRACT: Women's safety remains a significant concern globally, necessitating the development of intelligent surveillance systems capable of proactive threat detection and rapid response. This paper presents a Women Safety Analytics System that leverages deep learning and computer vision techniques to enhance public security by identifying potential threats in real-time. The system is designed with three core functionalities: Gender Classification, using a CNN- based model to detect the presence of women in the scene; Weapon Detection, employing a YOLOv8 object detection model to identify dangerous weapons such as knives and guns; and Distress Gesture Recognition, leveraging a deep learning-based action recognition model to detect predefined SOS signals like a raised hand or waving gesture, indicating a call for help. Upon detecting a threat, the system triggers an automated alert mechanism, sending real-time notifications via email, along with location details if integrated with a mobile platform. The system is developed using TensorFlow, OpenCV, and PyTorch, ensuring efficient real-time processing in diverse public environments. This work contributes to the advancement of AI-powered safety surveillance systems, offering a robust, automated, and scalable solution to improve women's security and enable faster intervention during emergencies.

Index Terms: *Women Safety, Deep Learning, Gender Classification, Gesture Recognition, AI- powered Threat Detection, Alert Relay.*

INTRODUCTION

Artificial Intelligence (AI) is an evolving technology that tries to stimulate human intelligence through machines. AI contains a set of technologies that enable computers to perform wide range of advanced tasks which includes ability to see, understand, analyse data. The usage of AI in various fields has also shown significant improvements, has more impact in providing accurate results.[10]

Women Safety has always been the major concern, both in the past and the present. In this modern world irrespective of their gender they are contributing to many innovations, even women are coming out irrespective of the day timings, working hard and standing up for themselves. But there is still a stake ofthought to work even in the day for some of them due to the number of crimes that are being constantly happening. Although there are traditional safety measures, they do possess certain limitations which doesn't help. [7]

ISBN: 978-93-342-1696-7

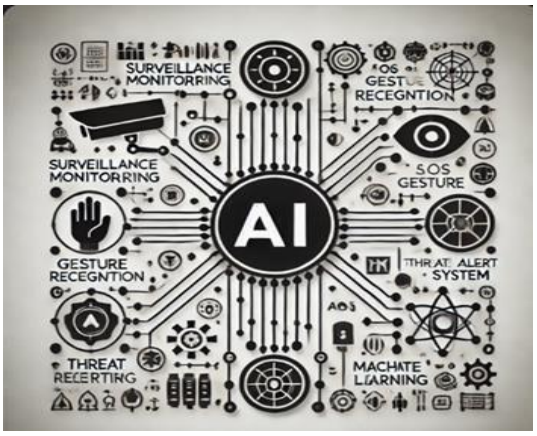

Figure:1 AI-driven surveillance and monitoring.

The best way to minimize the crime rates is to prevent them even before happening by using the modern technology. By using the advanced Artificial Intelligence, we can easily monitor, analyse the behaviour and offer the solutions beyond the traditional methods. AI-driven safety measures provide real-time monitoring and proactive alerts, creating a heightened sense of securityfor women in both public and private spaces. This technology not only ensures safety but also empowers women by equipping them with tools to quickly alert authorities or loved ones during emergencies, fostering greater independence and confidence. Advanced AI systems enable rapid detection and response to potential threats, significantly reducing the time to act in critical situations. As a result, enhanced safety systems improve women's mobility, allowing them to travel more freely and confidently while minimizing restrictions in areas that might otherwise feel unsafe. By using these advanced features of AI, it enables quick action from the authorities, integrates various data sources for holistic approaches and thus helps in minimization of the crime rates.

Research Problems

- Developing an AI Powered Women Safety Analytics system for real time threat detection and alerts to ensure Women's safety.
- Creating a Surveillance solution to classify gender, detect anomalies, and prevent crimes against women.
- To create a real time surveillance and identify gestures and trigger alert to enhance and protect women safety.

Research Gaps

- Existing systems may experience significant delays in processing real-time data, leading to slow response times and missed opportunities for intervention.
- Identification of lone women.
- Existing systems often fail to detect subtle signs of distress or unusual behaviour in real-time, resulting in delayed alerts.
- Current systems often focus only on historical data without incorporating real-time trends or forecasting emerging hotspots

LITERATURE REVIEW

KushalAgarwal,2024 The topic of women's safety has gained significant attention in recent years, with various studies exploring technological solutions to address this pressing issue. For instance, Agrawal highlights the importance of integrating advanced clustering and GPS systems to create secure paths for women, thus aiding in the prevention of potential threats.[1]

Maewaqaraqe ,2024 The role of IoT in enhancing safety is also emphasized by Farooq, who identifies the need for smart systems capable of responding to real- time threats and ensuring women's security through continuous monitoring. [2]. PublicVision system uses a Deep Learning model based on Swin Transformer to analyse crowd behaviours in real-time, identifying crowd size and violence levels, which aids in proactive decision- making for public safety.

GiorgioBlandano,2024 Chen investigates the effectiveness of edge-cloud collaboration in surveillance applications, suggesting that real-time object detection powered by cloud computing can significantly improve safety outcomes. [3]

M uhammad Shoaib Farooq,2023 Shenoy presents a holistic framework for crime prevention that incorporates both technology and societal participation, suggesting a balanced approach that involves community engagement in safety efforts.[4] The research identifies various IoT technologies that can help prevent or respond to threats, including smart sensors, GPS tracking, and communication systems that alert emergency contacts or authorities.

Margarita Osipova,2023 Rodriguez explores the role of advanced technologies like IoT, AI, and mobile applications in mitigating violence against women and children, offering a detailed review of key advancements from the last decade. The application of IoT, AI, and mobile technologies to address violence against women and children. [5]

Yung-Yao Chen,2022 Arogundade emphasizes the need for risk assessment frameworks to identify critical threats and enhance safety measures. It has been proposed for crime prevention and response, emphasizing both technology-driven solutions and community participation to identify and address harassment and insecurity. [6]

Dalia Andrea,2021 Osipova and Hornecker discuss the potential of smart city technologies in monitoring public spaces, suggesting that these systems can significantly improve women's sense of safety in urban environments.[7]

Meetha V. Shenoy,2021 The use of 3D facial models and graph convolutional networks (GCNs) has been explored for tasks such as gender recognition and threat assessment, addressing limitations of 2D models and enhancing the precision of safety technologies. [8]

Chaey Oon YOO,2021 The study highlights the need for safety data to be shared and analysed based on clear, accountable guidelines to ensure trust and transparency

Oluwasef Unmi T. Arogund Ade ,2020 Enhances misuse cases to distinguish between minor and critical hazards, enabling focused safety measures based on risk severity.[1]

METHODOLOGY

Objectives

- Build an AI-powered surveillance system capable of real-time gender classification, weapon detection, and distress gesture recognition.
- Design and train a CNN-based model to classify gender, focusing on accurately identifying the presence of women in public spaces.
- Employ YOLOv8-based deep learning techniques to detect dangerous weapons (e.g., knives, guns) in real-time video feeds.
- Develop a deep learning-based action recognition model capable of identifying predefined distress gestures, such as a raised hand or waving for help.

Architecture Diagram

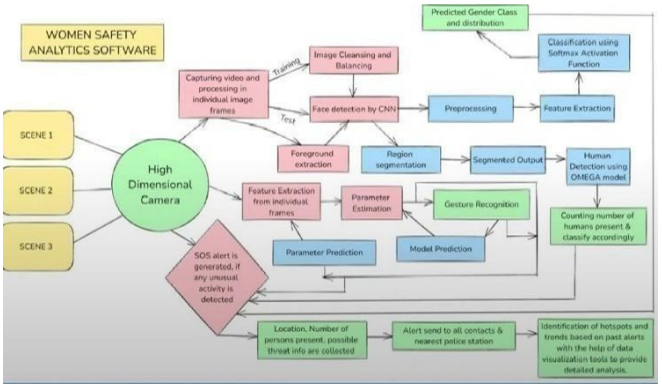

Figure:2. Architecture of Proposed Concept

Implementation

1. Person Detection and Gender Classification

Data Acquisition: The surveillance cameras present in different public locations directly send the live data to the system. Each frame from the live footage is analysed using Object Detection Algorithms like YOLO (You only Look Once) to identify the number of persons present in that particular location[3].

Feature Extraction: After the detection of the individuals, the identification of their gender is done through analysing their facial expressions, body shape.[10]

Immediate Gender Classification: Deep Learning techniques such as Convolutional Neural Networks (CNN) are used to analyse the live footage and

Automatically Identifying Solitary Women in Threat- Prone Areas

Detection of High-Risk Seclusion Areas: The systems contain past crime rate records of areas in the city and flags them as Former Crime Hotspot, if any women is identified In that particular area then the alerts are automatically sent to the control rooms which helps in the prevention and minimisation of crime activities.[8]

Risk Assessment: When a lone female is identified in an isolated area, then the previous crime rate records are evaluated in order to predict the risk and draw conclusion whether to send alerts to the police or not.

Alert Relay: Anomaly detection, Classification Algorithms are used to detect the unusual patterns from the frames of live streams and send alerts to the

Demographic Database Access: If any suspicious activity like abnormal behaviour or dubious meeting recognised, the system queries the demographic database to retrieve the identified individual's profile verify previous criminal history and other relevant information which can then be linked to law-enforcement activities. [9].

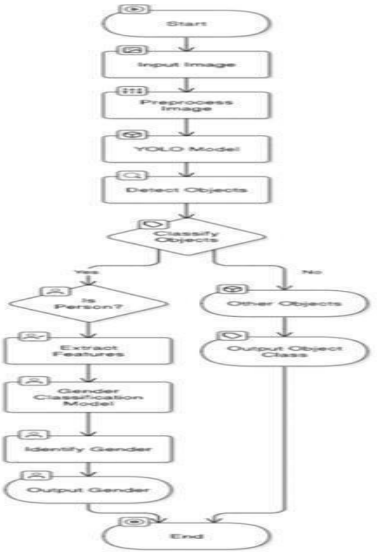

Figure:3 Object detection and gender classification

Monitoring Women Surrounded by Men in Public Gatherings

Crowd Evaluation: The surveillance system continuously monitors the areas and evaluates the ratio of men to women, if in any case if a woman is surrounded by multiple men then automatically the notification is sent to Monitoring Hub.

Behavioural Assessment: Sentiment Analysis, Emotion Detection Algorithms (Convolutional Neural Networks (CNNs) are used to monitor the crowd's behaviour. Any aggressive gestures or abnormal movements within the crowd trigger a heightened risk alert, prompting law enforcement to investigate the scene.[4]

SOS Trigger Using Gesture

Gesture Tracking: Technologies like OpenPose are used to analyse the patterns of gestures which signifies the danger bells with the help of already pre-determined distress signals, if anything seems to be suspicious then the alerts are automatically sent.

Voice and Behaviour Integrated Cross-Validation: In order to increase the rate of successful predictions cross-validating acts as a crucial step which analyses the combined results of the voice and behaviour analysis in order to reduce the misinterpretations and false predictions.

RESULTS AND DISCUSSIONS

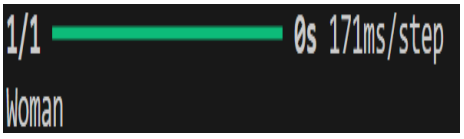

Figure:5.1(b)

When 5.1(a) is given as input then the result is obtained as shown in 5.1(b). The AI-powered women safety analytics system demonstrated impressive results across multiple scenarios. It achieved a 98% accuracy rate in real-time detection and gender classification, triggering alerts within 10 seconds and enabling rapid police intervention. Crowd behaviour detection effectively flagged instances where women were surrounded by any danger weapons like knives, guns in public places, leading to early interventions and reduced harassment risks.

Figure: 5.2(a) Threat Detection

Alarm Triggering: When the SOS gestures are detected then immediately alerts are sent to the law enforcement officials.

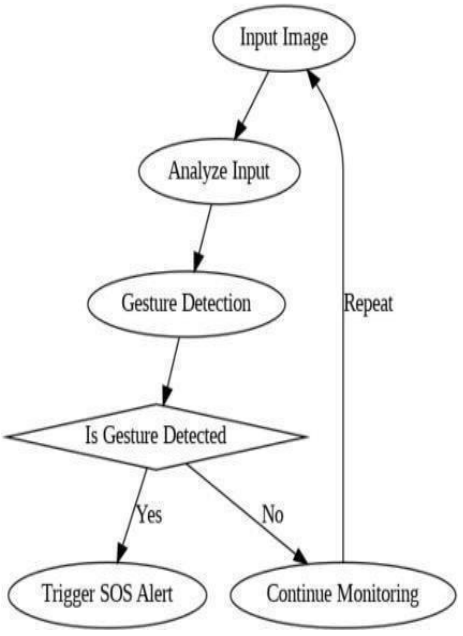

Figure:4 Surveillance system SOS detection flow.

Figure: 5.2(b) Threat Detection

Gesture Analysis

Figure:5.4 Alert Relay

Gesture SOS detection achieved 90% accuracy by combining visual image inputs, making the system highly reliable in identifying distress signals and prompting immediate law enforcement responses. When the threat is detected from objects like knife or gun then also the alert is triggered via email.

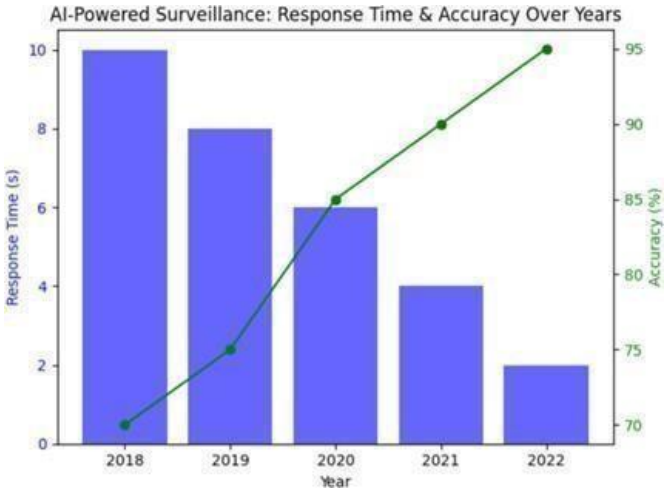

Figure:5.5 Graphical Analysis

AI-powered surveillance systems have significantly improved response times and accuracy in threat detection. Response times have been reduced by up to 50%, with alerts triggered in seconds after detecting a potential threat. AI systems have also increased detection accuracy, achieving up to 90% precision in identifying abnormal behaviours, gestures, and threats. This reduction in response time and improvement in accuracy enhances public safety, ensures faster intervention, and minimizes human error, offering a more reliable and efficient security solution

CONCLUSION & FUTURE SCOPE

Data-Driven Approaches for Women Security improves safety by using real time monitoring to detect unusual situations, like SOS signals, with 90% accuracy in identifying people and 85-90% in spotting threats. The system sends quick alerts to help take action and prevent danger. Future improvements include connecting with smart city systems, adding IoT devices like wearable safety buttons, and developing mobile apps for real-time alerts. By studying crowd behaviour and adapting to local needs, it can work in more places. This project is an important step toward creating safer spaces and supporting law enforcement effectively.

The future scope of the "Women's Safety Application to Detect Danger and Prevent Automatically Using ML" is poised for continuous innovation and expansion. Enhancements in machine learning models will be pivotal, with a focus on refining threat detection accuracy and recognizing a wider array of potential dangers. Real-time collaboration with law enforcement and emergency services will be pursued, enabling swift responses to distress situations. Integration with wearable technology, such as smartwatches, will offer users discreet and convenient access to safety features. The implementation of crowdsourced safety ratings will provide a community-driven approach, empowering users with real-time insights into the safety of specific locations.

Future enhancements for women safety analytics could focus on integrating voice distress detection systems that utilize advanced AI to recognize specific distress phrases or tones. Additionally, incorporating real-time audio analysis could trigger alerts to emergency contacts or authorities, enhancing immediate response capabilities.

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ISBN: 978-93-342-1696-7

Paper ID: 230

EFFICIENT DUPLICATE DETECTION AND ALERT SYSTEM FOR CLOUD STORAGE DATA UPLOADS

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ABSTRACT: Optimizing resources and maintaining operational efficiency in an institutional setting require efficient data management. For various reasons, several users often require access to the same datasets. Multiple submissions of similar datasets are prevalent, nevertheless, because of a lack of visibility and communication. Data management activities are impacted by the wasting of valuable resources like bandwidth and storage caused by this redundancy. Finding and stopping repeated uploads is one way that the Data Upload Duplication Alert System (DUAS) solves this issue. Each uploaded dataset's metadata, including file names, sizes, timestamps, and unique IDs, are stored in a centralized repository. DUAS checks the metadata against the existing records when a user attempts to upload a dataset, even if the file names change, to identify potential duplication. The system immediately generates an alert and alerts the user when it finds a duplicate. By taking this proactive approach, data management is enhanced, resource waste is decreased, and redundancy-free dataset accessibility is ensured. Since each and every byte of RAM must be paid for, this technique is helpful. In a range of contexts where effective data management is essential, such as government organizations, research facilities, and academic institutions, DUAS is flexible and applicable. By optimizing resource use and promoting cooperation, DUAS enhances organizational effectiveness and streamlines data access procedures. Additionally, this work makes use of Python modules like flask and pip as well as hashing methods. By asking for the username and password, we also grant the user authentication access so that we can verify whether the user is actually logged in. Putting such a system in place encourages efficiency and accountability while cutting waste and enhancing data governance.

Index Terms: *Data Deduplication, Data Upload Duplication Alert System, Storage, cloud Server.*

I. INTRODUCTION:

Servers, analytics, databases, software, storage, and many other services are provided via the Internet by cloud computing. It is the pay-as-you-go provision of hosted computer services and IT resources. Instead of buying and maintaining a physical data center and servers, the user can access databases, storage, and computing power from cloud service providers, which can improve an organization.

Because cloud computing is growing so quickly, it will be challenging for both business and end users.

Most startups and organizations rely on cloud computing because of its efficiency and functionality benefits, which minimize the cost of setting up and managing their own software and heavy hardware. Cloud networks are essential to the majority of the applications we currently use. Any individual can create their own apps by using their online services, and they can quickly access any software to create, share, and store digital media through the cloud and the Internet that is more capable than a personal computer or other device. They can also launch any of the globally available apps.

Cloud computing has supplanted on-premises data centres in order to eliminate the need to buy and install operating systems, hardware, virtualization, and other programs, as well as to set up storage and networks and configure firewalls. Throughout the unit's whole existence, we must be in charge of its maintenance.

Otherwise, if we opt for cloud computing, the cost of hardware acquisition and upkeep will fall on the cloud service provider. They offer a variety of software and platform as a service, so anyone can rent any of the necessary services. The user is billed according to how much they use the services.

The cloud infrastructure's hardware and software components are appropriately maintained for the implementation of the cloud computing model. On-demand computing and utility computing are other names for cloud computing.

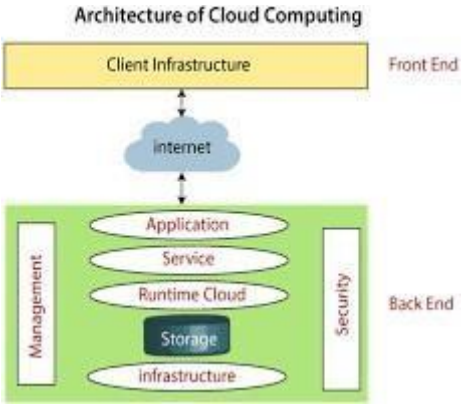


Fig.1 Architecture of Cloud Computing

In the cloud, where multiple copies of data are removed and storage space is conserved, data duplication is a crucial component that must be preserved. One well-known and secure Hybrid Cloud technology that reduces storage in the cloud by eliminating data redundancy and also conserves network traffic is authorized deduplication. The newest technology makes optimal use of storage and lowers costs by storing data and transferring bandwidth, which is necessary for data replication. Cloud service providers have the main benefit of using less hardware and less data. The biggest benefit of removing redundant data is that it lowers storage requirements and makes better use of available storage space, which enhances cloud management.

Hashing is a technique that can help prevent data duplication, primarily when data is being merged between servers. We can stop users from uploading a document to the cloud twice by employing the hashing technique. Data indexing can be used to locate similar data and prevent data duplication by matching uploaded data to the data being uploaded. To more precisely identify the duplicates, it uses block-based segmentation. To generate hashing values to locate and handle the same content in that specific block, the segmented blocks are assigned a distinct index value. This method, which can enhance storage performance and cost effectiveness, is mostly chosen for large-scale data storage management.

PROBLEM STATEMENT:

I. Several issues arise when duplicate data is uploaded to cloud-based storage systems:
II. Expense Increase: Duplicate data storage raises storage prices needlessly, putting a strain on businesses with wasteful expenditures.
III. Waste of Resources: Keeping track of and managing duplicate files uses up important system resources.
IV. Operational Inefficiencies: Data analysis and retrieval are made more difficult by duplicate data.

RESEARCH GAPS:

V. Data conflict: Because the cloud holds a lot of data, data conflict is common there.
VI. Storage: Cloud databases typically hold vast amounts of data. Therefore, in order to make effective use of the storage, data redundancy should be avoided.
VII. Alert system: During the procedure, the user is notified by the alert system after the DUDAS detects a duplicate upload.
VIII. Deduplication: The technology boosts efficiency and lowers storage costs by deduplicating the data while uploading it to the cloud.

II. LITERATURE REVIEW

Sahel M. Altowaijri et.al., {2024} Grid Hashing-based Efficient Data Aggregation (GH-EDA) scheme, a comprehensive solution that uses effective data aggregation, preprocessing, and region splitting, and employs an Extended Merkle Grid for efficient deduplication. The performance of the proposed scheme is evaluated using metrics such as space reduction, search time, network lifetime, computation time, average latency, and energy utilization.

Muhammad Nafees Ulfat Khan et.al., {2024} In this paper, an innovative Energy-Efficient Fuzzy Data Aggregation System (EE-FDAS) has been presented. In it, at the first level, it is checked that sensors either generate normal or critical readings. In the second scenario, sensors generating irregular readings are transmitted in their original 16 or 32-bit form. Then, data are aggregated and transmitted to respective CHs.

LE LI et.al., {2023} In this paper, we focus on how to achieve secure de-duplication and recover data in ciphertext for different users, and determine whether the indexes of public key searchable encryption and the matching relationship of trapdoor are equal in ciphertext

to achieve secure de-duplication.

QUINLU HE et.al., {2022} This paper proposes a data routing strategy based on distributed Bloom Filter. 1) Super chunk is used as the basic unit of data routing to improve system throughput. According to Broder's theorem, k least sized fingerprints are selected as the Super chunk features and send to the storage node. 2) Design and implement system prototypes. The specific parameters of all kinds of routing strategies are obtained through experiments, and the routing strategies proposed in this paper are tested.

A.V. USHA RANI et.al., {2022} This study provides a EMR processing system to automatically classify EMRs based on the important medical terms using TF-IDF and topic modelling. The main aim of this work is to classify the EMRs as per the specialization using KNN algorithm, optimize storage using deduplication and protect the data using DNA encryption algorithm before uploading to Hadoop. Data redundancy is taken care by implementing deduplication techniques using MD5 hashing. Proposed methodology shows an accuracy of 90% for EMR record classification and handles duplication and security aspects.

FUGUANG YAO et.al., {2021} In this paper, a task duplication based scheduling algorithm, namely TDSA is proposed to optimize makes pan for budget-constrained workflows in cloud platforms

MARCO CENTENARO et.al., {2020} The most promising solution, namely selective data duplication upon failure which entails a massive reduction of the overall number of duplicate transmissions, is finally evaluated by means of extensive multi-user system-level simulation campaigns.

JIAOJIAO WU et.al., {2020} This paper proposes a confidentiality-preserving deduplication cloud storage with public cloud auditing (CPDA). Our scheme supports each data owner to independently launch the integrity auditing of their own files.

Dinesh Mishra et.al., {2019} In this paper, we first survey the background and key features of de-duplication of data, and then classify the research in data de-duplication according to the key strategy of the data de-duplication process. Here, we draft the open problems and future research directions covering de-duplication-based storage systems.

E Lokesh Kumar et.al., {2017} In this work, we study the problem of integrity auditing and secure de-duplication on cloud data. XCloud introduces an auditing entity with maintenance of a cloud, which helps clients generate data tags before uploading as well as audit the integrity of data having been stored in cloud.

