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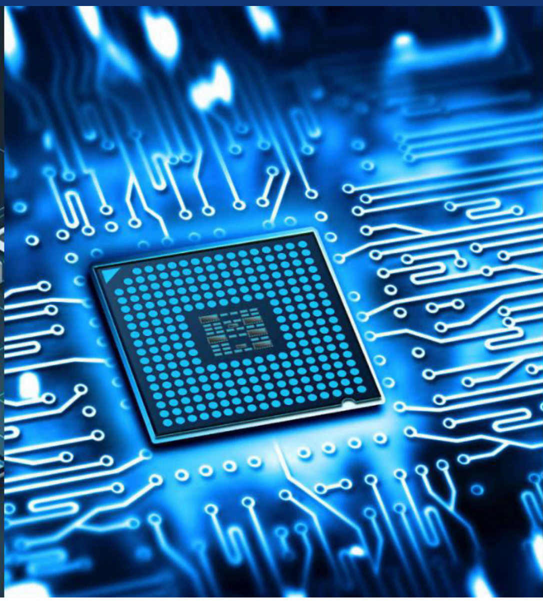


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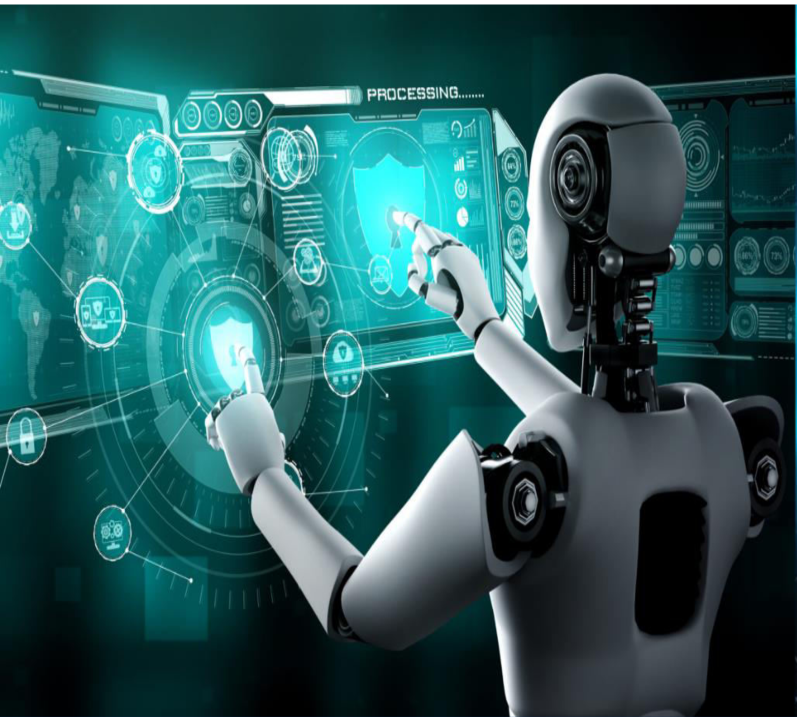

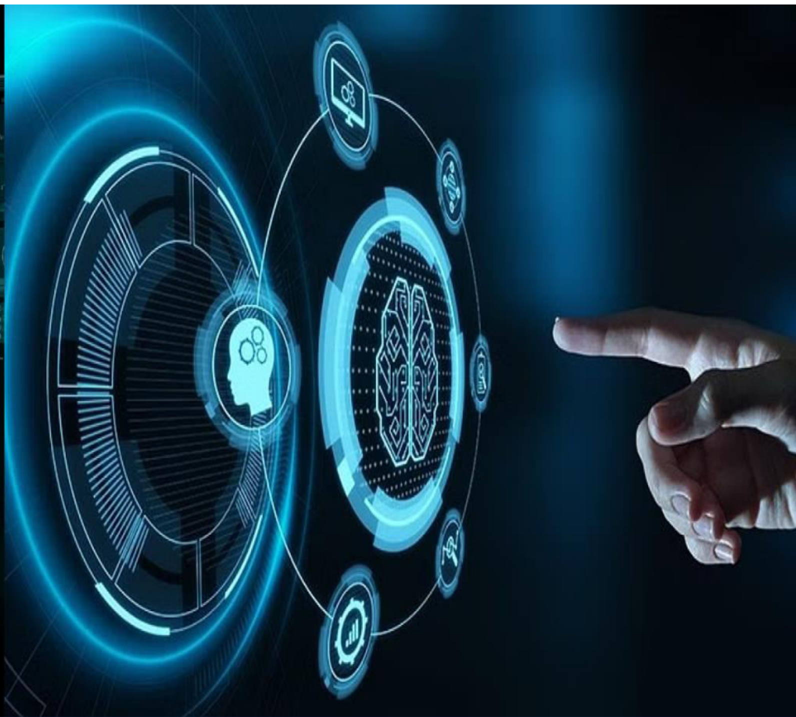

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Face Recognition under Disguise