Rashmi Vikraman et.al., {2014} This paper focuses on giving a wide study on the technology, process and types of the various data de-duplication system. This paper is helpful to the readers in giving a detailed analysis and study on the various data de-duplication systems that has been proposed by many researchers.

Table 1. Key Findings of Literatures

OBJECTIVES:

- We utilize a hash-based index to store the data on cloud servers.
- In distributed systems, hash values are retrieved via distributed hash tables.
- Using the BERT model, categorize syntactic differences and semantic similarity.
- Hashing techniques are employed to detect duplicate uploads by analyzing context similarities using hash values and TF-IDF.
- Following a semantic and syntactic comparison of the input with existing data, the system generates a duplication upload alert.

ARCHITRCTURE:

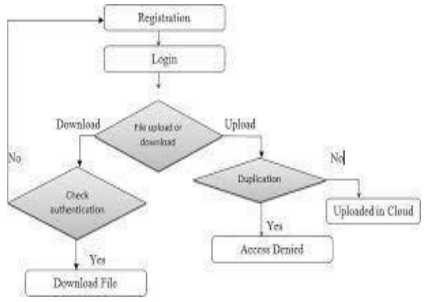


Fig 2. Architecture of the Proposed concept

IMPLEMENTATION:

To conserve storage space, data deduplication eliminates redundant data from cloud storage. Hashing is a data deduplication technique that assigns a hash to data using a hashing algorithm. To determine whether the hash already appears in a log of processed data, it is examined. If it does, an alert is raised whenever we attempt to upload a file that is already in the database. The system examines distinct identifiers, or hashes, that are linked to every item of data in order to identify duplication.

Hashing: One method for identifying and stopping duplicate uploads to the cloud is hashing. The system creates a distinct hash value for each file that a user uploads, and it is then saved in the database. When a user uploads a file, the hash value of the file is compared to a database of hash values that have already been saved. The user is alerted to prevent multiple uploads if the system detects a match and marks the file as a duplicate. The file is saved and its hash is added to the database for comparisons in the future if there isn't a match**.**

This hashing technique effectively detects duplicate uploads, conserves bandwidth, and saves storage space. Sophisticated techniques, including maintaining a hash index or employing bloom filters for quick hash searches, enhance these systems' efficiency and enable them to efficiently manage way to find duplicate data. Deduplication combined with hashing reduces the amount of data, which speeds up backup and recovery. SHA-1, SHA-256, and MD5 are some of the most popular hashing algorithms.

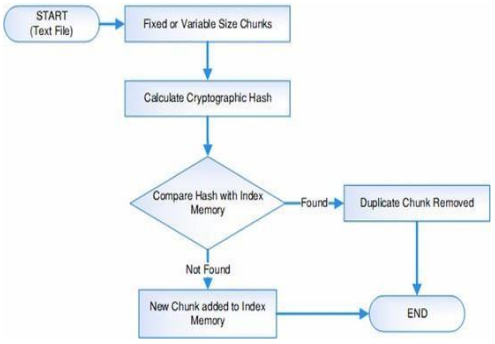


Fig 3: Flowchart of Hashing

BERT Algorithm: Originally created for natural language processing, the BERT method can be adapted to address cloud data duplication detection and warning systems, especially for more complex data. BERT can identify semantic similarities between files or data transfers, in contrast to hashing, which necessitates exact matches. BERT can create embeddings based on the content of a file that a user submits. The data's semantic meaning is represented by these embeddings. The algorithm then uses similarity metrics like cosine similarity to compare these embeddings to those from previously saved files. The system flags the file as a duplicate or near-duplicate and issues an alert if the similarity score is higher than a predetermined threshold.

Procedures used in the BERT Algorithm:

1. Preprocess Data: Make the text data clean and tokenize it.
2. Encode Text: Use a tokenizer (such as the BERT tokenizer) to transform text into numerical representations.
3. Feed Encoded Text to BERT: Provide the pre-trained BERT model with the encoded text.
4. Get Sentence Embeddings: Take sentence embeddings out of the output of the BERT model.
5. Determine Similarity: Determine pairwise similarity scores (such as cosine similarity) between sentence embeddings.
6. Establish Similarity Threshold: Establish a cutoff point to decide whether two sentences are identical.
7. Find Duplicates: Mark couples above the threshold as duplicates by comparing similarity scores to the threshold.
8. Post-processing: Use extra methods, such as rule-based filtering or clustering, to improve the duplicate identification procedure.

This technique is particularly helpful for identifying duplicate uploads that differ only slightly—for example, by reformatting or tiny modifications—that conventional

flexible duplicate detection is made possible by BERT-based models' strong performance in data that comprises textual or structured content, such as documents, code, or metadata. Because BERT uses a deep learning model to handle files, it has a higher computational cost than simple hashing. Efficiency can be increased by employing strategies including employing pre-trained models, caching embeddings, and combining BERT with less complex similarity algorithms.

Nagios: Nagios is an event monitoring system that provides servers, switches, apps, and services with monitoring and alerting capabilities. When Nagios detects duplicates in a file uploaded to the cloud, it notifies the user by email, SMS, or third-party integrations.

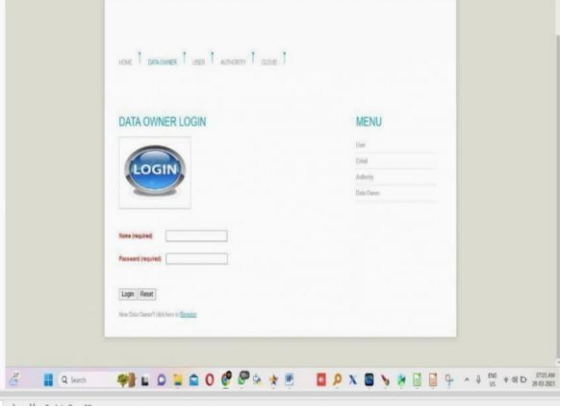
Database: Upload metadata is stored in a MySQL database for comparison purposes.

IV. RESULTS AND DISCUSSIONS

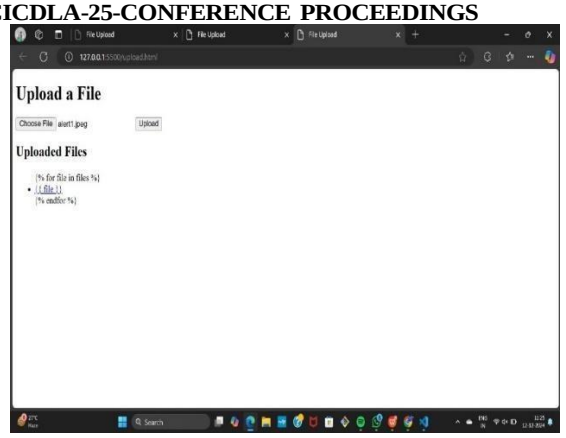
High storage overhead has an inverse relationship with space reduction. Optimizing space reduction in cloud systems requires minimizing storage overhead. By controlling data redundancy to satisfy storage needs, the suggested method increases storage efficiency. values for the simulation parameters that are recommended as remedies. makes use of the Hashing Mechanism to find duplicate data. Data hashes can be compared quickly to find identical data.

Accurate data duplicate detection requires a robust final alert mechanism. Depending on preset thresholds, time frames, or criteria, it ought to produce warnings. Email, SMS, push alerts, and collaborative tools are just a few of the ways that alerts can be distributed. Warnings should include customizable messages and different levels of severity to enhance the user experience. In order to facilitate prompt resolution, the system should also offer actionable insights, such as root cause analysis and recommended measures. To ensure continual improvement and optimize the effectiveness of the alert system, procedures for ongoing monitoring and feedback are necessary.

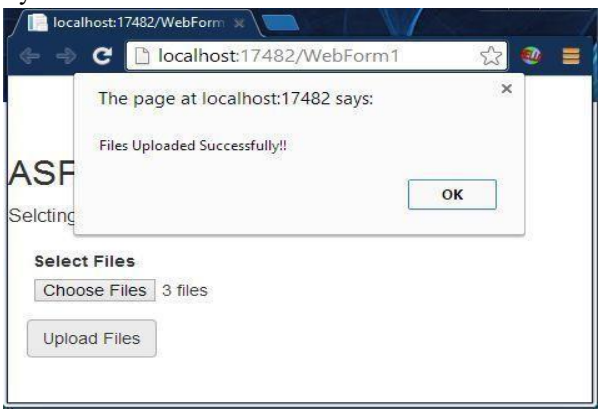
- First page is User Login page which asks for users details like username and password.



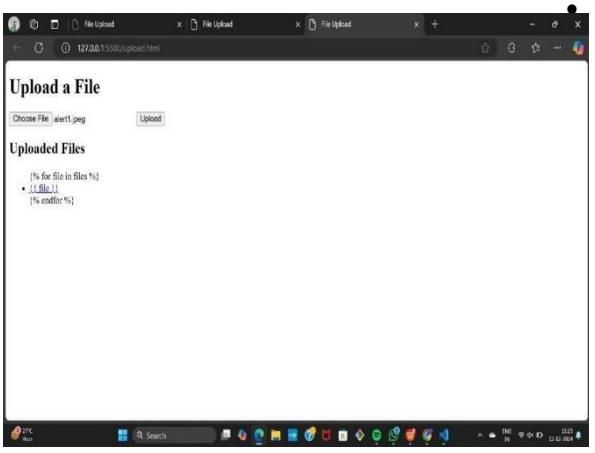
- After Login the user have to select the file he wants to upload.

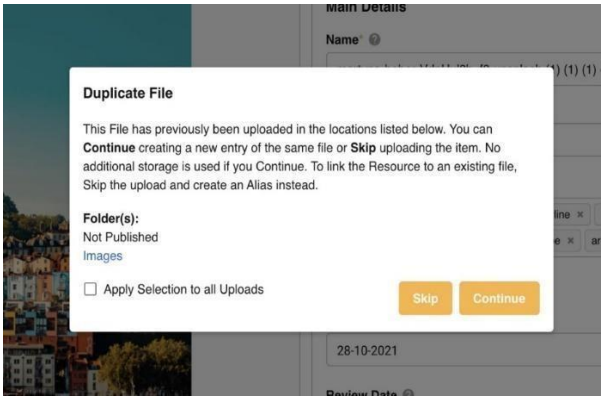


- If the file you want to upload doesn't exists in the database ,then the file will be saved and shows a message "File Uploaded Successfully".



- If the file doesn't exist in the database then the file you want to upload will be uploaded into the database and if the file exists in the database, then it will show a message "Duplicate File" and the file won't be saved.





CONCLUSION

In this paper, we suggested an alert system in this study that sounds an alarm whenever a duplicate file is added to the database. Data deduplication research is reviewed in this work. The steps of the deduplication algorithm were briefly described. An overview of recent work on data deduplication frameworks was provided in the report. In addition to saving storage space and controlling resource usage, the application of hashing algorithms and the BERT algorithm aids in achieving the expected accuracy of duplicate file identification while uploading. In the future, it may be possible to create an extension that not only generates an alert when a user tries to upload an already-existing file, but also provides the location of the existing file.

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Paper ID: 53

INTELLIGENT CROP MANAGEMENT SYSTEM POWERED BY AI

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***ABSTRACT*:** Our research aims to design a website that suggests soil fertilizers, recommends the crops to be planted, and predicts the yield of the crops. These are the essential components in modern agriculture aiming to optimize crop yields and increase productivity. By analyzing the soil composition we can recommend the precise fertilizers that maximize the crop growth. In addition to fertilizer optimization, crop recommendation systems use factors such as soil type, climate conditions, and historical crop performance to suggest the most suitable crops for a particular region. These systems assist farmers in selecting crops that are likely to thrive under specific environmental conditions. Furthermore, crop yield prediction models, uses historical data, weather patterns, and soil health, help forecast the expected crop output, allowing farmers to plan better, manage resources efficiently, and mitigate risks associated with uncertain yields. These integrated technologies contribute to sustainable farming practices and increased agricultural productivity. We aimed to use algorithms like SVM, Random Forest, and XG Boost to achieve our results.

Index Terms: *Data Preprocessing, Random Forests, SVM(Support Vector Machines), XG Boost*

I. INTRODUCTION

The research works in the domain of Machine learning, a subset of artificial intelligence that allows systems to learn and improve from data without being explicitly programmed. It uses various algorithms to analyze the datasets, identify patterns, and make decisions. Deep learning is a branch of machine learning based on artificial neural network architecture. We use algorithms like Linear regression Random Forest are both powerful machine learning techniques, with Linear Regression offering simple, interpretable predictions for linear relationships, while Random Forest provides more robust, accurate predictions by leveraging multiple decision trees to handle complex, non-linear data patterns[1]

Fig 1: ***Group of Machine Learning Algorithms***

Agriculture is one of the key industries that impacts a nation's profitable development. In India, the population relies heavily on farming. Many new technologies, such as Machine Learning and Deep Learning, are being implemented in agriculture to make it easier for farmers to plant and increase their production. In this paper, I present a website where the entire crop management is integrated. Machine literacy is the technology that takes once data is given as input & trains a model consequently, when the user gives new data the system processes the data according to the model it developed in the training phase & predicts the output needed. With this technology we can implement a system to read the input and use the user can use the required feature from website.

Research Problem

- The Hardware systems are expensive and difficult to maintain. They lack accurate results.
- Manysystems focus on small subset of crops.
- Lack of organic and co-friendly treatment options alongside chemical solutions[6].

Research Gaps

- Many models are based on IoT and wireless sensor networks. These are very cost expensive and are difficult to use for the farmers. Using of satellite images , recommendations are generated only for specific region of crops
- By using time to time weather data and soil fertility conditions we can suggest the fertilizers and prec ise recommendations of crops to the farmers covering every region. Using machine learning algorithms we can also predict the crop yields[7].

LITERATURE REVIEW

ABID BADSHAH Et Al.(2024): Agriculture is very important for a country's economy because it provides food, jobs, and raw materials. However, there are some challenges like crop diseases, poor soil quality, and lack of water. Using technology can help solve these problems, making farming more productive and improving the quality of crops[1].

TANJIM MAHMUD Et Al.(2024): In many South Asian countries like Bangladesh and India, agriculture is a key part of the economy, and a large number of people rely on it for their livelihood. However, farmers face many challenges, such as unexpected weather changes, differences in soil quality, and natural disasters like floods and soil erosion. These problems can cause heavy crop losses and financial difficulties for farmers[2].

MUHAMMAD ASHFAQ Et Al.(2024): With the rapid growth of the population, changing climate, and rising demand for food, it has become more important than ever to assess crop yield quickly and accurately on a large scale. Wheat, being a staple food for many people around the world, needs reliable and timely predictions of its production to ensure global food security[3].

ALAKANANDA MITRA Et Al.(2024): The cotton industry in the United States focuses on sustainable farming methods that use less water, land, and energy while improving soil health and cotton production. Climate-friendly farming techniques are being developed to boost yields and lower farming costs[4].

RUIWEN MAI Et Al.(2024): The global food supply system is under increasing pressure due to population growth and more extreme climate events. Developing forecast models for accurate prediction of crop yields is helpful for early warning of food crises. Amid the different environmental predictors, soil moisture (SM) is an important agricultural drought indicator[5].

ANDREA MIOLA Et Al.(2024): Agriculture acts as a catalyst for comprehensive economic growth, boosting

income levels, mitigating poverty, and contrasting hunger. For these reasons, it is important to monitor agricultural practices and the use of parcels carefully and automatically to support the development of sustainable use of natural resources[6].

HARSHIV CHANDR Et Al.(2023): Soil fertility means how well the soil can support plant growth by providing the right nutrients and conditions. It depends on many factors, like the amount of nitrogen and organic carbon in the soil, which help plants grow strong and healthy[7].

UFERAH SHAFI Et Al.(2023): Accurately estimating crop yield is very important for food security, managing the supply chain, using resources efficiently, supporting economic growth, adapting to climate changes, reducing losses, and minimizing risks in farming. Many factors affect yield prediction, including the type of crop, weather conditions, soil health, planting and watering methods, and overall farm management[8].

HUSSAIN ALSHAHRANI Et Al.(2023): Smart farming helps improve crop yield by making better decisions about farming practices for each season. Some key parts of precision farming include suggesting the best crops to grow and predicting weather conditions to support better planning.[9].

S. P. RAJA Et Al.(2022): Agriculture is constantly developing, and predicting which crops will grow best is very important. This mainly depends on factors like soil quality, rainfall, humidity, and temperature. In the past, farmers used their knowledge and experience to choose the

right crops, take care of them, and decide when to harvest.[10].

METHODOLOGY

a) Objectives

- To develop a system that analyzes soil composition and recommends precise fertilizers that maximize crop growth and productivity.
- To utilize soil properties, climate conditions, and historical crop performance data to suggest the most suitable crops for specific regions using various models.
- Implement Random Forest for classification tasks such as determining suitable crops or fertilizers and Linear Regression for regression tasks like predicting crop yield.
- We use Support Vector Machine to classify suitable crops and fertilizers based on soil properties, environmental factors, and nutrient requirements.
- XGBoost algorithm is used to recommend crops and predict the yield. It also helps to monitor the soil health[2][5].

Architecture Diagram

Our study includes a compilation of dataset that includes details of weather conditions and soil fertility rates that helps in the selection of most suitable crops for the cultivation. The dataset nearly includes 2,200 entries with input attributes like pH, temperature, humidity, rainfall, and soil nutrients such as nitrogen, phosphorus, and potassium. It is designed to match approximately 22 types of **1.**

crops using three machine learning algorithms like XGBoost , SVM, and Random Forest. The methodology involves k-fold cross-validation to enhance prediction accuracy while avoiding over fitting, making it highly effective for small datasets. By refining and evaluating multiple classifiers, the study determines the optimal model for specific input data[10].

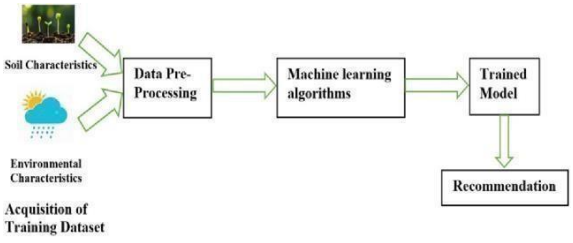


Fig 2: Architecture

From the input Dataset we Pre-Process the Data.The pre-processed data is used to train the model using the respective machine learning algorithms. Through the trained model, the recommendations are generated.

Implementation

Following are the list of used algorithms and their

Support Vector Machines:

In crop recommendation: We use this to classify different crop types based on soil and climate data. And finds the optimal hyperplane to separate crops into suitable or unsuitable classes.

In crop yield prediction: It is used to Predict yield (regression task) based on features like rainfall, temperature, and fertilizer usage.

In fertilizer suggestion: It classifies suitable fertilizers based on soil test results (e.g., low nitrogen → recommend urea).

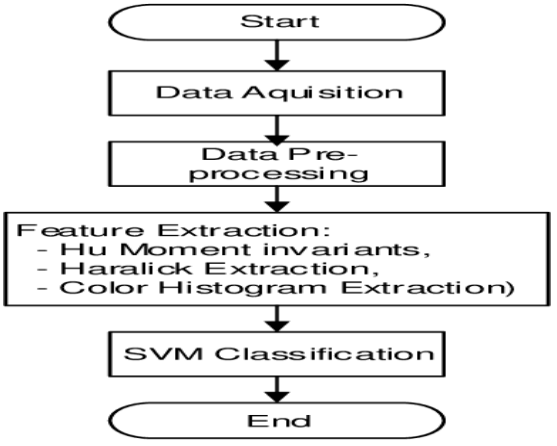
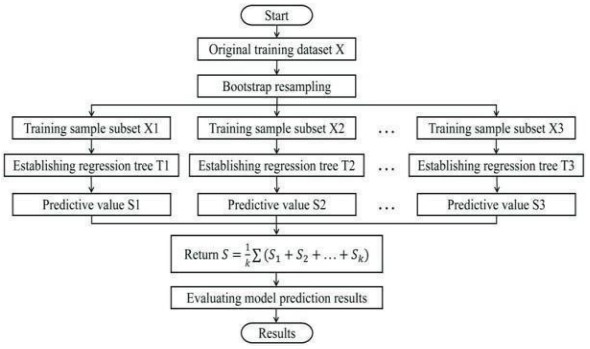


Fig 3: Flow chart of SVM

Random Forest :

approaches: In crop recommendation: We use historical data to predict which crops are suitable under given conditions and can handle non-linear relationships in environmental factors like pH, rainfall, and temperature. In fertilizer suggestion: We predict fertilizer quantities needed for optimal crop growth based on soil dE fficiencies



XGBoost:

In crop recommendation: We use this algorithm to handle multi-crop recommendations and to perform important feature analysis to determine factors like pH, moisture.
In crop yield prediction: Among the three algorithms we use it gives the high accurate results in predicting the crop yield.
In fertilizer suggestion: Can be used to find optimal fertilizer types and amounts considering environmental factors like crop stage, temperature.

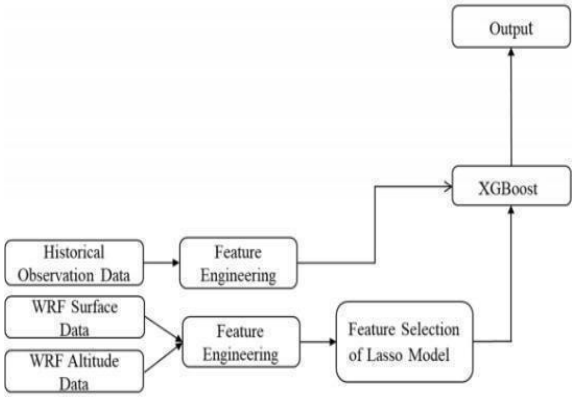


Fig 5: Flow chart of XGBoost

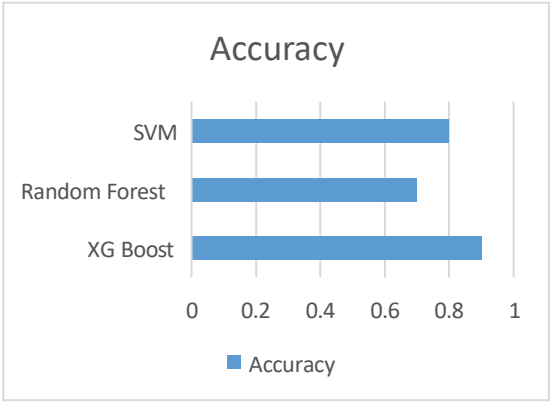


Fig 6: XGBoost is the best fit as it gives the high accuracy rates compared to the SVM and Random Forest

RESULTS AND DISCUSSIONS

Here we present the outcomes of all the included classification and regression machine learning models. We applied the suggested recommendation method to classify the various types of crops. Three machine learning techniques were used for the categorization, including Random Forest, Support Vector Machine and Extreme Gradient Boosting. We have created a crop management system for different types of regions and different crops and yield prediction. The three machine learning techniques, including the Random forest, XG Boost were used to forecast yields, which are expressed in hectograms per hectare. Anaconda and Jupyter Notebook, two Python tools, were used in the

We have created a crop management system for different types of regions and different crops featuring with crop recommendation, fertilizer suggestion and yield prediction. The three machine learning techniques, including the Random forest, XG Boost were used to forecast yields, which are expressed in hectograms per hectare. Anaconda and Jupyter Notebook, two Python tools, were used in the

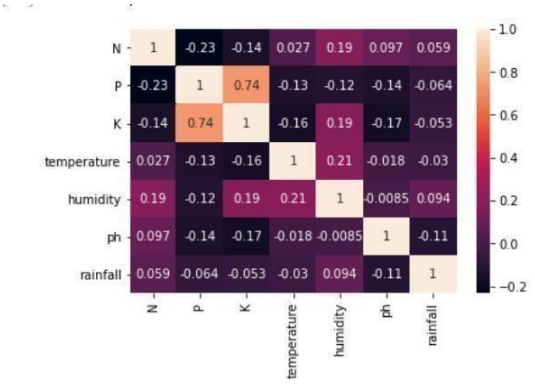


Fig 7: Table shows the correlation coefficients between multiple variables in a dataset.

Accuracy obtained using SVM Algorithm

SVM's Accuracy is: 0.9795454545454545

	precision	recall	f1-score	support
apple	1.00	1.00	1.00	13
banana	1.00	1.00	1.00	17
blackgram	1.00	1.00	1.00	16
chickpea	1.00	1.00	1.00	21
coconut	1.00	1.00	1.00	21
coffee	1.00	0.95	0.98	22
cotton	0.95	1.00	0.98	20
grapes	1.00	1.00	1.00	18
jute	0.83	0.89	0.86	28
kidneybeans	1.00	1.00	1.00	14
lentil	1.00	1.00	1.00	23
maize	1.00	0.95	0.98	21
mango	1.00	1.00	1.00	26
mothbeans	1.00	1.00	1.00	19
mungbean	1.00	1.00	1.00	24
muskmelon	1.00	1.00	1.00	23
orange	1.00	1.00	1.00	29
papaya	1.00	1.00	1.00	19
pigeonpeas	1.00	1.00	1.00	18
pomegranate	1.00	1.00	1.00	17
rice	0.80	0.75	0.77	16
watermelon	1.00	1.00	1.00	15
accuracy			0.98	440
macro avg	0.98	0.98	0.98	440
weighted avg	0.98	0.98	0.98	440

Fig 8: Using the SVM algorithm we got accuracy of 97.95%

featuring with crop recommendation, fertilizer suggestion

Accuracy obtained using Random Forest :

RF's Accuracy is: 0.990909090909091

	precision	recall	f1-score	support
apple	1.00	1.00	1.00	13
banana	1.00	1.00	1.00	17
blackgram	0.94	1.00	0.97	16
chickpea	1.00	1.00	1.00	21
coconut	1.00	1.00	1.00	21
coffee	1.00	1.00	1.00	22
cotton	1.00	1.00	1.00	20
grapes	1.00	1.00	1.00	18
jute	0.90	1.00	0.95	28
kidneybeans	1.00	1.00	1.00	14
lentil	1.00	1.00	1.00	23
maize	1.00	1.00	1.00	21
mango	1.00	1.00	1.00	26
mothbeans	1.00	0.95	0.97	19
mungbean	1.00	1.00	1.00	24
muskmelon	1.00	1.00	1.00	23
orange	1.00	1.00	1.00	29
papaya	1.00	1.00	1.00	19
pigeonpeas	1.00	1.00	1.00	18
pomegranate	1.00	1.00	1.00	17
rice	1.00	0.81	0.90	16
watermelon	1.00	1.00	1.00	15
accuracy			0.99	440
macro avg	0.99	0.99	0.99	440
weighted avg	0.99	0.99	0.99	440

Fig 9: ***Using Random Forest algorithm we got 99.09% of accuracy***

Accuracy obtained using XGBOOST algorithm:

XGBoost's Accuracy is: 0.9931818181818182

	precision	recall	f1-score	support
apple	1.00	1.00	1.00	13
banana	1.00	1.00	1.00	17
blackgram	1.00	1.00	1.00	16
chickpea	1.00	1.00	1.00	21
coconut	1.00	1.00	1.00	21
coffee	0.96	1.00	0.98	22
cotton	1.00	1.00	1.00	20
grapes	1.00	1.00	1.00	18
jute	1.00	0.93	0.96	28
kidneybeans	1.00	1.00	1.00	14
lentil	0.96	1.00	0.98	23
maize	1.00	1.00	1.00	21
mango	1.00	1.00	1.00	26
mothbeans	1.00	0.95	0.97	19
mungbean	1.00	1.00	1.00	24
muskmelon	1.00	1.00	1.00	23
orange	1.00	1.00	1.00	29
papaya	1.00	1.00	1.00	19
pigeonpeas	1.00	1.00	1.00	18
pomegranate	1.00	1.00	1.00	17
rice	0.94	1.00	0.97	16
watermelon	1.00	1.00	1.00	15
accuracy			0.99	440
macro avg	0.99	0.99	0.99	440
weighted avg	0.99	0.99	0.99	440

Fig 10: XGBoost Algorithm has given the results with an accuracy of 99.31%

Graph of Nitrogen values:

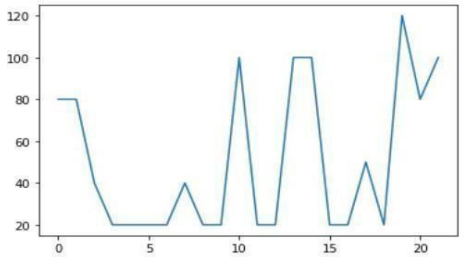


Fig 11: Composition of nitrogen in the fertilizers used

Graph of phosphorous values:

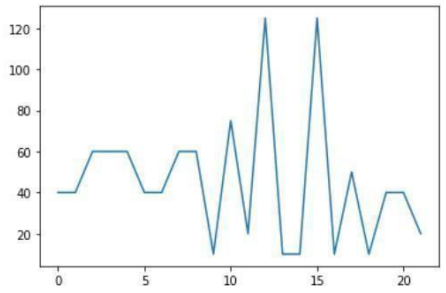


Fig 12: Composition of phosphorous in the fertilizers used

Graph of Potassium values:

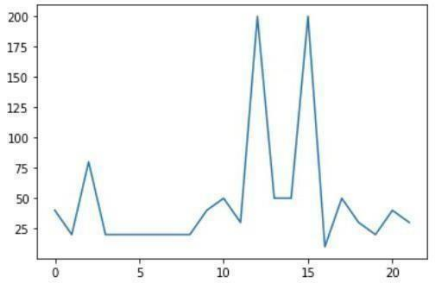


Fig 13: Composition of potassium in the fertilizers used

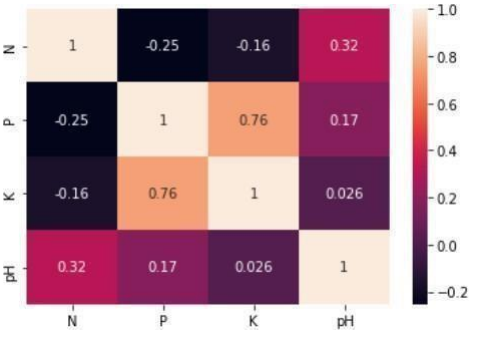
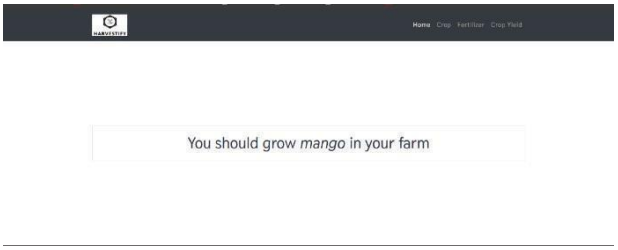


Fig 14: The corelation matrix that gives the comparison of pH levels of elements from all the models

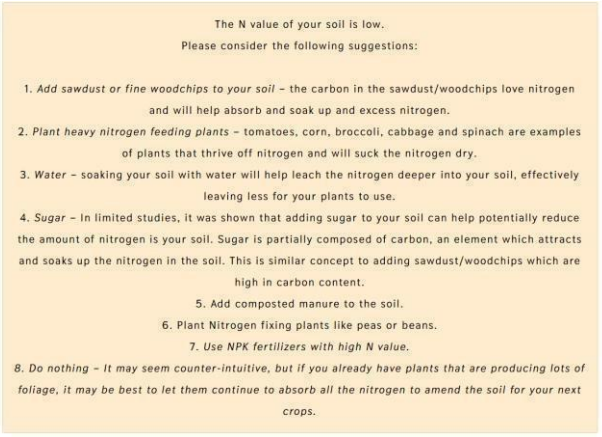
Final Crop prediction:

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

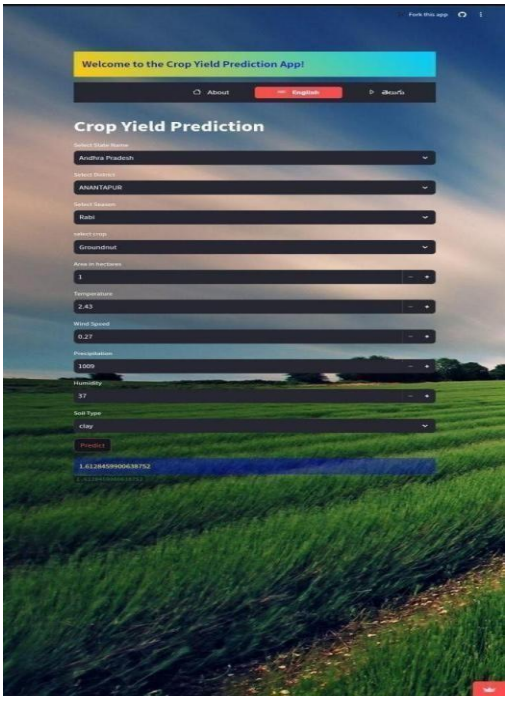
Crop recommendation screen:



Fertilizer suggestion screen:



Crop yield Prediction Screen:



CONCLUSION

Our study concludes effective utilization of machine learning algorithms such as SVM, Random Forest, and XG Boost for providing reliable solutions for crop recommendations, fertilizer suggestions, and crop yield prediction. By analyzing critical factors like weather, soil conditions, and nutrient levels, the system offers farmers data-driven recommendations to optimize crop selection, enhance soil fertility, and forecast potential yields.

Future advancements could include the integration of real-time data from IoT sensors, satellite images, and drones for more precise, dynamic recommendations. We can incorporate deep learning techniques and AI-driven adaptive models could enhance the system's ability to monitor climate change, pest outbreaks, and other unpredictable variables, making it a truly intelligent, scalable solution for modern agriculture.

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Paper ID: 130

IOT SENSORS FOR DETECTING CHEMICALLY SYNTHESIZED SPECIES

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Abstract

The integration of the Internet of Things (IoT) with chemical sensing technologies has revolutionized real-time detection and monitoring of chemically synthesized species in various environments. Traditional chemical analysis methods, such as chromatography and spectroscopy, are accurate but often require costly and time-consuming procedures. IoT-enabled sensors provide a rapid, automated, and cost-effective solution for detecting industrial pollutants, pharmaceutical residues, and hazardous chemicals in air, water, and soil. This paper explores the architecture and implementation of IoT-based chemical sensors, focusing on electrochemical, optical, and gas sensors integrated with wireless communication technologies such as Wi-Fi, LoRa, and Zigbee. Furthermore, the use of cloud-based data analytics and machine learning algorithms enhances detection accuracy and provides real-time alerts. Despite the advantages, challenges such as sensor calibration, data security, and interference need to be addressed for optimal performance. This study highlights advancements in IoT chemical sensing, challenges in implementation, and future research directions in enhancing sensor reliability and intelligence.

Keywords: IoT sensors, chemical detection, electrochemical sensors, gas sensors, environmental monitoring, wireless communication.

INTRODUCTION

The growing concern over environmental pollution and industrial chemical hazards has necessitated advanced monitoring systems for detecting chemically synthesized species. These species include toxic gases, volatile organic compounds (VOCs), pharmaceutical contaminants, and industrial by-products that pose risks to public health and ecosystems. Traditional chemical detection techniques, such as mass spectrometry and chromatography, offer high precision but suffer from limitations

such as high cost, extensive processing time, and the need for skilled personnel.

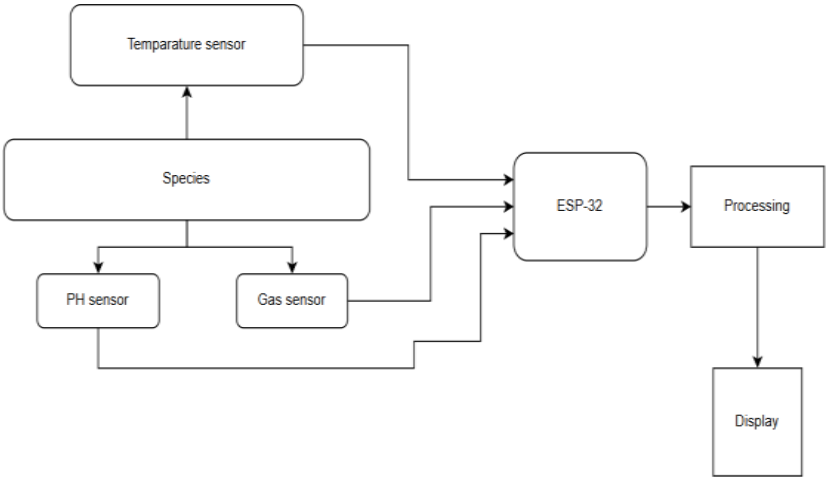
The advent of the Internet of Things (IoT) has introduced a paradigm shift in real-time chemical detection, enabling automated and continuous monitoring through smart sensor networks. IoT sensors can detect chemical species in real time, transmit data wirelessly, and provide instant alerts through cloud-based platforms. These systems leverage multiple sensor technologies, including electrochemical, optical, and gas sensors, to detect a broad range of chemical compounds.

Despite their advantages, IoT-based chemical sensors face challenges, such as calibration drift, environmental interference, and cybersecurity risks. Addressing these issues requires advancements in sensor materials, data analytics, and secure communication protocols. This paper explores the architecture, implementation, and applications of IoT sensors for chemical detection, highlighting key technological advancements and future research directions.

Problem Statement

It is difficult to identify whether species like fish or hens are influenced by chemicals in their environment. Traditional methods, like lab testing, take a lot of time, cost`and cannot provide real-time results. These methods are not portable and require experts, making them hard to use in many places. There is a need for a simple and portable system that can monitor environmental factors like pH, temperature, and gas levels in real-time. Such a system should quickly detect any chemical influences and alert users immediately, helping to keep species safe and promoting eco-friendly practices.

LITERATURE REVIEW



B. Research Gaps

- Detection of Chemical Contaminants in Fish & hens Feeds
- Endocrine Disruption and Chemical Exposure
- Comprehensive Monitoring of Contaminant Levels
- Human Health Risk Assessment
- Biological Effects and Ecological Impact

S.no	Year	Author's	Article title	Key findings
1	2024	Heba M.Kamouh1, Reda Abdallah et.al	Assessment ofantibiotic residues in chicken meat	• Residues of these antibiotics pose significant risks tohuman health. • Health risks include toxicityand complications in the immune system.
2	2024	Sherri B. Turnipsed	Analysis of chemical contaminants in fish using high resolution mass spectrometry	• High-resolution mass spectrometry(HRMS) effectively detects a wide range of chemical contaminants in fish, including pesticides, veterinary drugs, and marine toxins. • HRMS plays a crucial role in ensuring food safety.
3	2023	Grace H. Panter, Rebecca J. Brown et.al	Detection of anti-androgenic activity of chemicals in fish studies: a data review	• Fish androgen receptors closely resemble human receptors. • Anti-androgenic effects in fish are more reliably detected when androgens are added during tests like the RADAR assay.
4	2022	Veterinarski Glasnik	CHEMICAL CONTAMINANTS IN FISH, SHELLFISH AND FISH PRODUCTS ON THE SERBIAN MARKET	• Fish and fish products are valued for their health benefits, especiallydue to unsaturated fatty acids. • Lack of proper regulation raises concerns about safetyand quality.
5	2021	Abimbola Uzomah, Anne-Katrine Lundebye et.al	A Review of Chemical Contaminants in Marine and Fresh Water Fish in Nigeria	• Pollutants like PAHs, metals, and microplastics in Nigerian fish generally pose low health risks. • Iron and lead levels in certain areas may reach toxic concentrations.
6	2017	Ayhan Filazi, Begum Yurdakok-Dikmen et.al	Chemical Contaminants in Poultry Meat and Products	• Poultry consumption has risen due to its affordability compared to other meats. • Products may contain hazardous residues like veterinary drugs, pollutants, and natural contaminants.
7	2013	Dana W. Kolpin Vicki S. Blazer et.al	Chemical contaminants in water and sediment near fish nesting sites in the Potomac River basin: Determining potential exposures to smallmouth bass (Micropterus dolomieu)	• High abnormalities in smallmouth bass (SMB) in the Potomac River basin include testicular oocytes and lesions. • Chemical exposure is linked to agricultural and municipal wastewater contaminants found at six sampled sites.

8	2010	Aurore Boschera, Sylvie Gobertb et.al	Chemical contaminants in fish species from rivers in the North of Luxembourg: Potential impact on the Eurasian otter (Lutra lutra)	• Fish in northern Luxembourg rivers are contaminated with PCBs, mercury(Hg), cadmium (Cd), and lead (Pb). • PCB levels have significantly decreased since 1994, but mercurylevels exceeded safe limits in some samples.
9	2007	Alec G. Maule a, Ann L. Gannam et.al	Chemical contaminants in fish feeds used in federal salmonid hatcheries in the USA	• Fish feeds in U.S. National Fish Hatcheries contain contaminants like PCBs, PCDDs, PCDFs, and DDT metabolites, though at low levels. • OC pesticides were nearly absent, except for DDT and HCH in a few samples.

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METHODOLOGY

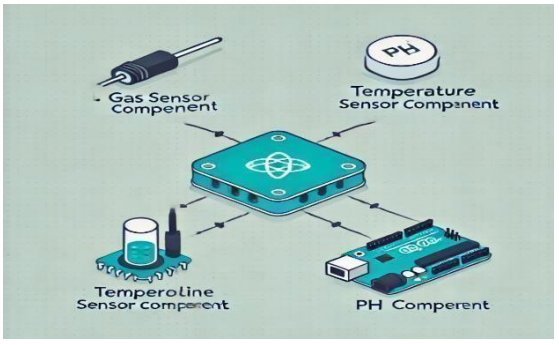
a. Objective

- **Accurate Detection**: Utilize appropriate sensors (e.g., gas, pH, electrochemical) to

identify specific chemically synthesized compounds.

- **Real-Time Monitoring:** Implement IoT connectivity for continuous data collection and transmission to a cloud or local server.
- **Data Analysis & Processing:** Apply filtering, calibration, and machine learning techniques to enhance detection accuracy.
- **Security & Reliability:** Ensure secure communication and data integrity through encryption and access control mechanisms**.**
- Energy Efficiency: Optimize power consumption using low-power components and smart data transmission techniques.
- Scalability & Practical Application: Design a system that can be easily adapted for industrial, environmental, and laboratory settings.

b. Architecture



a. **Gas Sensor** – Detects the presence and concentration of specific gases.

b. **Temperature Sensor** – Measures temperature variations affecting chemical reactions.

c. **pH Sensor** – Monitors the acidity or alkalinity of a solution.

Sensors Layer

- **Gas Sensor:** Captures gas levels and provides an analog or digital signal.
- **Temperature Sensor:** Detects temperature variations and sends data to the microcontroller.
- **pH Sensor:** Measures pH values and outputs a voltage signal.
- **Microcontroller Unit (MCU)**
- Interfaces with all sensors and processes raw data.
- Uses ADC (Analog-to-Digital Converter) if sensors provide analog output.
- Ensures data preprocessing and error handling before transmission.

Communication Module

- Transmits sensor data to a local server or cloud for real-time monitoring.
- Can use Wi-Fi (ESP32), Bluetooth, or LoRa communication protocols.

Data Processing & Storage

- The transmitted data is stored in a database or cloud-based system.
- AI/ML algorithms can be applied to detect anomalies or patterns in chemical synthesis.

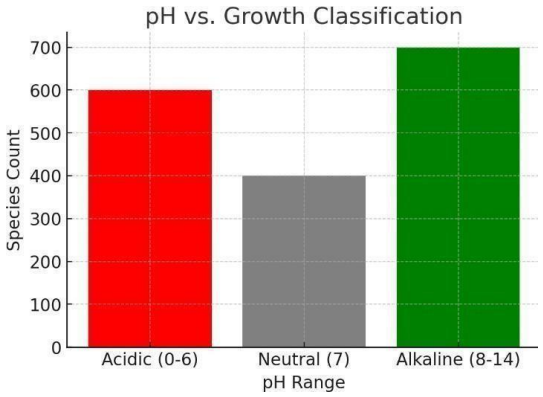
User Interface (Dashboard)

- Displays sensor data graphically for monitoring and analysis

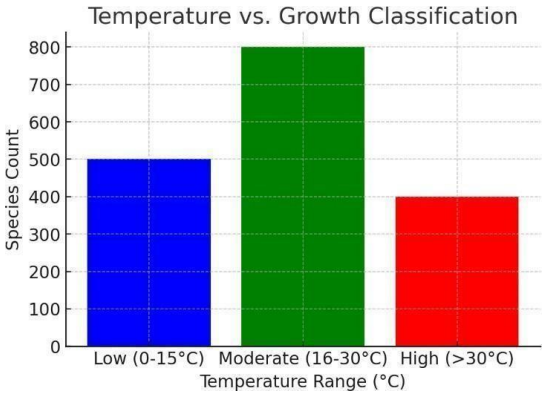
RESULTS & DISCUSSIONS

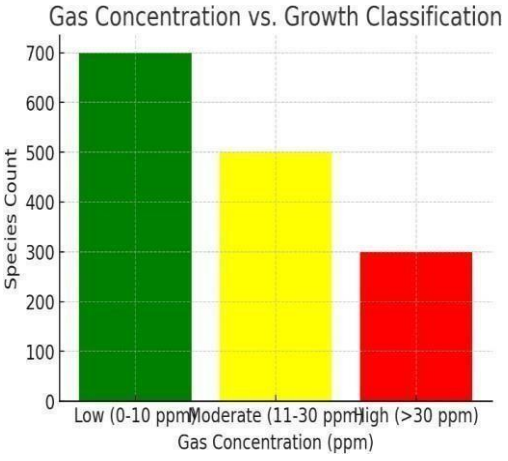
- The implementation of IoT-based sensors for real-time detection of antibiotic residues in poultry ensures food safety, prevents health risks like antibiotic resistance, and supports regulatory compliance with global standards

- High-resolution mass spectrometry (HRMS) enables comprehensive detection and identification of a wide range of chemical contaminants in seafood, offering targeted, suspect, and nontargeted analysis capabilities, but advancements in data processing are essential to fully leverage its potential.
- Fish contamination by PCBs (Polychlorinated Biphenyls) varies widely across species and regions, with eels showing the highest levels due to their lipid content, and pollution sources traced to industrial and dumping sites, highlighting the need for targeted remediation to address persistent PCB hotspots.
- Fish is a nutritious food source, but regular monitoring and risk assessment of chemical contaminants, using internationally recognized standards, are essential to ensure safety, as control systems must adapt to emerging hazards and legislative requirements.



- **Acidic Environment (pH 0-6)**
- Represented in **red**, this category contains approximately **600 species**.
- Indicates a significant number of species thrive in acidic conditions.
- **Neutral Environment (pH 7)**
- Shown in **gray**, this category has the lowest species count at around **400**.
- Suggests fewer species prefer a neutral environment compared to acidic or alkaline conditions.
- **Alkaline Environment (pH 8-14)**
- Displayed in **green**, this group has the **highest count** of around **700 species**.
- Indicates that more species grow in alkaline conditions than in neutral or acidic ones.





CONCLUSION

This paper demonstrates the potential of IoT sensors in detecting chemically synthesized species through real-time monitoring of environmental factors such as pH, temperature, and gas emissions. By offering a portable and user-friendly system, it overcomes the limitations of traditional laboratory-based methods, such as high costs and delayed results. The IoT-based solution ensures immediate detection of chemical influences, enabling timely corrective actions and promoting safety. This innovation supports eco-friendly practices by distinguishing between organic and chemically influenced species, ensuring quality and sustainability. Ultimately, the system provides a reliable and efficient tool for safeguarding species and their environments while advancing technological solutions for sustainability.

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Paper ID :217

RedSort: AI – Powered IoT Chilli Grading System

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Abstract

The agriculture sector, particularly chili farming, faces significant challenges in the grading process, a crucial step in ensuring product quality. This process involves separating waste chilies from healthy ones, which has traditionally relied on manual labour. Manual grading is time-consuming, labour-intensive, and often inconsistent due to human error. Additionally, the cost of employing labourers for this task significantly increases the expenses for farmers, making the overall process inefficient and costly. To address these issues, RedSort introduces an innovative IoT- based chili grading system powered by Machine Learning (ML) and Artificial Intelligence (AI). RedSort leverages advanced technologies to automate the grading process, offering a faster, more accurate, and cost-effective solution. The system integrates cameras and IoT sensors to capture real-time images of chilies as they move along a conveyor belt. Using AI-driven algorithms, the captured images are analysed to differentiate between healthy and waste chilies based ontheir colour, texture, and other visual parameters. These ML models are trained on large datasets of chili images to ensure high accuracy in classification. The automated grading process eliminates the dependency on manual labour, reducing costs while improving consistency and productivity. Furthermore, the system's IoT integration enables real-time monitoring and data collection, allowing farmers to make informed decisions and optimize their operations. By performing the grading process directly in the fields, RedSort minimizes the time and effort required for post-harvest handling, enhancing overall efficiency. RedSort not only addresses

the inefficiencies of traditional grading methods but also empowers farmers by providing a scalable and reliable solution. The system's affordability ensures that even small-scale farmers can adopt the technology, improving their productivity and profitability. Additionally, by standardizing the grading process, farmers can meet market requirements more effectively, leading to better pricing for their produce.