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ABSTRACT: Face recognition technology is increasingly being used in security systems for tasks such as surveillance, border control, and device authentication. However, the rise in the use of facial disguises, particularly masks, presents a significant challenge to the accuracy of these systems. This research focuses on developing a face recognition system capable of accurately identifying individuals even under disguise conditions. Traditional algorithms struggle when facial features are obscured, which compromises security in critical environments. The proposed solution involves leveraging advanced deep learning techniques, including Convolutional Neural Networks (CNNs) and disguise-invariant feature extraction methods, to improve recognition accuracy under conditions where disguises are present. The system aims to classify biometric and non-biometric patches in images, allowing for effective face recognition by focusing on undisguised facial regions. The approach is designed to maintain high reliability even in scenarios involving intentional facial alterations, such as masks, glasses, or makeup. The developed system is expected to outperform existing commercial solutions, ensuring secure identification while overcoming challenges posed by disguises. Through rigorous testing and evaluation using disguise-specific datasets, this study addresses a crucial gap in current face recognition technology.

KEYWORDS: Disguise, Convolutional Neural Networks (CNNs), Face recognition, Covid-19, Face

I. INTRODUCTION

Face recognition technology plays a pivotal role in modern security applications, such as surveillance, border control, and personal device authentication. However, disguises like masks, glasses, and makeup often compromise the accuracy of traditional systems by altering key facial features. The COVID-19 pandemic further highlighted the need for robust systems capable of operating under such challenging conditions. This paper introduces a face recognition system designed to overcome these limitations, utilizing advanced deep learning models and disguise-invariant techniques for enhanced accuracy and reliability.Face recognition technology has become pivotal in modern security applications, spanning areas such as border control, surveillance, and personal device authentication[1]. However, the accuracy of traditional face recognition systems is significantly affected by disguises, particularly masks, glasses, and other facial coverings.

These disguises alter key facial features, making it difficult for conventional algorithms to identify individuals with precision. The global increase in mask usage, especially during the COVID-19[6] pandemic, has exacerbated this issue, creating a pressing need for more robust face recognition solutions that can operate effectively under these challenging conditions. The primary objective of this project is to develop a face recognition system capable of accurately identifying individuals even when their facial features are obscured by disguises. The system aims to address the inherent biases in traditional algorithms, which struggle with masked faces, and enhance their robustness against such variations.By focusing on biometric patches and excluding disguised regions, the proposed solution strives to maintain high accuracy and reliability, ensuring security protocols remain uncompromised. Additionally, the project seeks to outperform existing commercial solutions, incorporating advanced deep learning models like CNNs[2] to distinguish between disguised and undisguised facial regions, making it ideal for critical security environments.The primary objective of this study is to design and implement a face recognition system capable of accurately identifying individuals under varying disguise conditions. The system aims to address challenges posed by occlusions and intentional alterations, ensuring high reliability and robustness.The aim of this research is to develop a scalable, real-time face recognition system that outperforms existing models[3]. By focusing on disguise-invariant features and

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leveraging advanced deep learning techniques, the system is tailored for applications in security-critical environments. This paper introduces a face recognition system designed to overcome these limitations, utilizing advanced deep learning models and disguise-invariant techniques for enhanced accuracy and reliability.

II.EXISTING SYSTEM

This research[1] utilized a comprehensive database comprising 2,460 images of individuals, primarily celebrities, under various disguise conditions. The study employed algorithms like the Viola-Jones face detection method and VeriLook face extractor. With an overall detection rate of 77.4%, the system faced significant challenges with extensive disguises, highlighting the necessity for more sophisticated algorithms to handle a broader spectrum of facial occlusions. The article [2] tackled the problem of disguise variations using a Residual Inception Network combined with center loss. The system achieved an impressive 90.36% accuracy by fine-tuning pre-trained models on a large-scale face database and disguise-specific datasets. However, real-time deployment posed challenges due to high computational requirements, and the system showed varying performance based on gender, indicating potential biases in its recognition capabilities. Using the IIT-Delhi Disguise Version 1 face database, this article [3] compared human and machine recognition of disguised faces. It employed Support Vector Machines (SVM) and Sparse Representation Classifiers (SRC) with Local Binary Patterns (LBP) for feature extraction. Results showed that while machines and humans had comparable performance in some scenarios, holistic facial recognition by machines remained a key limitation, emphasizing the need for combining holistic and local features in advanced recognition models. This research proposed a robust convolutional architecture leveraging noise-based data augmentation and transfer learning