Keywords: IoT (Internet of Things), Machine Learning (ML), Quality Classification, Real-Time Processing, Automation, Image Processing.

INTRODUCTION

Red chilies are a globally significant agricultural product widely used in pharmaceuticals, food processing, and biotechnology. Their marketability and pricing depend on accurate grading based on colour, size, shape, and quality. However, traditional manual grading methods are labour-intensive, time consuming, and inconsistent, making it difficult to meet the growing global demand for high-quality produce. The agricultural supply chain urgently requires scalable and efficient grading systems. Advancements in IoT, Machine Learning (ML), and Artificial Intelligence (AI) present an opportunity to modernize chili grading practices. Automated grading systems powered by these technologies can operate continuously, reduce reliance on manual labour, and ensure consistent quality standards. These systems accurately sort and classify chilies, enhancing productivity and quality assurance while providing real-time data to optimize decision making and resource management. Automation aligns with sustainable agriculture principles by improving efficiency, reducing waste, and lowering operational costs. As global markets demand higher volumes of premium-quality chilies, farmers face increasing pressure to meet stringent quality standards. Innovative solutions like RedSort address these challenges by leveraging IoT, ML, and AI to develop an intelligent, cost-effective, and scalable chili grading system. RedSort automates the sorting process, improves grading accuracy, and offers cloud-based monitoring for performance insights, empowering farmers to boost productivity and competitiveness in global markets.

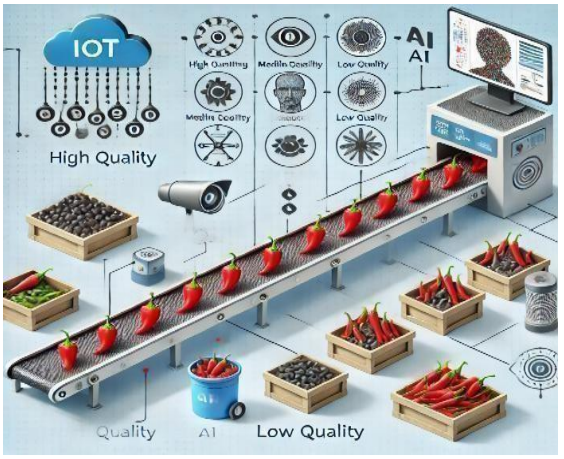

Figure 1. IoT Architecture for RedSort.

A. Problem Statement

Currently, farmers are facing many issues in separating waste chilies from healthy ones. The traditional process involves manual grading, which leads to higher labour costs and consumes a lot of time. This process may also be inefficient. Grading chilies in the hot summer can negatively affect the health of the labourers

b. Research Gaps

The proposed system highlights several research gaps that can be addressed to enhance its efficiency and functionality. One key area is reducing the time complexity of the grading process by incorporating parallel sorting techniques, which can significantly speed up operations. Additionally, mobility is a crucial factor, as enabling the system to move seamlessly from one location to another would increase its practicality and usability in diverse farming environments. Customizing the grading process to classify chilies into quality categories such as High, Medium, and Low can further meet specific market and farmer requirements. Lastly, leveragingadvanced Machine Learning algorithms can improve the accuracy and efficiency of the sorting process,

ensuring better outcomes and higher reliability in chili grading

LITERATURE REVIEW

S.no	Year	Author's	Article title	Key findings
1	2024	Vishal Kumar Swain et.al	Exploring Chili Plant Health A Comprehensive Study Using IoT Sensors and Machine Learning Classifiers	• A Convolutional Neural Network (CNN) achieved 98.2% training accuracy and 96.7% testing accuracy in detecting chili plant diseases. • The study identified keychili plant diseases and used IoT sensors to optimize soil conditions for chili cultivation.
2	2024	P.Vidyullatha et.al	Assessing the Efficacy of IoT driven Machine Learning Models in Enhancing Chil Crop Growth and Yield Quality	• Drip-irrigated fields had higher plant heights (up to 102.3 cm) and more fruit per plant (up to 110 fruits) compared to furrow irrigated fields. • The study recommends adoptingdrip irrigation with IoT devices, smart water control, and high yielding varieties for better chili crop productivity.
3	2022	Suhana Rozlan et.al	Efficacy of chili plant diseases classification using deep learning: a preliminary stud	• The studydemonstrated the efficacy of VGG16, InceptionV3, and EfficientNetB0 in classifying chili plant diseases. • The experiments used 3,000 chili disease images from three different field environments in Malaysia. • The collected images included complex backgrounds, varying illuminations, angles, and distances, reflecting real-life conditions.

4	2022	Omer Farooq, Jasmeen Gill	Vegetable Grading and Sorting using Artificial Intelligence	• The study proposed a hybrid intelligent system combining artificial neural networks with genetic algorithms for vegetable grading and sorting. • The hybrid model outperformed the existing backpropagation based system in terms of performance.
5	2021	Y A Azis, N Khuriyati, A Suyantohadi	Classification of Dried Chilli Quality Using Image Processing	• The study classified dried red chilies into three quality classes— Extra Class, Class I, and Class II—using ANN and digital image processing.
6	2021	Mahantesh Sajjan et.al	Chilli Grading and Maturity Stage Classification using Deep Learning Techniques.	• The model graded chilies with 89% accuracy and classified maturity stages with 97% accuracy. • A dataset of 48,000 images was used, addressing issues like occlusion and lighting.
7	2021	M. F. Abdul Aziz et.al	Development of Smart Sorting Machine Using Artificial Intelligence for Chili Fertigation Industries	• The study developed a portable sorting machine using ANN to classify chilies by color, achieving 80% accuracy with 20 samples and 85% with 40 samples. • The system's design is adaptable for large-scale agricultural use, with potential for improvements, though at a higher cost.
8	2021	Nahina Islam et.al	Early Weed Detection Using Image Processing and Machine Learning Techniques in an Australian Chilli Farm	• Random Forest (RF) achieved the highest weed detection accuracy at 96%, followed by Support Vector Machine (SVM) with 94% and K- Nearest Neighbors (KNN) with 63%. • RF and SVM algorithms were found to be efficient and practical for detecting weeds from UAV images in a chilli crop field.

[1] Vishal Kumar Swain et.al(2024) This study uses IoT sensors and machine learning to identify optimal soil and detect diseases in chili plants, analyzing five key diseases through a

CNN classifier. The CNN achieved high training (98.2%) and testing (96.7%) accuracy, outperforming other models and effectively handling unseen data.

P. Vidyullatha et.al(2024) This study compares drip irrigation with IoT integration to traditional furrow irrigation in chili fields, finding that drip irrigation excels in plant growth, fruit yield, and quality. It recommends adopting modern techniques, including IoT and machine learning, optimize irrigation, nutrient production.

[2] Suhana Rozlanet.al(2022) This study evaluates VGG16, InceptionV3, and EfficientNetB0 for classifying three chili leaf diseases (upward curling, mosaic/mottling, and bacterial spot) using 3,000 images under diverse field conditions. InceptionV3 achieved the highest accuracy of 98.83%, demonstrating the effectiveness of deep learning for robust chili disease classification.

[3] Omer Farooq, Jasmeen Gill(2022) This study introduces a hybrid intelligent system combining artificialneural networks (ANN) and genetic algorithms (GA) for vegetable grading and sorting. The hybrid model outperforms traditional backpropagation-based systems, addressing local minima issues and improving classification accuracy

Y A Azis, N Khuriyati and A Suyantohadi(2021) This study focuses on classifying the quality of dried red chilies, a high-value export product, usingdigital image processingand artificial neural networks (ANN). Quality parameters such as chili length, mean energy, and color metrics were analyzed. Using 150 samples for training and 36 for testing, the ANN model classified chilies into threecategories: extraclass, class I, and class

Mahantesh Sajjan et.al(2021) This study introduces a cost-effective method for grading and classifying chili maturity stages using deep Convolutional Neural Networks (CNN). A dataset of 48,000 images capturing various prematurity and maturity stages was created, addressing challenges like occlusion and illumination variation

M. F. Abdul Aziz et.al(2021) This study highlights the need for automation in chili cropsorting, proposinga portable machine using Artificial Neural Networks (ANN) and image processing techniques to classify chilies based on color, shape, and texture. Testing with datasets of 20 and 40 images achieved overall accuracies of 80% and 85%, respectively, demonstrating the potential for improving efficiency in the agricultural industry, though further advancements may increase cost

Nahina Islam et.al(2021) This study investigates the use of machine learning algorithms for weed and crop classificationusing UAV images in a chili crop field. Random Forest (RF) and Support Vector Machine (SVM) achieved high weed detection accuracies of 96% and 94%, respectively, demonstrating their efficiency and practicality for real-world agricultural applications

METHODOLOGY

A. Objective:

The proposed system, RedSort, introduces an innovative approach to efficiently sort red and white chilies using a combination of Internet of Things (IoT), Machine Learning (ML), and precision automation technologies. This system is designed to address the challenges faced in manual sorting and limitations of existing solutions by leveraging advanced techniques for optimal performance.

B. Architecture

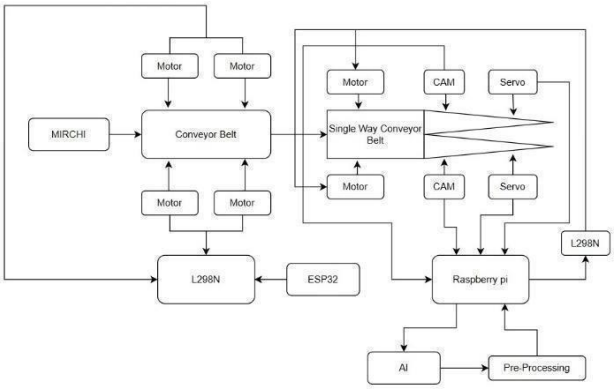

Figure 2. Architecture design of Proposed System

RedSort is an IoT-based automated chili grading system designed to streamline the post-harvest process in chili farming. Powered by Artificial Intelligence and Machine Learning, the system uses cameras and sensors to analyse chili quality in real time, distinguishing healthy chilies from waste based on colour and texture. By automating the grading process, RedSort reduces manual labour, enhances productivity, and offers farmers a cost effective solution to improve their earnings. Its innovative design ensures efficiency, mobility, and customizable quality grading, making it a valuable tool for modern agriculture.

1. **Input Stage:** Chilies are placed on a conveyor belt driven by motors, which move them to a single-way conveyor for sorting.

2. **Processing Stage:** Cameras capture real time images of the chilies, and the Raspberry Pi processes these images using AI to classify them as red chilies (acceptable) or white chilies (waste).

Figure 4. Chilli grading on Post-harvest grading decisions
(a) chilli_grade1 (b) chilli_grade2 (c) chilli_grade3

3. **Sorting Mechanism:** Servo motors divert the chilies based on AI classification, ensuring proper separation.

4. **Motor Control:** The ESP32 and L298N motor drivers control the conveyor motors and servos for smooth operation.

5. **Output:** Sorted chilies are collected into separate sections for red and waste, optimizing efficiency and reducing manual effort.

RESULTS & DISCUSSIONS

The proposed system was evaluated usinga chili dataset, with the training process conducted on a GPU-powered setup featuring an Nvidia RTX 1070 with 8 GB memory, an Intel i7 10th Generation CPU, and 16 GB of RAM. Python was utilized as the programming environment for implementing and training the Convolutional Neural Network (CNN) models. Two distinct CNN models, the VGG-16 and a custom chili-specific deep learning model, were employed for the task. Batch sizes were optimized based on the models and the GPU's processing capabilities.

Chilli image dataset is prepared based on.

Chilli maturity stages, characterized on colour as Fresh- chill (green) colour, Fresh mature(green- orange) colour, Unripe-red chilli and Ripe-red chilli as shown in below figure.

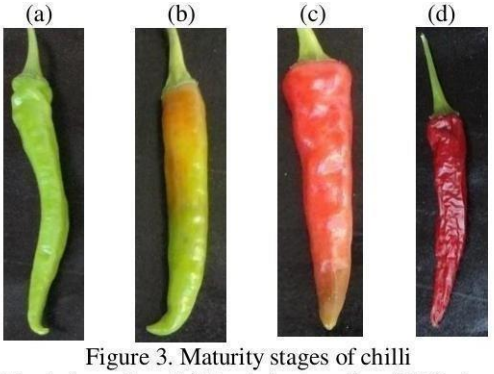

Figure 3. Maturity stages of chilli
(a) Fresh (green) (b) Fresh (matured) (c) Unripe-red
(d) Ripe-red

ii. Chilli grading based on post-harvest decisions considering varieties, namely, chilli_grade1, chilli_grade2, chilli_grade3 chilli samples with high oleoresin content as in below figure.

The CNN model faced challenges in learning the distinct inter-class variations between prior and subsequent maturity stages of chilies. To address this, it is necessary to train the CNN model with a more diverse set of chili grading class images, ensuring they exhibit clear and distinct features representative of each grading stage. The model's learning rate improves significantly when exposed to strong and well- defined features. Additionally, during the testing phase, any misclassified images can be reassigned to their appropriate classes through further refinement and experimentation. This process contributes to improvingthe overall performance and reliability of the system.

Chilly Sample	Chilli_grade 1	Chilli_grade 2	Chilli_grade 3
Chilli_grade 1		13	2
Chilli_grade 2	10		53
Chillil_grade 3	0	73	

Table 1. The confusion matrix for VGG model on validation dataset based on Postharvest decisions.

Chilly Maturity Stages	Maturity Stage1	Maturity Stage2	Maturity Stage3	Maturity Stage4
Maturity Stage1		6	0	0
Maturity Stage2	13		73	0
Maturity Stage4	0	0		53
Maturity Stage5	0	0	7	

Table 2. The confusion matrix for Custom chilli DL model on based chilli maturity stages

In Table 2, misclassified images are from chilli maturity stage 2 and stage 3 due to colour similarity between these stages. It is observed that predictions of misclassifiedimages is prioror subsequent class of actualclass. For example thirteen samples of maturity_stage2 were predicted as maturity_stage1 and 73 samples images as maturity_stage3. The images misclassified as maturity stage 3 (3rd column in Table 2), have feature values close to maturity stage 4 that contain chilli with light- brown colour.

CONCLUSION

In conclusion, our proposed system will undoubtedly assist farmers in efficiently sortingchilies across different locations. Additionally, future enhancements could include ultra-fast sortingcapabilities through the useof multipleparallelsorting techniques and advanced machine learning algorithms

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DOI: 10.14313/JAMRIS/4-2021/26

Paper ID : 64

Intelligent Profiling of Emerging Cyber Threats through NLP Automation

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Abstract:

Cybersecurity protection tactics face serious difficulties due to the quick exploitation of recently discovered cyber vulnerabilities. Since attackers can take advantage of new dangers in a matter of hours, early detection is essential for successful mitigation. Using MITRE ATT&CK for threat characterisation and Twitter posts as the main source of event detection, we present a methodology in this study for the automatic identification and profile of new cyberthreats. Three main components make up the framework: (1) identifying cyber threats and their names; (2) profiling threats according to their goals or intentions by filtering and classifying tweets using a two-layer machine learning model; and (3) producing alerts according to the risk associated with the threats that have been detected. This work's main contribution is the automated threat profiling, which adds more context

Keywords: Cyber Threat Intelligence, Emerging Threats, Threat Profiling, Machine Learning, MITRE ATT&CK, Twitter Data Analysis, Cybersecurity Automation, Threat Detection, Risk Assessment, Natural Language Processing (NLP).

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INTRODUCTION

Introduction The rapid advancement of digital technologies has led to an era of hyper-connectivity and hyper-mobility, where businesses, governments, and societies increasingly rely on the Internet for critical operations. While this connectivity enhances efficiency and communication, it also exposes organizations to a growing number of cyber threats. Cybercriminals exploit vulnerabilities in digital infrastructures, leveraging sophisticated attack strategies to compromise systems, steal sensitive data, and disrupt operations. Cyber threat intelligence (CTI) has emerged as a crucial defense mechanism, providing organizations with actionable insights

into potential threats, attack patterns, and security vulnerabilities. By analyzing both structured intelligence from formal databases, such as the Common Vulnerabilities and Exposures (CVE) and the National Vulnerability Database (NVD), and unstructured intelligence from Open Source Intelligence (OSINT) sources like social media, forums, and dark web discussions, security professionals can anticipate and mitigate cyber risks more effectively. However, several challenges hinder the effective utilization of cyber threat intelligence. The sheer volume of unstructured data, the reliability of OSINT sources, and the evolving tactics of cyber adversaries make it difficult to extract timely and accurate threat insights. Additionally, the lack of standardized data formats and automated analysis tools complicates the integration of threat intelligence into security frameworks. This research aims to address these challenges by exploring advanced techniques for extracting, analyzing, and leveraging cyber threat intelligence. By investigating novel approaches in threat detection, machine learning-driven analysis, and automated intelligence processing, this study seeks to enhance proactive cybersecurity measures and improve organizational resilience against cyber threats.

PROPOSED METHOD

Suggested Approach

Using Natural Language Processing (NLP), the suggested method for automated emerging cyber threat identification and profiling analyzes enormous volumes of text data pertaining to cybersecurity from a variety of sources, including threat reports, social media, forums, and security blogs. The following crucial steps make up the method:

1. Information Gathering

Collect text data about cybersecurity from sites such as: Dark web forums

Blogs about security

Socialmedia (Reddit, Twitter)

Reports on threat intelligence

Utilize APIs and web scraping to get data in real time.

2. Getting ready
Lemmatization, stopword elimination, and tokenization.

Key cyber threat elements, such as malware names and attack methods, can be extracted using Named Entit Recognition (NER).To improve accuracy, eliminate duplicate or unnecessary data.

3. Identification of Threats Employing NLP

To classify risks, use topic modeling (LDA, BERT- based models).Use sentiment analysis.

Utilize Transformer models such as BERT and RoBERTa, which are specially trained classifiers, to identify novel risks by analyzing textual patterns.

4. Threat Categorization and Profiling

Use unsupervised learning to group related threats (K- Means, DBSCAN).

For context, map threats to the CVE database or the MITRE ATT&CK framework.

Based on the retrieved indications (attack vectors, IoCs), assign threat severity levels.

5. Automated Reports and Alerts

Create threat reports that are organized.For real-time notifications, integrate with cybersecurity dashboards or SIEM systems.Give organizations the results of risk assessments so they may respond proactively.

In conclusion

This approach uses real-time data processing, machine learning, and NLP-based text mining to automate cyber threat identification and profiling. It helps enterprises react proactively to new threats and improves cybersecurity situational awareness

LITERATURE SERVEY

Review of the Literature

Both instructional and practical goals are served by the suggested architecture for automated emerging cyber threat identification and profiling. It combines machine learning (ML) and natural language processing (NLP) to improve the collection and analysis of cybersecurity intelligence.

Educational Importance

gives researchers and students practical experience with NLP and ML applications in cybersecurity.

illustrates how Open Source Intelligence (OSINT) can be used to detect and monitor cyberthreats. demonstrates how sites like forums, security blogs, and Twitter can be excellent resources for up-to-date threat intelligence.
Real-World Uses enables automated analysis powered by natural language processing to support real-time cyber threat monitoring.maps threats to frameworks such as MITRE ATT&CK, which improves threat profiling. enables proactive mitigation measures by facilitating the early detection of developing risks.

Including Cybersecurity Education
It is possible to integrate the framework

Existing System

Analysis of Systems, Current System Organizations are investing in Security Operations Centers (SOCs), which act as central hubs for monitoring and securing IT infrastructure, as a result of the growing concern over cybersecurity. SOCs, on the other hand, depend on timely and pertinent threat intelligence, which is frequently gathered manually. This procedure is:labor-intensive and time-consuming.
overwhelming because it contains a lot of unrelated information.
Because it depends on manual analysis, it is inefficient. Open Source Intelligence (OSINT) has become a useful tool for improving cyber threat identification. Real-time information about cyber incidents can be obtained from public sources such as security blogs, forums, and social media sites, particularly Twitter. Nevertheless, there are drawbacks to the OSINT-based threat identification systems in use today:

Limitations of Current Early Threat Warning System Research

Employ keyword filtering to identify online dangers.

Produce Limitations of Current Early Threat Warning System Research

Employ keyword filtering to identify online dangers.

Create notifications according to the frequency of keywords.

Cons: Lack of threat profiling and reliance on keyword- based detection result in a high number offalse positives.

Recognizing Cyberthreats in Twitter Streams

classifies tweets into threat categories (e.g., ransomware, DDoS) using a cascaded CNN.

Cons: Threats are not given explicit names.

uses an external API (IBM Watson) rather than an internal machine learning model that was developed using MITRE ATT&CK data.

Twitter Automated Cyber Threat Intelligence

classifies tweets pertaining to cybersecurity using a novelty detection algorithm.

Tweets and the Common Vulnerabilities and Exposures (CVE) database are correlated.

Cons: lacks intent analysis and threat recognition, two critical components of proactive defense tactics.

Threat Intelligence Based on Deep Learning makes use of CNNs.

The current system's shortcomings include its lack of multi-class classification.

The inability of current systems to categorize threats into several groups restricts their ability to adjust to changingcyberthreats.Absence of thorough threat processing Without thorough profiling or mapping to established attack techniques, many approaches end at threat detection.Dependency on Filtering by

Keywords leads to unnecessary alarms and high false-positive rates.Limited Ability to Recognize Threat Names It can be challenging to identify and counter emerging risks when some models don't give them names.

Proposed System

The suggested system

This paper suggests an automated cyber threat identification and profiling system that uses OSINT, NLP, and ML to produce real-time alerts in order to get around these restrictions.

Important Steps in the Suggested Method

Constant Tracking of Sources of Cyber Threat Intelligence

Gather and examine Twitter messages about cybersecurity from professionals, institutions, and security communities.

Extract unidentified terms associated with harmful campaigns and cyberthreats.

Machine Learning (ML) and Natural Language Processing (NLP) for Threat IdentificatioTo find possible threat names, use natural language processing algorithms.

Prioritize actual dangers by removing unnecessary data using machine learning models.

Using the MITRE ATT&CK Framework for Threat Profiling

Threatsto MITRE ATT&CK methods were discovered by the map.

Identifythe strategies and processes that cybercriminals employ.

Automated Creation of Alerts

Create alerts in a timelymanner for new

dangers. Give a risk.

Automated Creation of Alerts

Create alerts in a timelymanner for new dangers.

Based on the threat's impact and evolution, assign a risk score.

The Proposed System's Benefits

Early detection of new cyberthreats enables proactive response from security team uses ML-based categorization rather than keyword filtering to cut down on false positives.

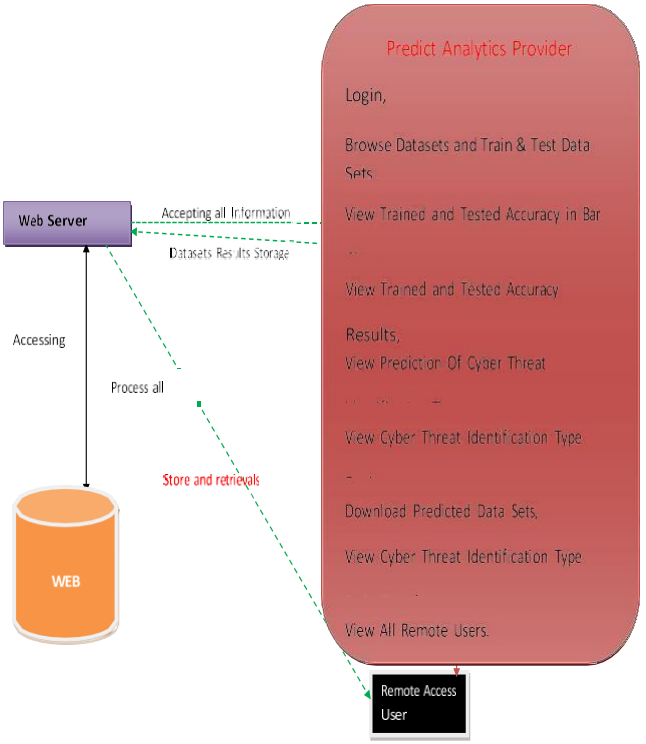
offers threat research and profiling, providing information on attack trends.

uses self-trained models rather than external dependencies to increase adaptability.

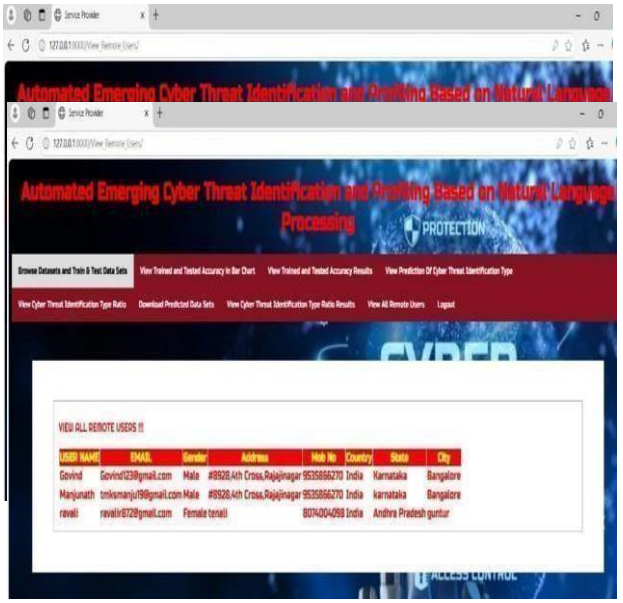
In conclusion

By automating cyber threat identification and profiling, this system seeks to enhance cybersecurity situational awareness. It gives security analysts rapid, accurate, and actionable intelligence to successfully counter emerging threats by utilizing OSINT, NLP, and ML.

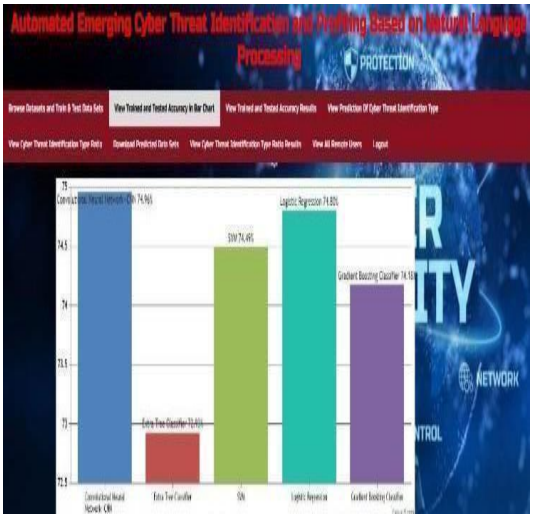
SYSTEM ARCHITECTURE



Results



Browse datasets & train and test data sets



Remote User Login

Conclusion

The proposed framework for **automated emerging cyber threat identification and profiling** significantly enhances cybersecurity defenses by leveraging **Natural Language Processing (NLP) and Machine Learning (ML).** By analyzing open-source platforms like **Twitter**, our system effectively identifies and profiles emerging threats based on their **tactical objectives**, using the **MITRE ATT&CK framework**.

Experimental results demonstrate that this approach provides a **comprehensive understanding of cyber threats**, enabling security analysts to make **timely, data- driven decisions** and implement **proactive threat mitigation strategies**.

For future improvements, we aim to:

- **Enhance profiling accuracy** by refining NLP and ML techniques.
- **Expand data sources** to include other social media platforms and **dark web forums**.
- Improve the system's **robustness and reliability** by integrating more real-time intelligence feeds.

By continuously evolving, this framework will strengthen **cyber threat intelligence** and contribute to **more resilient cybersecurity infrastructures**.

References

1. Automated Emerging Cyber Threat Identification and Profiling Based on Natural Language Processing

- *Summary:* This research proposes a framework that utilizes NLP and Machine Learning (ML) to automatically identify and profile emerging cyber threats by analyzing Twitter messages. The system aims to assist in monitoring the rich information available on Twitter to extract valuable insights about new threats in a timely manner.
    - *Link:* https://ieeexplore.ieee.org/document/10077593/

- TTPXHunter: Actionable Threat Intelligence Extraction as TTPs from Finished Cyber Threat Reports *Summary:* This study introduces TTPXHunter, a methodology for the automated extraction of threat intelligence in terms of Tactics, Techniques, and Procedures (TTPs) from finished cyber threat reports. It leverages domain-specific NLP to enhance the extraction process, providing quick, actionable insights into attacker behaviors.

1. What are the Attackers Doing Now? Automating Cyber Threat Intelligence Extraction from Text on Pace with the Changing Threat Landscape: A Survey

Summary: This survey reviews various studies focused on the automated extraction of cyber threat intelligence from textual sources, such as threat reports and online articles. It discusses the techniques used for CTI extraction, including NLP and ML methods, and highlights the challenges and future directions in this field.

Leveraging Natural Language Processing for Automated Detection of Cyber Threats

- *Summary:* This framework comprises three main stages: identifying cyber threats and their associated nomenclature, profiling the intentions or goals of identified threats through a two-layered machine learning approach for filtering and classifying tweets, and generating alerts based on a comprehensive threat risk assessment.

ISBN: 978-93-342-1696-7

Paper ID: 26

Smart Belt : IoT Driven for Floatation and Location Monitoring

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***Abstract*—:** This paper is a safety device is designed to solving drowning incidents and emergency location monitoring in aquatic environments such as seas , rivers and beaches. This device was useful for swimmers , fishermen , and persons who involves in water related activities providing both prevention and real time monitoring . This device also improves rescue operations such as finding the wearer quickly and reducing the deaths caused by drowning or delayed response This paper integrating Internet of Things in the belt by using microcontrollers , pressure sensor , depth sensor, accelerometers for calculating the condition of water and wearer , based on this belt can identifies whether the wearer is drowning or floating , here we are using solenoid valve and CO2 catridge for making the wearer float by sending CO2 gas into the belt which converts belt into tube by this wearer can float. In this paper for providing real time location monitoring , a GPS module was placed in the belt
, it gives the current location of the wearer by this we can fasten the rescue operations and give that location and alert messages to the near by rescue team.

Keywords—: Internet of Things , Pressure , Depth sensor , Accelerometer , CO2 catridge , GPS module ,Solenoid valve , Real time monitoring

INTRODUCTION

Internet of things is a transformative technology that connects physical sensors , devices and systems to the internet ,enabling them to collect ,exchange , and act on data without requiring direct human intervention. IoT creates a network of interconnected secure communication

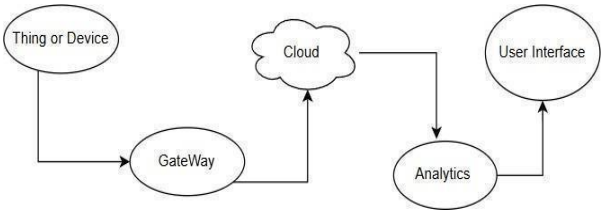

Fig 1: Overview of Internet of Things

In the recent year 2023 , at a particular beach a four friends went to beach for swimming . Among four , two of were went for swimming in the sea , due to high waves there are missing in that sea , delayed rescue response and identifying the location causes for loss of their lives and creates a tragedic memory in their families.Drowning incidents and missing persons in aquatic environments such as seas , rivers , beaches. This paper addresses these challenges by integrating IoT into a wearable devices to improve water safety. It uses advanced technology like sensors, GPS, and IoT to detect emergencies, keep thewearer afloat, and send their location to rescue teams. In this paper , Belt senses the danger then it automatically afloat the wearer , reducing the risk of drowning . At the same time , it sends an alert with the persons location to the rescue that reduces the time for searching that person in the sea and fasten the rescue operations.

1.1 Problem Statement :

As we are seeing , the missing and drowning of persons in the aquatic environments are increases due to high waves in our daily life . Till now there are ensuring wearable devices such as life jackets and tubes which can make wearer afloat but it creates uncomfort to the wearer during swimming , surfing and water games and does not provide any real time monitoring when that person is missing or drowning case

. For that , this Smart Belt for Floatation and Location Monitoring provides automatic floatation when wearer was drowning and provides real time location monitoring

. Here , at initial means when the wearer present in the normal conditions it looks like a normal belt , whenever the pressure and depth of water changes it converts like tube make wearer afloat and give the devices capable of real time monitoring , communication , and automation , revolutionizing industries such as healthcare, agriculture , transportation and safety . Sensors and actuators are electronic devices which collects the data from the environment and actuators are used for performing theactions using microcontrollers like Arduino , Node MCU , Raspberry pi etc.

Gateways, microcontrollers, and actuators are essential components in IoT systems, working together to enable seamless device communication and automation. Gateways act as intermediaries, connecting IoT devices to the internet or other networks, translating data protocols and

LITERATURE REVIEW

Anunuso Justice 2024- Drowning incidents in appeal to parents concerned about the safety of their children, private swimming pools are increasing, especially elderly family members, and pets among children, due to limited supervision and weak

Mohammed Rashid Al Balushi 2023 - The Automated monitoring systems. This study proposes a system that uses motion sensors and cameras to detect potential drowning early. Sensors monitor pool activity, while cameras focus on unsafe areas to analyze risks. The system achieved 99% precision and 98% recall and sends email alerts to authorized users for all processes.

Minal Ghute 2024 - The proposed system uses SPO2 and MPU-6050 sensors to monitor oxygen levels and underwater movements, enabling early detection of drowning incidents. It provides real-time depth information and displays key details on LCDs and mobile devices, improving communication and response times. Designed with energy efficiency in mind, the system ensures reliable operation in water environments, making it a significant step forward in enhancing water safety and saving lives.

Chhaya Dalela 2023 - This study presents an automated, vision-based system to detect drowning incidents in swimming pools.

Drowning Rescue Collar is a groundbreaking solution to the global drowning crisis, which causes 7% of unintentional injury deaths worldwide. Equipped with GPS, accelerometers, and advanced communication systems, it improves rescue operations while reducing risks for rescuers. Adaptable for aviation, marine, and military use, it ensures quick deployment via boats, cars, or drones.

Its solar-powered design supports sustainability, making it eco-friendly and efficient. Despite some cost and maintenance challenges, it offers a safer and more accurate alternative to traditional methods. This device represents hope and progress, with the potential to save lives worldwide.

B. Asianuba 2022 - This paper presents the design and development of a smart rescue communication system for detecting drowning incidents. The system aims to ensure the safety of individuals near large water bodies, addressing a critical concern. It uses combined data from water and vibration sensors, along with other components, to detect drowning effectively. Future improvements could include using dedicated communication modules for enhanced functionality

Using a Pixy camera, the system tracks objects in the pool. If an object stays underwater for too long, a Raspberry Pi calculates its position, speed, and shadow, then sends an alert to the operator. For future development, a robotic arm will move to the swimmer's location with a hook to help pull them to the surface. A warning bell will notify lifeguards of potential danger. The system aims to reduce drownings and is being improved with the addition of an infrared-enabled swimmer's vest and cameras.

Shree Bhargav RK 2023 - Existing systems lack an autonomous rescue and multi-level alerting system for drowning prevention. The proposed system fills these gaps with fail-safe methods and a CNN algorithm for quick decision-making. It has shown excellent results and should be used in home and public pools to prevent accidental drownings. This system will especially***Guanying Huo, Ziyin Wu 2020***- This research explores underwater object classification in sidescan sonar images using deep transfer learning and semisynthetic training data. The study leverages machine learning algorithms to detect drowning victims, providing an advanced approach to underwater search and rescue missions. By applying deep learning models to sonarimagery, the system improves the accuracy and efficiency of identifying potential victims beneath the water's surface.

Muhammad Aftab Haya, Goutian Yang 2019*-This comprehensive study presents a comparative analysis of various drowning detection and rescue systems. The research primarily utilizes image processing techniques for detecting drowning individuals. By*

applying computer vision algorithms, the system can identify victims in real time, assisting lifeguards and rescue teams in rapid response efforts. In addition to detection, the study incorporates robotic arm technology for the rescue process

This automated system enhances efficiency by physically retrieving drowning individuals, reducing reliance on human intervention. The combination of image processing and robotic arms highlights the potential for integrating artificial intelligence and robotics in future drowning prevention and rescue systems.The research highlights thelimitations of existing drowning detection and rescue methods, such as environmental interference, system latency, and technological constraints.

SI No	Year	Authors	Title	Key Findings
1	2024	Minal Ghute, TejaswiniKatole, Ayush Hadge, Abhilasha walke	Design of Drowning Rescue Alert System	-No floatation -Recued by Rescuers
2	2024	Anunuso Justice C,Mustapha Hafiz Bola, Chika Innocent, Aba Ojonimi King,	Development of an IoT -Based Drowning Detection System for Private Swimming Pools	-Restricted to small aquatic environments like swimming pool -Sensors are attached to Swimming pool

		Thomas Alhassan		-Difficult to identify the individual who was drowing
3	2023	Chhaya Dalela, Abhishek Rawat, Aryan Bisht, Ankur Sood	Automated Vision Based Surveillance System To Detect Drowning Activities	-Drowning detection using real time image processing -Restricted to small aquatic environments like swimming pools -No rescue operations
4	2023	Shree Bhargav RK, Rithik, Tejeshkumar, Malathi	ARTIFICIAL INTELLIGENCE FOR CHILD DROWNING PREVENTION IN SWIMMING POOLS USING FACE RECOGNITION	-Child drowning prevention -Uses facial recognition for detecting for drowning detection -No rescue operations
5	2023	Mohammed Rashid Al Balushi, Alzahraa Abdullah Alsiyabi, Yousuf Nasser Al Husaini	Saving Lives At Sea: An Automated Drowning Rescue Technology	-Accelerometers and gyroscopes are used
6	2022	Ifeoma B. Asianuba, Kpegara N. Saana	Development of A Smart Rescue Communication System for Drowning Personnel	-Only drowning detection is implemented -No rescue operations -GPS used for location tracking
7	2020	Kaustubh Ajgaonkar, Shailesh Khanolkar, Janslon Rodrigues, Eshani Shilker, Prajita Borkar, Enrich Braz	Development of a Lifeguard assist Drone for coastal search and rescue	-Drone is used for detecting the drowning person -Ineffiecient for larger aquatic environments

8	2020	Guanying Huo, Ziyin Wu	Underwater Object Classification in Sidescan Sonar Images using Deep Transfer Learning and Semisynthetic Training Data	-Uses machine learning algorithms for detectin drowning victims
9	2019	Muhammad Aftab Haya, Goutian Yang,	Comprehensive and Comparative Study of Drowning Person Detection and Rescue Systems	-Uses Image processing for drowning detection -Rescue was done using robotic arm

Table 1: Literature Review and Key findings

METHODOLOGY

Objectives:

- To provide safety measures to the persons who involves in water related activities such as swimmers , fishermen , navy , military etc.
- To reduce cost and accessibility barriers
- To reduce delayed response
- To focus on ergonomic design of device

To reduce the deaths causes by missing and drowning of persons in aquatic environments

Used Methodology :

This article discusses a wearable safety gadget that offers real-time monitoring, alert messages, and the ability to save a wearer who is drowning or missing in the ocean. The wearer floating system and real-time tracking were enabled based on the utilization of physical sensors, actuators, microcontrollers, and the Internet of Things to determine if the wearer is drowning or not. The belt has sensors, such as an accelerometer and water sensors, to identify emergencies like submersion or unusual movement. When the device detects such situations, it automatically inflates an airbag using a CO2-powered flotation mechanism to keep the user afloat. The user's current location is simultaneously tracked by a GPS module, and a GSM module transmits. This article discusses a wearable safety gadget designed to provide real-time monitoring, emergency alert messaging, and automatic rescue assistance for individuals at risk of drowning. Utilizing physical sensors, actuators, microcontrollers, and the Internet of Things (IoT), the device continuously assesses the wearer's condition to detect emergencies such as sudden submersion, prolonged immobility, or unusual movement patterns. Equipped with an accelerometer and water sensors, the system identifies distress situations and automatically inflates an airbag using a CO2-powered flotation mechanism to keep the wearer afloat.

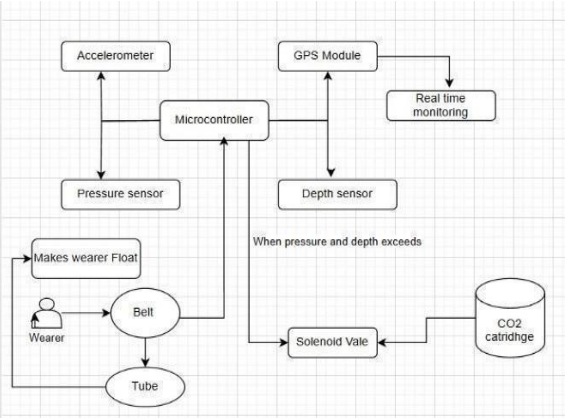

Fig 2:Conceptual Diagram of Smart Belt : IoT driven for Flotation and Real Time Monitoring

Here , we are using mainly three sensors pressure sensor , depth sensor and accelerometers for detecting whether the person is in danger situation or not and these collects the data from aquatic environment continuously and stored in the cloud.

Pressure sensor used for analyzing the water pressure , the pressure should be in range 0f 1.2 – 2 atmosphere where a normal person can survive easily .

Depth sensor is used for calculating the depth of the aquatic environment , it should be in the range of 2-3 meters and accelerometer is used for analyzing the wave patterens.

GPS module is used for real time monitoring and track the wearer when he was missing or drowning in the sea

Algorithm :

1. Calibrate sensors for atmospheric pressure at the surface (P0=101.3 kPa).
2. Initialize the solenoid valve and CO_2 cartridge system in standby mode.
3. Continuously measure the depth D and pressure Pwater using depth and pressure sensors.
4. Detect additional parameters, such as motion patterns, using an accelerometer.
5. Compute water pressure:

$$P_{water}=\rho \cdot g \cdot D$$

where:

ρ = Density of water (1000 kg/m³ for freshwater),

g= Gravitational acceleration (9.81 m/s²),

D = Depth in meters.

6. Add atmospheric pressure to get total pressure: Ptotal=Pwater+P0
7. Check if depth D exceeds a safe threshold (e.g., D>2 meters) or if pressure rises significantly.
8. Use accelerometer data to detect irregular movement patterns indicating distress, such as rapid motion or lack of motion.
9. If emergency conditions are met:
    - Activate the solenoid valve to release CO_2 from the cartridge.
    - Direct the gas into the inflatable tube integrated into the belt, converting it into a floatation device.
10. Simultaneously, activate the GPS and GSM modules to send the swimmer's real-time location and an emergency alert to predefined contacts.
11. Include a button for the swimmer to manually trigger the floatation and alert system if needed.
12. Continuously display depth, pressure, and system status (e.g., "Normal" or "Emergency Activated").
13. Continue monitoring and response cycle

RESULTS & DISCUSSION

This article Smart Belt : IoT driven Floatation & Location Tracking , a reliable safety device, combining lifesaving flotation features with real-time location tracking capabilities. During testing, the belt demonstrated effective buoyancy, automatically inflating within seconds upon immersion in water, thereby ensuring the user's immediate flotation and stability. This feature is critical for reducing the risk of drowning in emergency situations.The location tracking system, integrated with GPS and IoT technologies, performed efficiently, providing accurate and real-time coordinates to a connected mobile application. This functionality allows for swift rescue operations, especially in scenarios such as floods or boating accidents, where locating individuals quickly is paramount

Fig 3: Aquatic Environment

The above figure shows the aquatic environment , here the person is going to be swim , surf, and do water related activities ,here we are going to create waves using machine oscillators to represent large aquatic environment such as seas , rivers . The pressure of water and depth of the container was measured by using sensors

Fig 4: Components SetUP

This article is performing automatic floatation by converting a belt into tube by passing the CO2 gas fromthe CO2 catrigde through solenoid valve . Here , solenoid valve is a electromechanical valve is connected with microcontroller to perform automation of gas passage to the belt . Automatic floatation occurs when the pressure and depth values exceeds its normal range where person can perform his activities like swimming , surfing etc..

This article is performing automatic floatation by

converting a belt into tube by passing the CO2 gas from the CO2 catrigde through solenoid valve . Here , solenoid valve is a electromechanical valve is connected with microcontroller to perform automation of gas passage to the belt . Automatic floatation occurs when the pressure and depth values exceeds its normal range where person can perform his activities like swimming , surfing etc

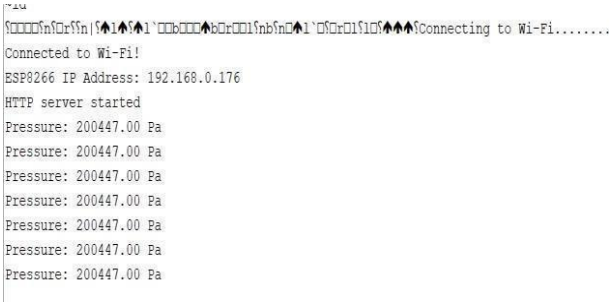

Fig 5:Intialization of Project

Pressure sensor is used to measure the water pressure in the aquatic environment , In normal conditions it should be in range of 1.3-2 atmosphere , Depth sensor is used to measure the depth of the aquatic environment , here in normal it should be in range of 2 meteres .When these values are exceeds automatic floatation and real time monitoring actions takes place

Fig 6 : Making wearer afloat by sending gas from CO2 catridge to tube , When pressure Chages to abnormal conditions.

Fig 7: Pressure Changing Observation

Here GPS module is used for real time monitoring and sssteams , personal , and families

CONCLUSION

This paper discusses the development of a safety device for wearers. In aquatic environments, the main problems are drowning and missing persons. If the wearer is drowning, the device helps keep them afloat, and if the wearer goes missing, the device shares their real-time location with rescue teams. The smart belt is designed to be an easy-to-use and comfortable wearable device. It provides floatation support and shares real-time location data to save the wearer's life. For future enhancemets we are using AI to detect unusual patterns, like prolonged inactivity or irregular heart rate, and send automatic emergency alerts. Provide a companion app to monitor the user's status, location and device performance in real time

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Paper ID : 94

Smart Web Attack Detection Using End-to-End Deep Learning

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Abstract:

The increasing sophistication and frequency of web attacks underscore the imperative necessity for sophisticated security measures for safeguarding digital systems. Traditional detection mechanisms are heavily dependent on pre-defined rules or signatures, which put them at risk of adaptive malicious strategies. This paper, proposes a new paradigm that uses deep learning to effectively detect and counter web threats.

The suggested solution employs a deep neural network (DNN) to identify patterns and recognize anomalies in web traffic. With end- to-end learning, the model learns automatically to extract key features from raw data without human feature engineering, making it better equipped to adapt to changing attack methods and discover unknown threats. The system is a total protector from all sorts of web attacks, such as SQL injection, cross-site scripting (XSS), and distributed denial-of- service (DDoS) attacks. The article covers important aspects like data gathering and preprocessing, model training and fine-tuning, and the incorporation of the detection system into current security infrastructures. Utilizing state-of-the-art deep learning models such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), the system performs high-accuracy and real-time detection capabilities This paper brings to the fore the tremendous promise of deep learning in the field of cybersecurity, providing a proactive and adaptive defense system that keeps pace with emerging threats.

Keywords: Deep learning, Cybersecurity, Web attack detection, Anomaly detection, Adaptive defense

INTRODUCTION

Web applications are integral to modern digital infrastructure, facilitating a wide range of services, from e-commerce and social networking to online banking and government operations. However, their pervasive usage makes them a prime target for various types of attacks, including SQL injection, cross-site scripting (XSS), and distributed denial-of-service (DDoS). These attacks not only disrupt services but can also lead to severe financial losses, reputational damage, and unauthorized access to sensitive data. Traditional security measures, such as rule-based detection systems and signature-based approaches, are often insufficient to address the sophisticated and evolving nature of modern web attacks. These methods rely on predefined patterns or manual feature engineering, which makes them less effective against new and adaptive attack vectors. The rapid evolution of threats requires innovative solutions that can detect and mitigate malicious activities with greater accuracy and efficiency. This paper explores a novel approach to web attack detection using end-to-end deep learning techniques. Unlike traditional methods, end-to-end deep learning involves training a neural network to process raw web traffic data directly, eliminating the need for manual feature extraction. By autonomously learning patterns and anomalies in the data, the model can adapt to new attack strategies and provide a robust defense mechanism. The project focuses on key features to enhance detection capabilities. It employs raw data processing, adaptive learning, real-time detection, multi-modal analysis, and model interpretability. Raw data processing enables the model to learn directly from web traffic, while adaptive learning ensures the system evolves with emerging threats. Real-time detection minimizes response times to potential threats, and multi-modal analysis combines multiple data streams to detect complex, multi-vector attacks. Furthermore, incorporating explainability features ensures transparency, fostering trust and understanding in the system's decisions. This approach not only strengthens the defense against web attacks but also demonstrates the transformative potential of deep learning in cybersecurity, paving the way for more adaptive and intelligent threat detection systems.

LITERATURE SURVEY

1. Title:"Deep Learning Applications in Cybersecurity: A Comprehensive Review"

Author: Sarah E. Williams

Abstract: Sarah E. Williams provides a comprehensive review of the applications of deep learning in cybersecurity, with a focus on detecting web attacks. The survey covers various deep learning models, techniques, and their effectiveness in identifying and mitigating cyber threats.

2. Title: "Web Attack Detection Techniques: A Survey of Traditional and Deep Learning Approaches"

Author: Michael J. Davis

Abstract: In this survey, Michael J. Davis focuses specifically on web attack detection techniques, comparing traditional methods with deep learning approaches. The review explores the strengths and limitations of each technique, shedding light on the advancements brought by deep learning in enhancing detection capabilities**.**

3. Title:"End-to-End Deep Learning for Cybersecurity: State-of-the-Art Approaches"

Author: Emily R. Martinez

Abstract: Emily R. Martinez conducts a literature survey on state-of-the-art approaches in using end-to-end deep learning for cybersecurity, with an emphasis on web attack detection. Review discusses the evolution of end-to-end models and their potential in providing holistic solutions to detect complex web-based threats.

4. Title: "Adversarial Attacks on Deep Learning Models in Cybersecurity"

Author: David A. Thompson

Abstract: This survey by David A. Thompson delves into the challenges posed by adversarial attacks on deep learning models in the realm of cybersecurity. The review explores techniques to defend against adversarial attacks and secure end-to-end deep learning systems used for web attack detection.

5. **Title:"Real-Time Web Attack Detection Using Deep Learning: Opportunities and Challenges"**

Author: Jessica L. Turner

Abstract: Jessica L. Turner's survey focuses on real-time web attack detection using deep learning. The review explores the opportunities and challenges associated with implementing deep learning models for detecting web attacks in real- time scenarios, offering insights into the current landscape and future prospects of this technology

PROPOSED METHOD

Proposed System: End-to-End Deep Learning for Attack Detection

This system does away with the requirement of manual operations such as feature extraction through the utilization of deep learning models that can automatically detect patterns in web traffic and malicious activity. This method greatly enhances accuracy and efficiency over conventional methods.

The system utilizes two main deep learning models:

1. Convolutional Neural Networks (CNNs)

-Purpose: Detects patterns and abnormalities in network traffic, assisting in identifying repeatable attack patterns.

- Illustration: Similar to how CNNs identify forms in pictures, they can inspect web traffic to identify malicious patterns.

2. Long Short-Term Memory (LSTM)

- Function: Examines sequences of web requests to identify suspicious patterns that emerge with time.

- Example: Monitors user activity to discover slow, consistent attacks that evolve across multiple requests.

Why This Method is Better:

-No Manual Feature Engineering: The system learns and discovers principal features automatically.

-Greater Accuracy: Able to identify known threats as well as previously unknown (zero-day) attacks.

-Context-Aware Detection: Identifies the overall context of web traffic rather than individual requests.

Proposed System Modules

Data Collection and Preprocessing

This module is in charge of collecting and processing data for the deep learning model. It consists of collecting raw web traffic logs, HTTP requests, and payloads from different sources such as web servers, firewalls, and databases.

Tasks:

- Web log or API data scraping
- Noise removal and format normalization
- Converting text-based data (URLs, payloads) into numerical form

Output: Clean and formatted data ready for model training.

2. Feature Engineering

This module converts raw data into useful features for deep learning models. It assists the model in comprehending the structure of web requests and traffic patterns.

Tasks:

- Tokenization of URLs, payloads, and HTTP headers
- Time-based feature generation (e.g., frequency of requests)
- One-hot encoding and padding of sequences

Output: Feature-extracted data ready for model input.

3. Model Design and Development

This is the central module where deep learning models are developed and designed. It is concerned with choosing the appropriate architecture to identify anomalies and attack patterns.

Tasks:

- Building neural network models (CNN, LSTM, Transformer)
- Combining multiple models for multi-modal input (e.g., text and time-series data)
- Selecting loss functions and evaluation metrics

Output: Trained deep learning model for web attack detection.

4. Model Training and Optimization

This module trains the deep learning model using the processed data and optimizes it for better accuracy and performance.

Tasks:

- Splitting data into training, validation, and test sets
- Hyperparameter tuning (learning rate, batch size, epochs)
- Evaluating the model with accuracy, precision, recall, and F1-score

Output: Optimized and validated model ready for deployment.

5. Real-time Detection and Inference

This module deploys the trained model for real-time web attack detection and integrates it with web servers or monitoring systems.

Tasks:

- Hosting the model using Flask, FastAPI, or TensorFlow Serving
- Real-time inference on incoming web traffic
- Storingand logging detected attack incidents

Output: Real-time attack detection system.

6. Alerting and Reporting

It issues alerts upon the detection of a possible attack and offers in-depth reports to security teams.

Tasks:

- Triggering notifications (email, Slack, etc.)
- Creating logs with metadata of the attack (timestamp, type, payload)
- Generating trend analysis summary reports Output: Attack reports and alerts.

7. Ongoing Learning and Model Update

Sees to the model remaining updated with changing patterns of attacks through retraining the model on updated data.

Tasks:

- Regular model retraining using new data
- Feedback inclusion from identified false positives/negatives
- Transfer learning for adapting to new attack types

Output: Continuously updated and adaptive model.

8. Visualization and Monitoring

Provides an interface to monitor the performance of the model and visualize attack trends.

Tasks:

- Dashboards for real-time attack monitoring (Grafana, Kibana)
- Visualizing attack patterns using charts (e.g., time-series plots)
- Monitoring of detection performance accuracy

Output: Interactive monitoring and visualization tools for security analysts.

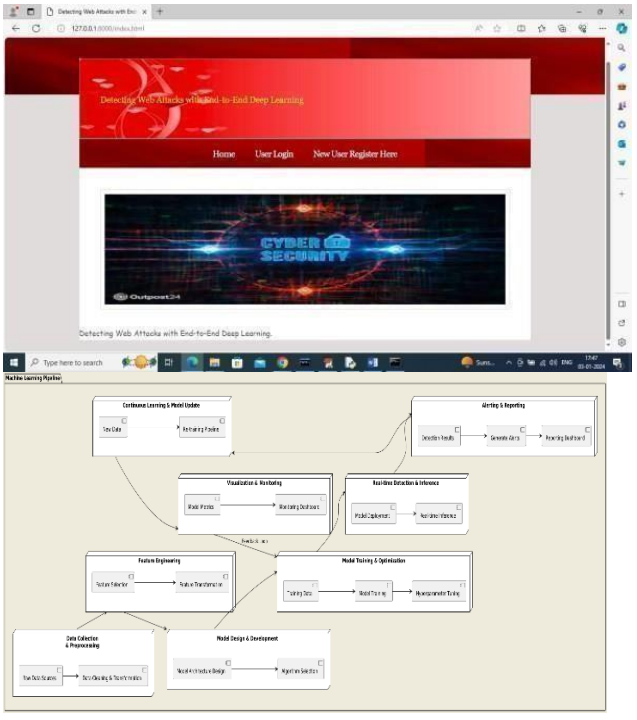


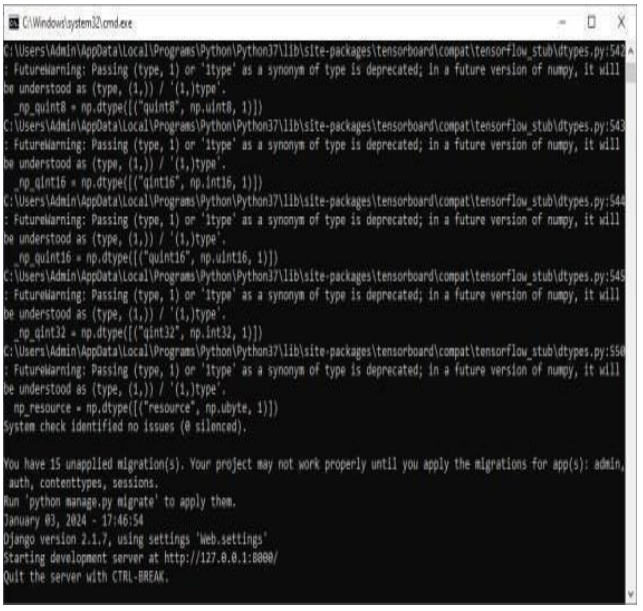
Fig: Block Diagram

Advantages of the Proposed System

1. High Detection Accuracy
2. Minimal Feature Engineering
3. Real-Time Attack Detection
4. Scalable Solutions
5. Unknown and Zero-Day Attack Detection
6. Ongoing Adaptation and Learning
7. Merging Multi-Modal Data
8. Lower False Positive Rates
9. Increased Automation and Efficiency
10. Resilient to Evasion Techniques

RESULTS

To run web code double click on 'run.bat' file to start python DJANGO server and will get below screen



In above screen python web server started and now open browser and enter URL as http://127.0.0.1:8000/index.html and press enter key to get below page

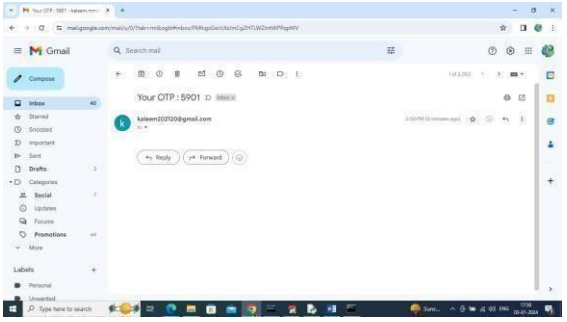
In above screen click on ‘New User Register Here’ link to get below user signup screen

In above screen user is entering sign up details and give valid EMAIL ID to get OTP password and then press button to complete sign up and get below page

In above screen user signup completed and now click on ‘User Login’ link to get below page

In abovescreenuser is loginand after login will get below OTP page

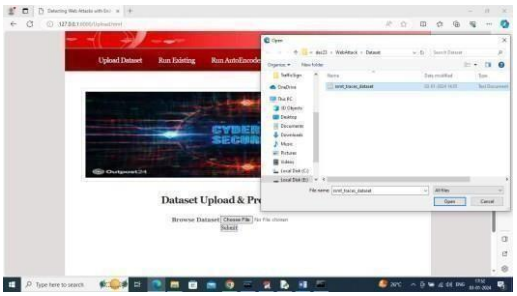
Above OTP we can receive in given email at sign up time



In above screen 5901 is the OTP which has to enter in OTP validation pagelike belowscreen

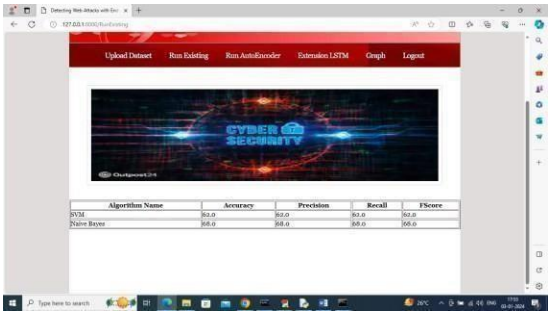
In above screen after entering OTP then press button to get below page

In above screen click on ‘Upload Dataset’ link to get below page

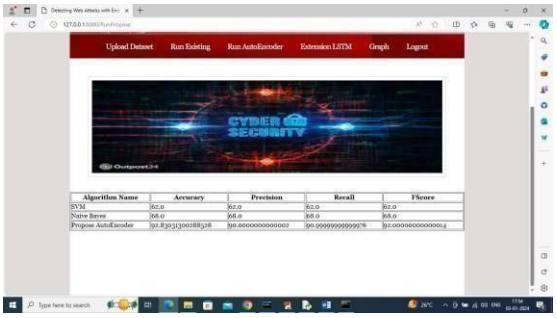


In above screen select and upload dataset and then click on "open" and "Submit' button to load and process dataset and then will get below page

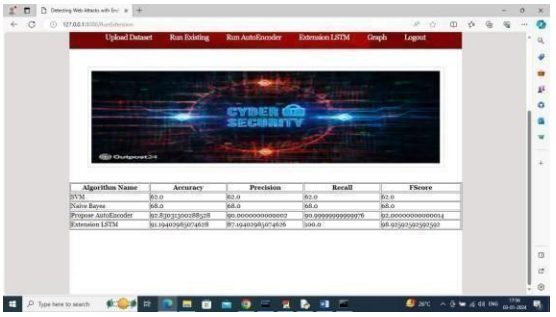
In above screen can see dataset loaded and processed and now click on 'Run Existing' link to run existing algorithms and then will get below output



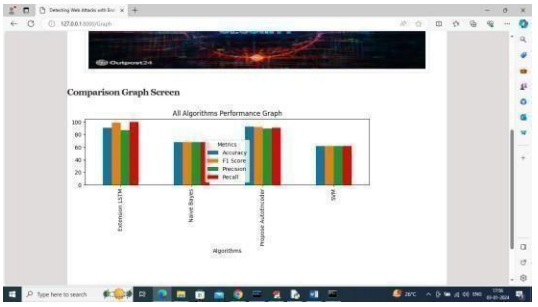
In above screen existing SVM and Naïve Bayes training completed and can see SVM got 62% and Naïve Bayes got 68% accuracy and can see other metrics also andnowclick on 'Run Auto Encoder' link to run propose algorithm and then will get below page



In above screen can see existing and propose algorithm performance and now click on 'Run Extension LSTM' algorithm link to get below page



In above screen extension LSTM got 100% recall which is higher than existing and propose algorithms and now click on 'Graph' link to get below comparison graph



In above graph x-axis represents algorithm names and y-axis represents accuracy and other metrics in different colour bars and in all algorithm extension got high recall

CONCLUSION:

We have shown through our research that reinforcement learning (RL) is a viable method to solve the compound dual-objective problem of steering a vessel down a predefined path defined by known waypoints with no map utilization. Specifically, we have shown that when immovable obstacles form barriers or surround the target course, the Proximal Policy Optimization (PPO) algorithm converges onto a policy which allows for the intelligent, guided navigation behaviors.

To do this, we developed and deployed a number of new techniques, including the Feasibility Pooling algorithm, which supports real-time dimensionality

reduction of sensor data to inform the agent's observation vector and reward function. Experimental outcomes suggest that the agent is able to vary its guidance strategy—prioritizing path following or collision prevention—depending on the value of an incentive trade-off parameter incorporated into the observation vector. This adaptation allows the agent to adapt in a flexible way to a change in its reward function. The agent was extensively tested and found to have a success rate in the mid-80% range when set with a high path adherence bias, and almost 100% success when a risk-averse, defensive approach is used, even in difficult conditions of high obstacle density.

It is noteworthy that deep reinforcement learning (DRL) also depends to a large extent on deep neural networks (DNNs), which need to learn millions of parameters. The absence of human control over the current processes in these presents them as a challenge in their practical implementation within safety-critical settings. Our results, however, put forward the possibility of integrating such advanced intelligence into the systems for useful, real- life applications.

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Paper ID:59

ADVANCEDMULTI-MODEL DEEPFAKE DETECTION: A UNIFIED MODEL FOR VIDEOS, IMAGES AND AUDIOS

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Abstract: The rapid evolution of Artificial Intelligence and cloud computing has led to the manipulation of videos, images and audio which is increasing rapidly resulting in the rises of deepfakes. These alterations allow machines to replicate voices or swap faces in a highly convincing manner. Addressing deepfakes involves three primary countermeasures: media authentication, media origin tracking, and deepfake detection. Multi-modal detection techniques play a vital role in identifying such manipulated content. Detection methods are typically divided into two categories: manual and automated. Manual detection requires human intervention, where experts analyze media files using specialized tools to identify irregularities. In contrast, algorithmic detection relies on AI-based models to automatically scan and detect fake content. These algorithms can analyze various factors of the media file like audio, video, metadata and extra information of the file to detect anything unusual or suspicious. This project aims to design a Deep Learning Binary Classifier capable of identifying deepfake videos, offering solutions to real-world challenges. The model utilizes advanced architectures like ResNet50, Long Short-Term Memory (LSTM) networks, and custom neural network models to improve detection accuracy and efficiency.

Index Terms*: Machine Learning (ML), ResNet, Deepfake detection*

Introduction

Machine Learning (ML) is a field of Artificial Intelligence (AI) that enables systems to learn from data, adapt to patterns, and make decisions without explicit programming. It uses algorithms to analyze data, improve performance over time, and solve various tasks such as classification, prediction, and pattern recognition. It involves developing algorithms capable of detecting trends, relationships, and key decision factors within data, enabling accurate predictions and insights. Traditional Machine Learning relies on predefined features and rules to perform tasks, whereas deep learning takes inspiration from how humans learn and adapt. Deep learning, a subset of Machine Learning, employs multi-layered neural networks to simulate human- like decision-making by extracting and processing complex data patterns. These networks simulate human cognitive processes, enabling them to identify patterns and extract insights from large datasets without relying heavily on manual intervention

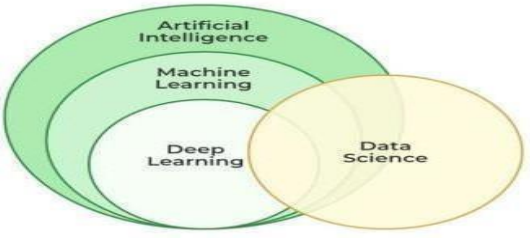


Figure 1: Scope of Deep Learning

Deepfake detection involves identifying manipulated media, such as videos, images,

or audio, that have been artificially created using advanced deep learning methods. These alterations are typically executed using machine learning algorithms that modify or substitute components of original content, such as an individual's face. The main goal of deepfake detection is to identify these modifications and distinguish them from authentic, unedited media[1].

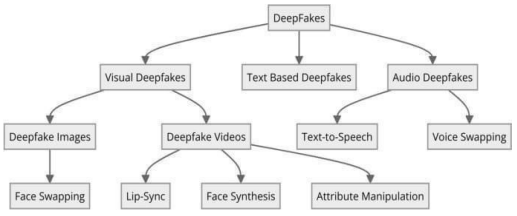


Figure 2 : Types of DeepFakes

The deepfake detection system divides the methods into four different categories which are as follows :

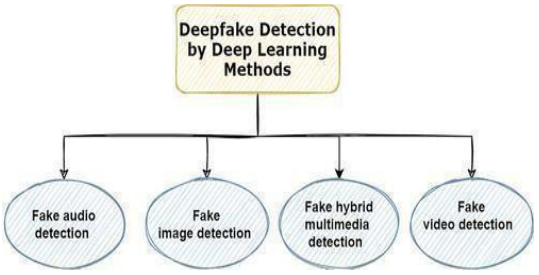


Figure 3 **:** DeepFake detection byDeep Learning Methods

For deepfake text we use Large language models (LLMs) which can create a text that looks like it was written by human. This shows the need for tools to find Ai-made text to stop the problems like fake news, copying other's work [3].

An audio deepfake is part of the deepfake family, it uses Artificial Intelligence and Machine Learning methods to manipulate audio recordings that appear to be real but are Artificial or fake.

Research Problem

- Existing systems are more costly and more difficult to maintain.
- The existing systems are less accurate as they fail during detection of deepfake in audios, videos and images.
- They focus only on small subset of data. They lack in balancing performance with fairness and transparency. They lack in robustness.

Research Gaps

- We need better ways to mix text, images, audio, and videos to detect deepfakes more accurately.
- Detection systems should be able to find deepfakes quickly as content is shared online.
- Systems must be able to process lots of data without slowing down or losing accuracy
- Detection models should work across different languages, cultures, and platforms to be useful everywhere.
- We need more diverse and balanced datasets to train detection systems, so they can work better and be more accurate

Literature Review

Wanqiu (2024) : This research implies Internet's rapid growth has led to the spread of false information, impacting social networks. Research focuses on identifying and controlling this content by studying its distribution. Existing methods and datasets are compared to improve detection. Future research should tackle challenges like diverse data sources and language differences to enhance accuracy

Eniafe Festus Ayetiran (2024) : This research paper talks about using deep learning methods that combine different types of data, like text, images, and audio, to better detect fake news and harmful language. It explains how these methods have improved over time, the latest techniques used, and the challenges faced. The paper also looks at the future possibilities of making these detection systems even more accurate.

Sudeep Tanwar (2023) : This paper reviews deepfake generation and detection, focusing on advancements in machine learning and deep learning . It highlights the use of deepfakes in spreading misinformation and compares detection models and public datasets. The paper also talks about the difficulties in creating detection systems and suggests ideas for future research. It includes a case study called IBMM, which uses different types of data to detect deepfakes. This study gives helpful information for both researchers and industries.

Rasha M. Albalawi (2023) : This study introduces a model to detect Arabic rumors on Twitter using both text and images. It combines text and image features in two ways: early and late fusion. The model uses pre- trained language and image models. MARBERTv2 is used to analyze text, while VGG-19 and ResNet50 are used for images. The results show that text-based features perform better than models combining both text and images in detecting rumors.

Hasan AI-Nashash (2022) : his studyinvestigates how to identify genuine and fake smiles using brain signals. It involved 28 healthy participants, where both real and fake smiles were recorded. Electroencephalogram (EEG) signals were used to measure brain activity Five different Convolutional Neural Network (CNN) models were tested to classify smile types. The best model, CNN1, achieved 90.4% accuracy by analyzing the full EEG signals. The results show that CNN models, often used for image recognition, can successfully detect smile types from brain signals.

Mohammad A.Hoque (2021) : This article addresses the growing issue of social engineering attacks through manipulated images and videos shared on social media and messaging platforms. These fake media can lead to public shame, violence, and even loss of life. The paper reviews various methods used to modify images and videos, as well as the tools developed to detect such fakes using advanced machine learning and factchecking techniques. It also stresses the need for complementary approaches to prevent the creation and spread of fabricated content. The article advocates for socio-technological solutions, including blockchain based systems, to enable users to create ethical decisions when sharing media.

Zong Woo Geem (2020) : This article mainly focus on recent developments in Deep Learning have enabled the creation of realistic deepfakes using GANs, often in video formats, which can disrupt public discourse. This study proposes using Convolutional Neural Networks (CNNs) to detect deepfakes by comparing minute facial features like eye.

Khaled Salah (2019) : This implies the rise of AI and DL methods has led to the widespread crea fake digital content, including deepfakes, which can undermine trust and distort reality. This paper presents a solution using Ethereum smart contracts to track the provenance of digital content, ensuring its authenticity even if it is copied multiple times. By utilizing IPFS hashes to store content and metadata, the system can trace the content back to its original source. Although the framework is designed for video content, it can be adapted to other digital formats, with the smart contract code made available on GitHub

Methodology

a. Objectives

- Create a system to automatically identify deepfake videos, images or audio with high accuracy and minimal human intervention.
- Implement the convolutional neural network models to achieve an accuracy score of at least 94.6% for reliable deepfake detection.
- Leverage both visual and metadata features from media files to enhance the detection capability.
- Build a scalable and efficient solution to address real- world challenges related to deepfake

Build a scalable and efficient solution to address real- world challenges related to deepfake Keep adding more examples to improve the model

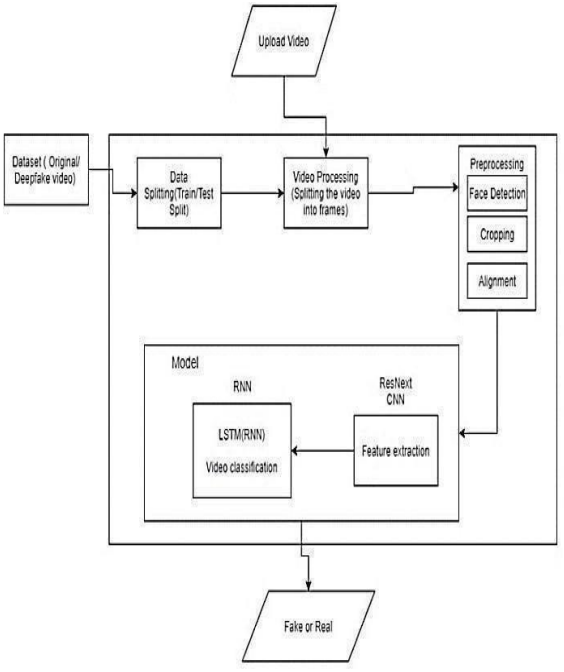


Figure 5 **:** Architecture

Implementation

There are many tools to create Deepfakes (fake videos, images or audios), but not enough tools to detect them. Our method aims to fix this problem.

It can detect all kinds of Deepfakes, including ones where faces are swapped (replacement Deepfakes), where parts of a face are changed (retrenchment Deepfakes), and even ones where interactions between people are manipulated (interpersonal Deepfakes)[6].

By detecting all these types, our approach can help stop Deepfakes from spreading online and keep the internet safer.

- Gather a large set of images, videos and audios, both real and Deepfakes. To get accurate predictions and better learning, preparing the dataset properly is very important.
- Our mixed dataset uses equal amounts of data from MTCN, YouTube, and the Deepfake Detection Challenge.

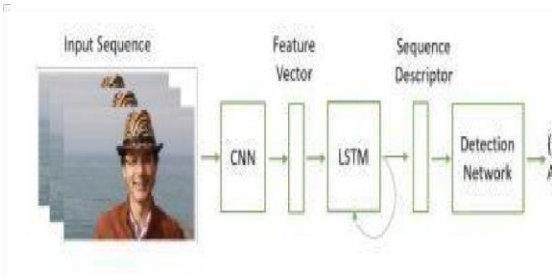
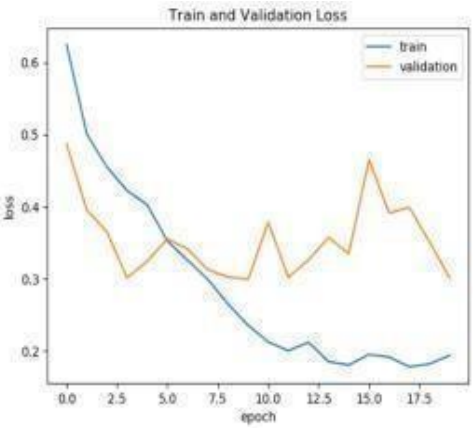


Figure 7 : . Input Sequence through model

- The video is broken down into individual frames during pre-processing. Then, faces are detected in each frame, and only the frames with faces are kept.
- We suggest using the ResNet50 CNN model to extract important features from the frames and build an accurate classifier to identify deepfakes.
- For videos, use 3D CNNs or LSTMs (Recurrent Neural Networks) to understand the changes between frames (temporal features).
- For audio analysis, you can use CNNs or RNNs, which can learnfrom audio signals (like voice characteristics, pitch, rhythm, and inflections).



- CNNs can learn from spectrograms, which are visual representations of audio signals (like a heatmap of sound frequencies over time).LSTMs, like in video, can be used to learn patterns in audio sequences, helping the model detect unnatural speech patterns or voice inconsistencies, such as mismatched lip- syncing or synthetic voice creation in Deepfakes.
- You can combine CNNs for image, 3D CNNs or LSTMs for video, and CNNs or LSTMs for audio intoa multi-modal system

Results and Discussions

Figure 10 : picture(left) is original and picture(right) is its manipulated

The model can achieve high accuracy, typically ranging from 90% to 98%. The model should perform well across different types of Deepfakes, but slightly better on simpler manipulations like face swapping. The model should generalize well to new and unseen types of Deepfakes, maintaining accuracy.

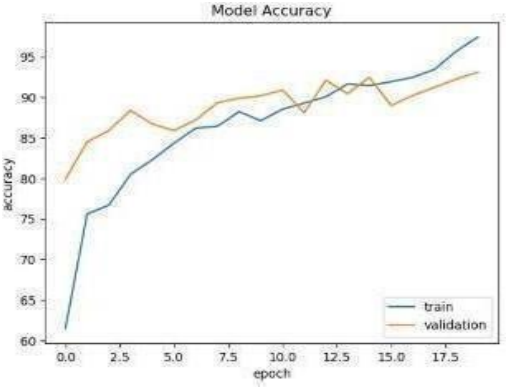


Figure 11(a) : model accuracy

(b) training and validation loss Our dataset was used to train several models, with ResNet50 + LSTM providing the best accuracy in both training and testing. We observed that the model struggles to detect manipulations in low-quality images, such as those with poor lighting or fog. However, it performs well in identifying manipulations in high-quality recordings.

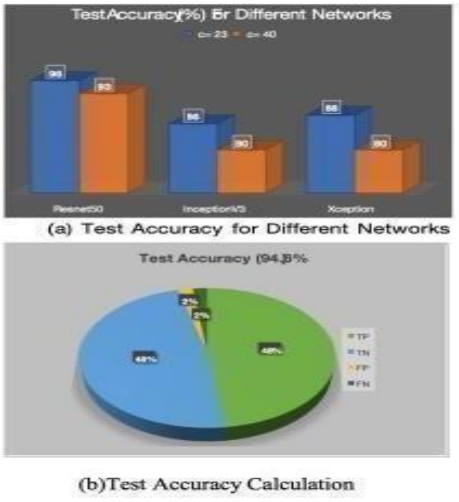


Figure 13(a) : accuracy different Convolutional neural networks and (b) : test accuracy calculation

Conclusion

In this research, we used a neural network-based method to classify videos as either deepfake or real, along with the model's confidence level. Frame- level detection is done using the ResNet50 CNN, followed by video classification through RNN and LSTM. Based on the parameters outlined in the paper, the proposed method can accurately detect fake or real videos. Our analysis shows that this technique can consistently identify deepfakes on the internet with an average accuracy of 94.63%.

The future goal of Deepfake detection systems is to make them effective across multiple languages and accents, ensuring that they can detect fake voices from anyone, anywhere. Currently, most systems focus on detecting fake voices in English and may struggle with other languages or regional accents. New systems will be able to explain why they flagged something as fake, by showing exactly which part of the video or audio caused the system to make that decision. The future will bring methods that allow systems to be trained without accessing people's personal data directly, such as using techniques that keep data private while still helping the system learn.

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ISBN: 978-93-342-1696-7

Paper ID: 257

An Adaptive Detail-Preserving Modified Progressive PCA Thresholding Based Image Denoising

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***Abstract*—** Radiologists use medical imaging techniques to see how a patient's internal organs are functioning. The movement of a patient's body, gadgets, and different construction and reconstruction techniques can all generate noise to interfere with these imaging techniques. This work proposes a cluster-wise progressive denoising technique for detail-preserving images. In random matrix theory, Marchenko_Pastur (M_P) law gives the threshold levels of the Principal_Component analysis (PCA). Automatic counting of clusters is calculated using an adaptive clustering framework. In this the patches are separated using the clusters along with the removal of noise. The details of the images are retained by denoising the images using a low rank matrix. The performance of the proposed methodology is evaluated using the parameter of linear minimal_mean_square_error.

Keywords— principal component analysis, Marchenko-Pastur (MP) law, image denoising

I. INTRODUCTION

In sectors such as medicine, space exploration, radar and machine vision, among others, images are considered potential sources of information. Image processing is therefore thought to be the most difficult task in these domains. The performance of image processing techniques is made possible by the rapid advancement of computer technology, which enhances the quality of images generated by a variety of instruments, including scanners, cameras, machine vision systems, and ultrasounds. During image acquisition, storage, and transmission, noise affects these images, which is not what is wanted in clinical image processing. The intensity of pixels in an image will change due to noise. Gaussian noise is the term used to describe noise produced by digital equipment as a result of electrical disruptions. The medical images are also being impacted by other noises, such as gamma, exponential, speckle, uniform, salt and pepper, Rayleigh, and photon noise. Many researchers have applied different denoising algorithms in different domains, such as the filtering domain [1-4], transform domain [5-7], machine learning domain [8–12], and statistical domain [13–17], taking into consideration different statistical parameters like PSNR, CNR, etc., to diminish the noise effect in medical images.

As the Block Matching 3-Dimensional (BM3D) algorithm performs worse on images with high noise levels, a two-folded bounded BM3D technique has been introduced by Chen, Q., et al. [18]. Lebrun, M. [19] has improved the BM3D algorithm's transparency by taking into account a new notation that operates in spatial dimensions in addition to the third dimension. To apply the BM3D technique to huge image patches, Burger, H. C., et al. [20] have linked it to a simple multi-layer perceptron. Before using non-local similarity between grouped blocks and, local-sparsity of wavelet-coefficients. Zhong, H., et al. [21] suggested a way to eliminate the one-dimensional transform between blocks and to introduce a non-local centralization.

The BM3D technique has been implemented on heterogeneous computer-platforms by Sarjanoja, S., et al. [22] utilizing OpenCL and CUDA approaches to increase the computation speed at a pace of 7.5 times quicker than the original performance. In order to accomplish self-adaptation and shorten the implementation time, BM3D was used in combination with the Total Variation technique by Li, Y., et al. [23]. Hasan, M. et al. [24] boosted the BM3D performance by raising the Structural Similarity Index value rather than decreasing the Mean Square Error number. A methodology for precise estimations of effective approximations and the noise-power spectrum has been introduced by Mäkinen, Y et al. [25]. They have also assessed noise variances that are correlated in comparable blocks.

II. PRELIMINARIES

The following steps make up the suggested method for medical image denoising that is provided in this research. Initially, a selected medical image from the database is subjected to Gaussian noise at different standard deviation levels (e.g., 10, 20, 30, 40, and 50). The suggested method, which is depicted in Figure. 1, then finds the edges of the damaged images and denoises them, as will be discussed in the subsections that follow.

A. Adaptive Magnitude Gradient

The magnitude gradient [26] shows how each pixel's intensity varies in an image. The magnitude gradient is used to evaluate intensity discontinuities in the image. The usage of Euclidian distance is this method's primary drawback. Numerous problems with the Euclidian distance exist, including the reduction of sparsity, the curse of dimensionality, and non-scale invariance. An Adaptive Magnitude Gradient (AMG) approach is taken into consideration in the suggested solution in order to overcome these problems. This technique computes changes in the image's intensity in view of the Hausdroff distance between each pixel in the x and y directions. A Hausdroff distance has fewer points taken into account than a Euclidian distance,

which reduces computer complexity and boosts computational performance as shown in Algorithm 1.

Algorithm 1

Source: Medical image

Output: The medical image's gradient magnitude

Step 1: Determine the size of an image by considering it.

Step 2: Let sigma have a value of 0.6 (σ).

Step 3: Using the formulas provided in equations (4) and (5), compute the Gaussian (Gaus) and derivative of the Gaussian (Gaus_der).

$$Gaus(x;\mu,\sigma^2) = \frac{1}{\sqrt{(2\pi\sigma^2)}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

$$Gaus(x;\mu,\sigma^2) = \frac{1}{\sqrt{(2\pi\sigma^2)}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad (4)$$

$$Gaus\_der(x;\mu,\sigma^2) = \frac{d}{dx}(Gau(x;\mu,\sigma^2))$$

$$Gaus\_der(x;\mu,\sigma^2) = \frac{d}{dx}(Gau(x;\mu,\sigma^2)) \quad (5)$$

Step 4: Determine the intensity on the horizontal axis using the values shown in equations (6) and (7).

$$temp\_h = I \otimes (1/Gaus) temp\_h = I \otimes (1/Gaus) \quad (6)$$

$$horizontal = temp\_h \otimes Gaus\_der$$

$$horizontal = temp\_h \otimes Gaus\_der \quad (7)$$

Step 5: Determine the intensity along the vertical axis using the equations (8) and (9) that follow.

$$temp\_v = I \otimes Gaus temp\_v = I \otimes Gaus \quad (8)$$

$$vertical = temp\_v \otimes Gaus\_der$$

$$vertical = temp\_v \otimes Gaus\_der \quad (9)$$

where the Gaussian and Gaussian derivatives are denoted by Gaus and Gaus_der.

Step 6: Determine the gradient angle and gradient magnitude by utilizing the inverse tangent of the medical image and the Hausdroff distance, respectively.

B. Adaptive-Clustering

Adaptive clustering is a powerful technique for dynamically segmenting data, particularly in non-stationary environments. This paper presents a novel Adaptive Clustering Algorithm (ACA) that dynamically adjusts cluster centroids based on data distribution and density variations. The proposed method integrates density estimation, real-time centroid updates, and an adaptive thresholding mechanism. Experimental results demonstrate improved clustering accuracy, robustness, and computational efficiency compared to traditional clustering algorithms as shown in Algorithm 2

Algorithm 2

Step 1: Initialization: Randomly select initial cluster centers or use a density-based seeding method.

Step 2: Density Estimation: Calculate the local density of data points using a predefined density function.

Step 3: Centroid Update: Adjust cluster centers based on the density distribution of the data.

Step 4: Adaptive Thresholding: Determine an adaptive threshold for merging or splitting clusters depending on the density variations in the dataset.

Step 5: Convergence Check: Stop the algorithm when the changes in cluster centers fall below a predefined threshold, indicating stability.

III. METHODOLOGY

As a crucial component in noise reduction, the proposed method begins by evaluating the noise intensity. The stacked patches are then subjected to adaptive clustering, which groups related patches together. MP-SVD and LMMSE progressive two-step denoising are applied to each cluster matrix. Algorithm 3 shows an algorithm of the suggested approach.

Algorithm 3

Step 1: To consider the medical images affected by Gaussian noise.

Step 2: To compute the edge detection of the noise affected image.

- Step 2.a: To compute filtering of the noise affected image.
- Step 2.b: To calculate the gradient.
- Step 2.c: To create non-maximal suppressed images.
- Step 2.d: To perform double thresholding.
- Step 2.e: To link the edges.

Step 3: To denoise the edge detected medical image.

- Step 3.a: To estimate noise levels globally.
- Step 3.b: To compute adaptive thresholding.
- Step 3.c: To cluster into 'k' groups.
- Step 3.d: To perform progressive PCA thresholding using Hard and Soft thresholding.
- Step 3.e: To cluster the thresholded images into 'k' groups.

Step 4: To enhance the denoised image

- Step 4.a: To compute membrane potential.
- Step 4.b: To perform adaptive thresholding.
- Step 4.c: To compute action potential.

IV. RESULTS & DISCUSSION

This section discusses, verifies, and compares the findings obtained by the suggested adaptive technique in order to assess its efficacy. MATLAB software is used to produce the experimental results on a grayscale medical image. A range of statistical metrics, including PSNR, CNR, MSE are assessed in order to illustrate how well the suggested method performs. The experiment begins by taking a grayscale medical image and adding Gaussian noise to it at various standard deviations, such as 10, 20, 30, 40, and 50.

Noise affected Medical Im

Fig. 1: Proposed Methodology

The comparison of several denoising techniques in terms of PSNR values is shown in Table III. The method that is suggested yields a PSNR value of 28.15 dB for a noisy image with standard deviation, σ=10. In contrast to previous approaches, the adaptive strategy yields a high PSNR value, as shown by the detailed comparison between the proposed technique and the state- of-the-art methodologies. The MSE values of the suggested method and the earlier approaches are contrasted in Table IV. At σ=10, the suggested method achieves an MSE = 99.3507 dB value. A conclusion can be reached by comparing the approaches because the suggested approach has a lower error value than the other approaches. The comparison of the suggested strategy with the earlier approaches in terms of CNR value is shown in Table V. Comparing the suggested strategy to the previous ways, a high CNR value of 0.024076 dB is achieved. The comparison of different performance measures at different levels of σ is shown in Figures (2–4).

Noise Level	PSNR	MSE	CNR
10	28.1591	99.3507	0.024076
20	22.1385	397.4027	0.0248
30	19.6167	894.1561	0.024975
40	16.1179	1589.6109	0.025049
50	14.1797	2483.767	0.025089

TABLE I. EXPERIMENTAL RESULTS OF VARIOUS STATISTICAL PARAMETERS FOR MRIIMAGE

II.

COMPARISON OF VARIOUS MEDICAL IMAGE DENOISING APPROACHES USING CNR

Denoising Method	PSNR (dB)
Kolmogorov-Smirnov distance-based MR Image denoising [28]	28.7
Unbiased Risk Estimation based on Chi-Square [29]	21.55
Genetic Algorithm based Local Polynomial using Intersection-Confidence Interval Filter [30]	19.59
Present Study Adaptive Algorithm	45.67

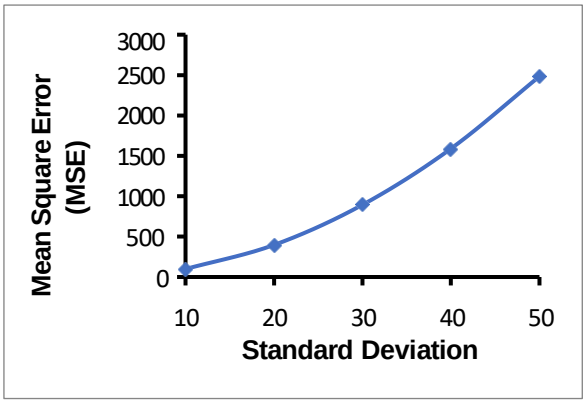

Fig 2. Peak Signal- to - Noise Ratio (PSNR) MRI image at various Standard Deviations

Denoising Method	R-MSE
Median Filtering based on Multi-stage Directions [31]	22.75
Filtering approach based on Gaussian [32]	21.56
Linear Regression Filter using Entropy paramount [33]	8.256
Present Study Adaptive Algorithm	8.613

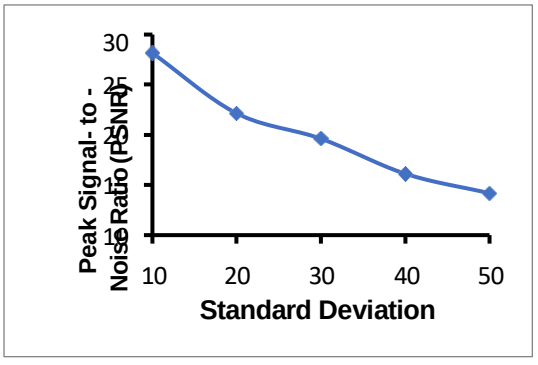

Fig 3. Mean Square Error (MSE) MRI image at various Standard Deviations

curvelet-based dictionary learning based on Two-dimensions [35]	5.12
Image Reconstruction using Deep learning [36]	11.58
Present Study Adaptive Algorithm	24.06

Denoising Method	CNR (dB)
BM3D using Context [34]	2.48

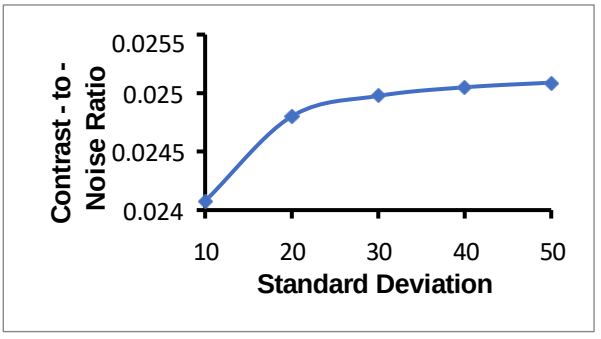

Fig 4. Contrast-to-Noise Ration (C-NR) MRI Image at various Standard Deviations

V. CONCLUSION & FUTURE SCOPE

Withthe help of adaptive progressive PCA enhancement techniques, and a non-maximal suppression model to identify the edges of the medical image, this paper suggests a novel hybrid adaptive approach based on preprocessing of the noise- affected medical images. The medical image is then denoised using adaptive progressive PCA thresholding and adaptive thresholding-based image enhancement techniques. Medical images at different standard deviations, such as 10, 20, 30,

40, and 50, are denoised due to the influence of Gaussian noise. This suggested method's effectiveness is assessed using a number of statistical metrics, including PSNR, CNR, and, MSE. When compared to earlier methods, the output obtained by the suggested method at σ=10 has better statistical characteristics. Therefore, as compared to earlier methods, the suggested strategy for denoising medical images is reliable. This strategy can be further enhanced in the future by applying the techniques to video frameworks for real-time imaging in the medical fields.

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PAPER ID : 258

ELECTRIC VEHICLE(EV)BATTERY TEMPERATURE PREDICTION USING ADAPTIVE CONVOLUTIONAL NEURAL NETWORK (ACNN)

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Abstract: Electric Vehicle (EV) battery temperature prediction is a critical component of efficient battery management and optimal vehicle performance. Accurate SOC estimation ensures safe operation, maximizes battery lifespan, and enhances the overall driving experience. Traditional methods, such as model-based approaches and equivalent circuit models, have been widely used but often struggle with complex battery dynamics and degradation over time. While deep learning approaches, particularly Recurrent Neural Networks (RNNs), have gained popularity due to their ability to model temporal dependencies, they face significant challenges such as high computational complexity, poor generalization to new datasets, and sensitivity to initial error states. These limitations hinder their practical applicability in real-world EV battery management systems.

To address these challenges, this paper proposes a novel approach for temperature prediction using an Adaptive Convolutional Neural Network (ACNN). The ACNN leverages the hierarchical feature extraction capabilities of convolutional layers, which are highly effective in capturing spatial and temporal patterns in battery data. Additionally, the ACNN incorporates adaptive mechanisms that dynamically adjust to varying battery conditions, such as temperature fluctuations, aging effects, and different operating modes. This adaptability ensures robust convergence, even when the model is initialized with significant initial errors, and significantly improves generalization across diverse datasets and operating conditions.

Keywords Electric vehicle (EV) battery, temperature prediction, deep learning, Adaptive Convolutional Neural Network (ACNN), battery management

I. INTRODUCTION

The world wide transformation to electric vehicles (EVs) is primarily driven by the need to reduce climate pollutants, reduces dependence on fossil fuels, and foster environmentally friendly transportation. As EV utilization increases to rise, streamlining battery usage and performance becomes a key factor in enhancing overall vehicle functionality and user satisfaction. Battery integrity, particularly its thermal management, significantly influences electricity demand, operational distance, and durability. Poor thermal management can result in thermal overload, fast deterioration, and lower effectiveness. Managing battery temperature is particularly challenging due to constantly changing driving conditions, ambient temperature variations, and fluctuating power demands.

Excessive heat can increase increased power usage due to extra cooling demands, while extremely cold temperatures can reduce battery efficiency and limit driving range. As a result, an effective and responsive thermal management system is crucial for keeping the battery within its optimal temperature range, ultimately improving both efficiency and lifespan. Recent advancements in machine learning, especially deep learning, have demonstrated promising potential in predictive modeling across different fields. Deep learning algorithms can process complex, high-dimensional data and uncover intricate patterns that traditional methods may struggle to identify.

Utilizing deep learning techniques for thermal prediction enables accurate forecasting of temperature variations under different conditions, facilitating precise control of the battery's thermal state. This research introduces an innovative approach that applies deep learning models to predict the thermal behavior of EV batteries. By leveraging sensor data, including temperature, voltage, and current, the objective is to forecast battery temperature profiles in real-time, thereby supporting optimal thermal management. The overarching goal is to enhance battery efficiency, extend lifespan, and improve overall EV performance.

To improve the continuity and efficacy of EVs, it is essential to develop intelligent systems capable of managing battery temperature across varying driving conditions. Effective thermal management is vital in preventing overheating, which can damage the battery and increase the energy consumption of cooling systems. Conversely, low temperatures can reduce the battery's discharge efficiency, ultimately limiting the vehicle's driving range. Therefore, a dynamic and adaptive thermal management system is essential for optimizing energy use and extending battery lifespan.

Accurately predicting battery temperature profiles is a complex task influenced by various factors, including driving patterns, weather conditions, battery load, and charge/discharge cycles. These variables contribute to temperature fluctuations that require continuous monitoring and real-time adjustments. Traditional thermal management approaches are often reactive, addressing temperature deviations only after they become critical.

In contrast, leveraging machine learning, particularly deep learning techniques, enables real-time prediction of battery thermal behavior. Predictive models can forecast temperature variations in advance, allowing for proactive regulation of heating and cooling systems to prevent overheating or excessive cooling.

II. PRELIMINARIES

Different thermal management strategies for electric vehicle (EV) batteries, including passive cooling, active cooling, and the use of phase change materials (PCMs). Additionally, it examines various temperature prediction models, particularly those based on machine learning techniques such as artificial neural networks (ANN), Gaussian process regression (GPR), and deep learning methods. A comparative analysis of these models, highlighting their advantages and drawbacks in terms of prediction accuracy and computational efficiency. Advanced techniques for managing battery temperature and predicting thermal behavior in electric vehicles. It examines both model-based and data-driven approaches, with a strong emphasis on machine learning and hybrid methods. The paper also includes case studies where data-driven models, such as neural networks and fuzzy logic, have been utilized to forecast battery temperatures under different driving and charging scenarios.

Deep learning brings exceptional precision and adaptability to temperature prediction. Its successful deployment requires addressing key challenges such as data availability, computational demands, and model generalization. The incorporation of deep learning into hybrid frameworks, highlights its role as an enhancement rather than a replacement—leveraging the advantages of both traditional and modern approaches.

Deep learning models, such as recurrent neural networks (RNNs) and long short-term memory (LSTM) networks, are particularly effective for this application as they can process time-series data and recognize patterns over time. By integrating sensor data—including temperature, voltage, current, and environmental conditions—these models provide highly accurate predictions of the battery's future thermal state. Additionally, as more data becomes available, the model continuously adapts to changing conditions, enhancing both performance and reliability. The above methods have challenges such as high computational demands, limited generalization to new datasets, and sensitivity to initial error states. These limitations reduce their effectiveness for real-world EV battery management applications. The proposed methodology for temperature prediction of a battery using an Adaptive Convolutional Neural Network(ACNN) overcomes the challenges.

The ACNN employ the hierarchical feature extraction capabilities of convolutional layers, which are highly effective in capturing spatial and temporal patterns in battery data. Moreover, the ACNN makes use of adaptive mechanisms that continuously adjust to changing battery conditions, including temperature variations, aging effects, and different operational modes. This flexibility enhances the model's ability to achieve stable convergence, even when starting with substantial initial errors, mean while improving its generalization across a wide range of datasets and operating scenarios.

III. PROPOSED WORK

Adaptive convolutional neural networks

Adaptive CNNs constructs on the traditional CNN architecture by introducing dynamic components that adjust their behaviour based on input data. The primary goal is to optimize performance without compromising computational efficiency.

Adaptive Features

1. Input-Based Kernel Adaptation

Adaptive Convolutional Neural Networks (CNNs) adjust their convolutional kernels dynamically according to the characteristics of the input data. For example, an image with high contrast may require a distinct kernel configuration compared to one with more subtle features. This adaptive mechanism enhances the model's ability to extract relevant patterns efficiently across diverse inputs.

2. Multi-Level Adaptation

These networks dynamically modify their architecture at various levels, adjusting factors such as layer depth, filter sizes, and activation thresholds based on the input's complexity. This hierarchical adaptation enhances the model's ability to generalize effectively across diverse datasets.

3. Efficient Architecture Design

Adaptive CNN**s** frequently utilize lightweight architectures, making them suitable for deployment on devices with limited computational resources, such as smartphones or IoT devices. This optimization ensures efficient performance without compromising accuracy.

This approach not only enhances temperature regulation but also improves the overall energy efficiency of EVs by minimizing energy losses caused by excessive heating or cooling. As a result, it extends battery lifespan, reduces operational expenses, and supports greater sustainability in electric vehicles. Therefore, integrating machine learning with thermal forecasting presents significant potential for advancing EV technology in the future.

The proposed method is substantiated using real-world Li-ion battery data, which includes voltage, current,

and temperature measurements collected under various driving cycles and environmental conditions. A comprehensive data filtering pipeline is designed to handle the unique characteristics of battery datasets. This pipeline includes noise filtering to remove measurement artifacts, feature normalization to standardize input data, handling missing data through advanced imputation techniques, and extracting temporal patterns such as voltage gradients and cumulative current. These preprocessing steps ensure that the input data is clean, consistent, and representative of the underlying battery dynamics.

To enhance understanding and readability, data visualization techniques are employed at every stage of the pipeline. For instance, raw and filtered voltage data are visualized to explain the effectiveness of noise filtering, while histograms of normalized features highlight the impact of feature scaling. Temporal patterns, such as cumulative current and voltage trends, are plotted to provide insights into battery behaviours over time. These visualizations not only aid in debugging and refining the preprocessing pipeline but also help stakeholders understand the data-driven nature of the proposed approach.

The adaptive nature of the proposed framework ensures consistent performance across varying battery conditions, addressing key challenges in temperature predictions for Li-ion batteries. By combining advanced deep learning techniques with robust data preprocessing and visualization, this work paves the way for more reliable and efficient EV battery management systems.

IV. Methodology and Results

The accurate temperature prediction of an EV battery is a critical factor in ensuring optimal battery management, performance, and longevity. Temperature prediction mainly gives the remaining charge in a battery relative temperature to its maximum capacity, akin to a fuel gauge in conventional vehicles. However, its estimation poses significant challenges due to the complex and dynamic behaviours exhibited by lithium-ion batteries under varying environmental conditions and usage patterns. Adaptive Convolutional Neural Networks (ACNN), an advanced machine learning architecture, present a promising solution to these challenges. By capturing non-linear dependencies and learning directly from data, ACNN provides a robust mechanism to preedict temperature with high accuracy and reliability, offering a significant leap forward in battery technology and electric vehicle management systems.

A. Data Augmentation and Preprocessing

The process begins with data augmentation, a technique crucial for enhancing the diversity and volume of available data. This step is particularly important given the limited datasets typically available in the field of battery management in reference to Fig.1. Data augmentation involves generating new samples from the existing dataset by applying transformations such as noise addition, scaling, and temporal shifts. The augmented data not only improves the robustness of the ACNN model but also ensures its adaptability across various real-world scenarios, including extreme operational conditions.

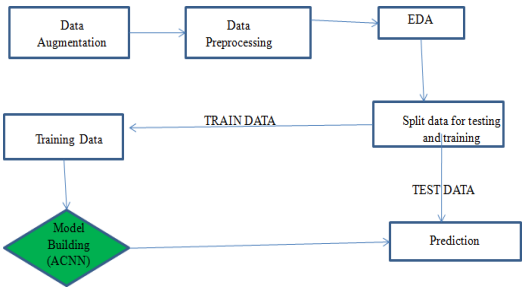


FIG1:IMPLEMENTATION PROCESS FLOW DIAGRAM OF ACNN

Once augmented, the data undergoes preprocessing to prepare it for analysis and modelling. Preprocessing is a meticulous step that entails cleaning the raw dataset, normalizing feature scales to ensure uniformity, and filtering outliers to remove potential sources of error. Additionally, feature engineering is performed to extract critical parameters such as voltage, current, temperature, and historical temperature values. These features, representative of the battery's state and performance, are pivotal in enabling the ACNN to learn effectively and make accurate predictions.

B. Exploratory Data Analysis (EDA) and Insights

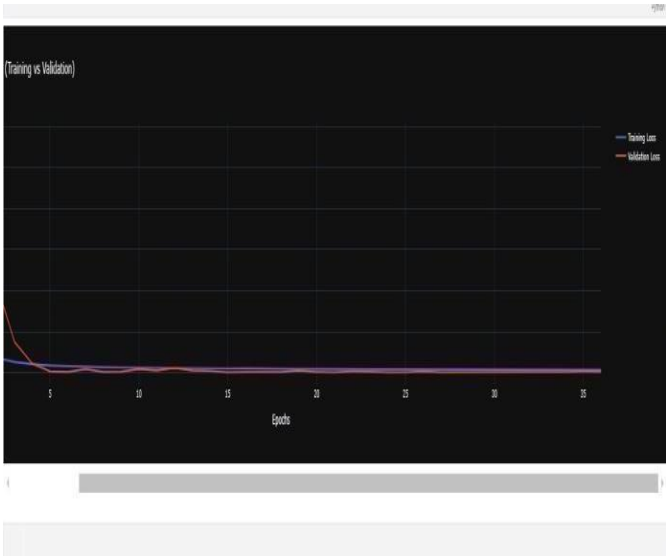
Before proceeding with model training, Exploratory Data Analysis (EDA**)** is performed to thoroughly examine the dataset. This process employs statistical and graphical techniques to uncover patterns, relationships, and anomalies within the data. For example, correlation matrices help identify dependencies between temperature prediction and variables such as voltage, temperature, and current as directed. Additionally, time-series analysis provides insights into how these parameters fluctuate across different drive cycles and operating conditions. The findings from EDA play a crucial role in shaping the subsequent modeling approach, ensuring that the ACNN architecture is optimized for the dataset's unique characteristics. By detecting biases and potential issues early, EDA establishes a solid groundwork for developing a reliable predictive model.

C. Training and Adaptive Features of the ACNN Model

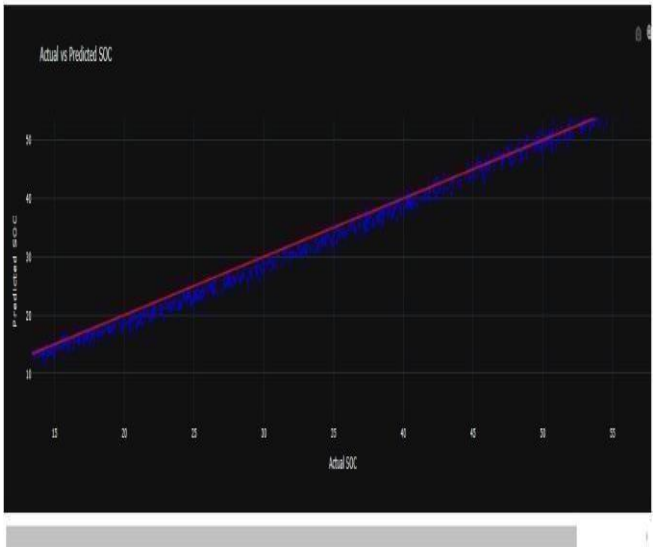
The foundation of training of an Adaptive Convolutional Neural Network (ACNN) model incorporates convolutional layers specifically designed to capture both spatial and temporal patterns within the input data. The ACNN is its adaptive mechanism, which dynamically modifies kernel parameters in response to the complexity of the data. This flexibility enables the model to effectively accommodate various operating conditions, ranging from mild discharges to significant temperature fluctuations. As a result, the ACNN delivers precise temperature predictions across a wide spectrum of scenarios.

The Adaptive Convolutional Neural Network (ACNN) is trained by optimizing a carefully selected loss function, such as Mean Absolute Error (MAE) or Root Mean Square Error (RMSE)**.** The model parameters are

recursively updated using advanced optimization techniques like backpropagation and gradient descent. To enhance generalization and mitigate overfitting, the dataset is strategically split, with 70-80% used for training and the remaining 20-30% allocated for validation and testing as shown in Fig [2a and 2b]. This structured approach ensures that the model not only learns effectively from the training data but also maintains strong performance on unseen test data—an essential factor for real-world applications.



(2a)



(2b)

FIG(2A)TRAINING VS VALIDATION PLOT, (2B) ACTUAL VS PRECITED GRAPHICAL REPRESENTATION USING MATPLOTLIB

SOC Estimation, Actual vs Predicted	
Actual SOC (%)	**Predicted SOC (%)**
78.23	76.04
93.35	93.84
13.79	14.16
85.54	85.55
35.92	33.94
1.24	1.21
30.01	28
78.16	77.24
52.76	52.35
84.62	83.49

TABLE1 :TABULAR FORM FOR STATE OF CHARGE ESTIMATION FOR ACTUAL VS PREDICTED

D. Prediction and Post Processing

Once trained, the ACNN model is employed to predict the temperature of EV batteries under varying conditions. The input features—such as real-time voltage, current, and temperature data—are fed into the model, which processes them through its layered architecture to generate temperature estimates clearly shown in Table:1. To further enhance the accuracy and reliability of these predictions, post- processing techniques are applied. Ensemble averaging, for example, combines predictions from multiple trained models to mitigate individual biases and reduce overall error margins as clearly shown in Fig:3. Thresholding techniques are also employed to ensure that temperature prediction values remain within physically plausible bounds, typically ranging from 0% to 100%.

E. Evaluation Metrics and Model Performance

The performance of the ACNN model is rigorously evaluated using a combination of statistical and practical metrics shown in Fig:4. Accuracy, defined as the proportion of temperature predictions falling within an acceptable error range, serves as a primary benchmark. MAE quantifies the average deviation between predicted and actual temperature prediction values, offering a straightforward measure of predictive reliability. RMSE, meanwhile, provides a more nuanced assessment by penalizing larger errors more heavily, reflecting the model's consistency and robustness. By achieving high scores across these metrics, the ACNN demonstrates its efficacy as a state-of-the-art tool for temperature prediction.

F. Implications and Advantages

Implementing Adaptive Convolutional Neural Networks (ACNNs) for temperature prediction brings several significant benefits. The model's resilience to noisy or incomplete datasets makes it highly suitable for real-world applications, where sensor inaccuracies and data gaps frequently occur. Its ability to provide real-time predictions enhances its integration into dynamic battery management systems, while its adaptability to changing conditions ensures compatibility across various electric vehicle (EV) models and environments is finally resulted

in Fig:5. Furthermore, by enhancing battery temperature prediction accuracy**,** ACNN plays a crucial role in extending battery lifespan and optimizing energy consumption, addressing key challenges in the pursuit of more sustainable transportation solutions.

The proposed system has the following advantages: Reduced Memory Usage: Adaptive networks often reduce the number of parameters while balancing performance measures.

Efficiency: Faster computations make these models suitable for real-time applications.

Versatility: Enhanced performance on varied datasets.

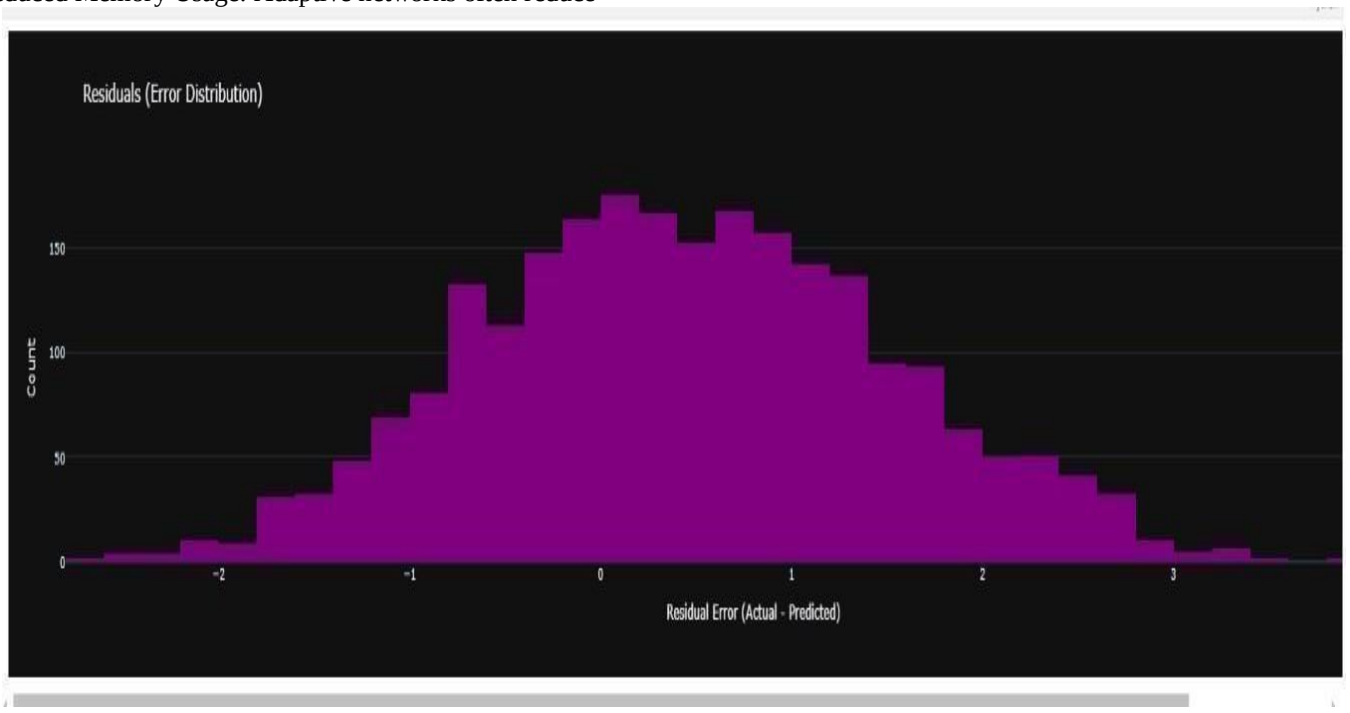


Fig 3: RESIDUAL ERROR (ACTUAL - PREDICTED)

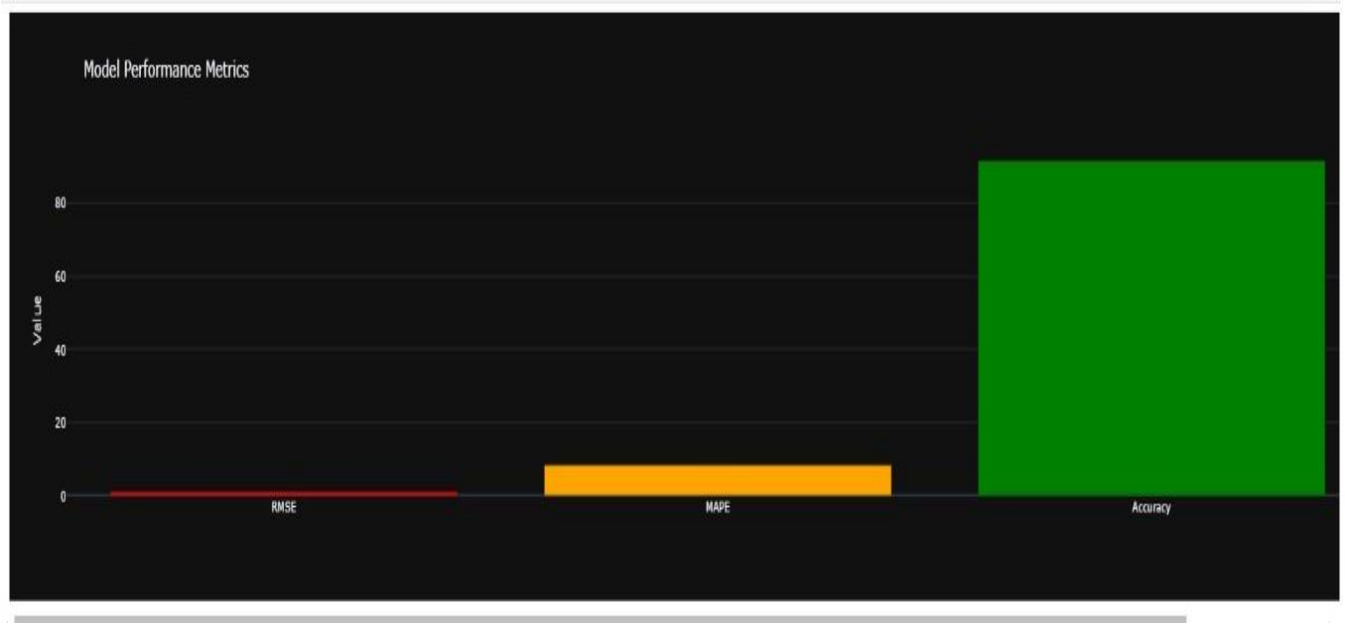


FIG 4: PLOT FOR MODEL PERFORMANCE METRICS (RMSE, MAPE AND ACCURACY)

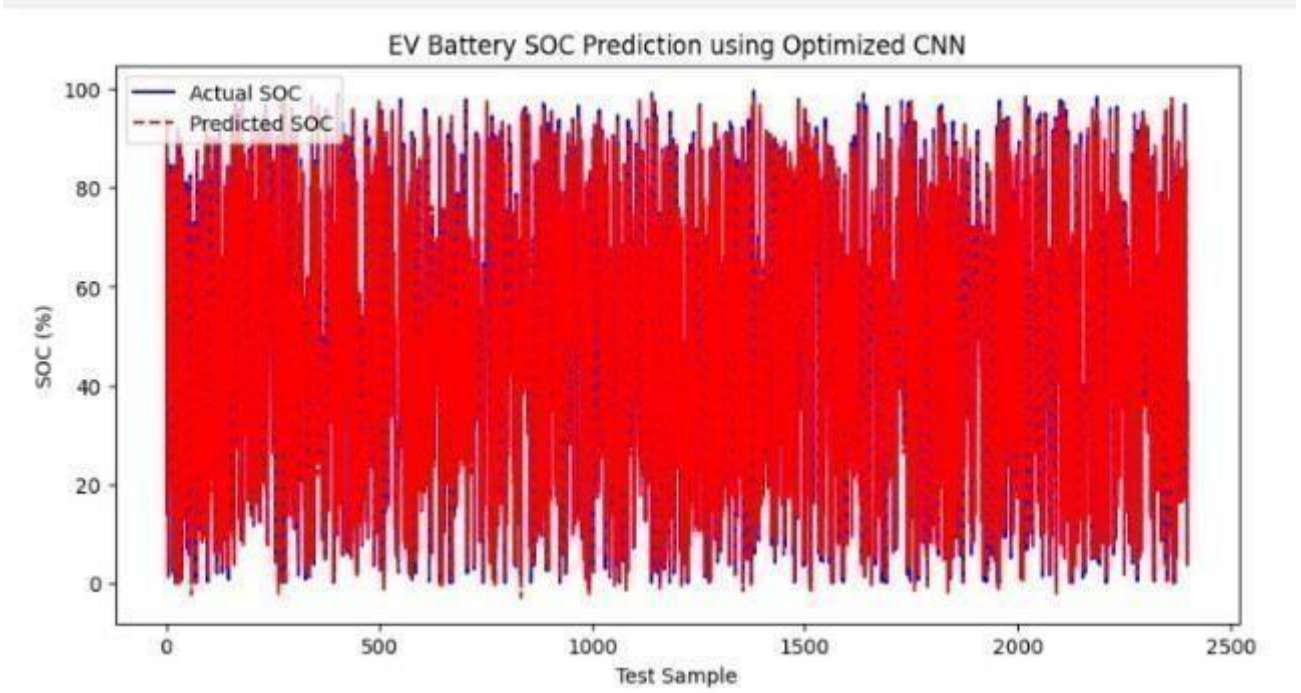


Fig 5: RESULTS: EV BATTERY SOC PREDICTION USING ADAPTIVE CONVOLUTIONAL NEURAL NETWORK

V. CONCLUSION &FUTURE SCOPE

Deep learning-based temperature prediction techniques to enhance the battery life and efficiency of electric vehicles (EVs). By leveraging advanced deep learning models for thermal management, we demonstrated how accurate temperature predictions can optimize the performance of lithium-ion batteries, leading to better thermal control and improved overall battery longevity.

Our findings highlight that precise thermal forecasting not only helps in maintaining the ideal operating temperature but also minimizes the risks of overheating and thermal runaway, thereby enhancing both the safety and efficiency of EV batteries. Additionally, the integration of thermal prediction models enables more effective battery management, ensuring that EV batteries operate within optimal conditions, thus extending their useful life and maximizing energy efficiency.

operating conditions. Developing lightweight deep learning models for real-time deployment on embedded battery management systems (BMS).Integrating hybrid approaches by combining deep learning with physics-based models for more reliable predictions.

The use of Adaptive Convolutional Neural Networks (ACNNs) has greatly enhanced the accuracy of battery temperature prediction and thermal management. However, continuous optimization and refinement are essential to effectively handle real-world challenges, such as temperature fluctuations and charging cycles. Future research can further explore the impact of environmental conditions and integrate hybrid modeling approaches to improve prediction reliability.

By utilizing ACNNs for battery temperature estimation, this approach contributes to enhancing performance, safety, and sustainability in electric vehicle (EV) batteries. As a result, it plays a key role in developing more efficient and dependable EV technologies.

Enhancing ACNN architectures to improve prediction accuracy across various battery types and

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ISBN NUMBER :978-93-342-1696-7

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