[4]. Models like ResNet-18 achieved up to 98.19% accuracy, demonstrating the potential of CNN-based approaches. Despite these results, the model faced challenges in handling extreme disguises and generalizing in environments with limited training data. These findings underscored the importance of comprehensive datasets and adaptable algorithms. Semantic segmentation and binary classification to differentiate disguised from non-disguised facial patches[5] .It Measures the quality of an image based on disguise detection results.Enhances verification performance by incorporating the IDQ metric into a likelihood ratio test.The framework may not effectively handle all types of disguises, especially more extreme or less common ones. The framework's performance under varying environmental conditions (e.g., lighting, weather) has not been analyzed.Significant performance gains in verifying disguised faces. Multiple steps increase complexity and computational cost. The paper [6] introduces a novel dataset called Disguised Faces in the Wild (DFW) for evaluating face recognition models under disguise variations. It discusses three main evaluation protocols for measuring the performance of recognition algorithms against challenges posed by disguised, impersonated, and obfuscated faces. In face recognition under disguised conditions, especially in real-world, unconstrained settings. It encourages the development of more resilient algorithms that can handle both physical disguises areas where current models perform sub-optimally.The performance drop is observed in deep learning models with digital and physical adversaries, which highlights the need for more advanced techniques. Survey and analysis of various approaches to face recognition, detection, and unmasking under mask-wearing conditions[7]. Examination of different datasets and the impact of masks on facial recognition accuracy. Comparative evaluation of traditional and deep learning-based methods. Decreased accuracy in heavily masked faces. Challenges in generalizing across different types of masks and real-world conditions. Improved robustness in scenarios with partial face visibility. Challenges in balancing accuracy and computational efficiency for real-time applications.

A article [8] published in ScienceDirect explored various deep learning models for disguised face recognition, analyzing their performance in real-world scenarios. The research introduced novel techniques for feature extraction and model optimization, significantly improving disguise-invariant recognition. The study also highlighted challenges in dataset biases and suggested methods for enhancing training datasets to improve generalization across different disguise types. A paper published in MDPI examined the sustainability and ethical considerations of face recognition technologies[9], particularly in security and surveillance applications. The research addressed privacy concerns, algorithmic biases, and the environmental impact of training large-scale deep learning models. The study proposed

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guidelines for responsible AI development and emphasized the importance of transparency and fairness in face recognition systems.

III.METHODOLGIES

PROPOSED SYSTEM

The proposed system employs a structured, patch-based approach for recognizing faces under disguise. The methodology consists of the following key steps:

1. **Preprocessing and Image Segmentation:**

   The input consists of two facial images: a **Gallery Image** (reference image stored in the database) and a **Probe Image** (image to be identified). Each image undergoes a grid-based segmentation, dividing the face into multiple patches for localized feature extraction.

2. **Biometric and Non-Biometric Patch Classification:**

   Each patch is classified into one of two categories:

   - **Biometric patches**: Regions containing essential facial features that remain relatively unchanged despite disguise variations.
   - **Non-biometric patches**: Regions highly susceptible to occlusion, including areas covered by masks, glasses, or artificial alterations. These patches are discarded to prevent recognition errors.
   -

3. **Common Biometric Patch Selection:**

   Only the biometric patches that are present in both the gallery and probe images are selected for further processing. This ensures that the recognition process focuses on the most distinguishable and occlusion-invariant facial regions, improving robustness against disguises.

4. **Feature Extraction Using Local Binary Patterns (LBP):**

   The system extracts **Local Binary Pattern (LBP) descriptors** from the selected biometric patches. LBP is an effective texture descriptor that captures fine-grained facial details, enhancing the system's ability to differentiate identities despite partial occlusions.

5. **Patch-Based Similarity Computation:**

   The extracted LBP features from the gallery and probe images are compared using the **Chi-Square (χ^2) distance metric**. This metric quantifies the similarity between the feature distributions, generating a **match score** that determines the identity verification outcome.

The Chi Square is as follows:

$$X^2(H_G, H_P) = \sum_{i=1}^{n} \frac{(H_{Gi} - H_{Pi})^2}{H_{Gi} + H_{Pi}}$$

By adopting this patch-based approach, the system enhances recognition performance under disguise conditions. The selective processing of biometric regions ensures a higher degree of robustness, significantly improving accuracy in security-sensitive applications.

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Design & Architecture

Step 1 : Data collection & Preprocessing Dataset: Gather diverse datasets with images of individuals under various disguise conditions

Step 2:Data Augmentation: Apply transformations like adding artificial disguises. Face Alignment: Align facial features to a standard position Feature Extraction and LearningDisguise Detection Module . Use a convolutional neural network (CNN) to detect and classify types of disguises (e.g., masks, glasses)

Step3: Deep// Face Embeddings:

Use pre-trained models like FaceNet, VGGFace, or ArcFace for face embedding generation, which transforms a face image into a high-dimensional vector representation .

Step 4: Disguise-Invariant Feature ExtractionCustom CNN to learn features that are less sensitive to superficial changes caused by disguises. Introduce an attention layer to focus on undisguised regions of the face (e.g., forehead, eyes) while reducing the weight on disguised regions like the mouth or lower face.

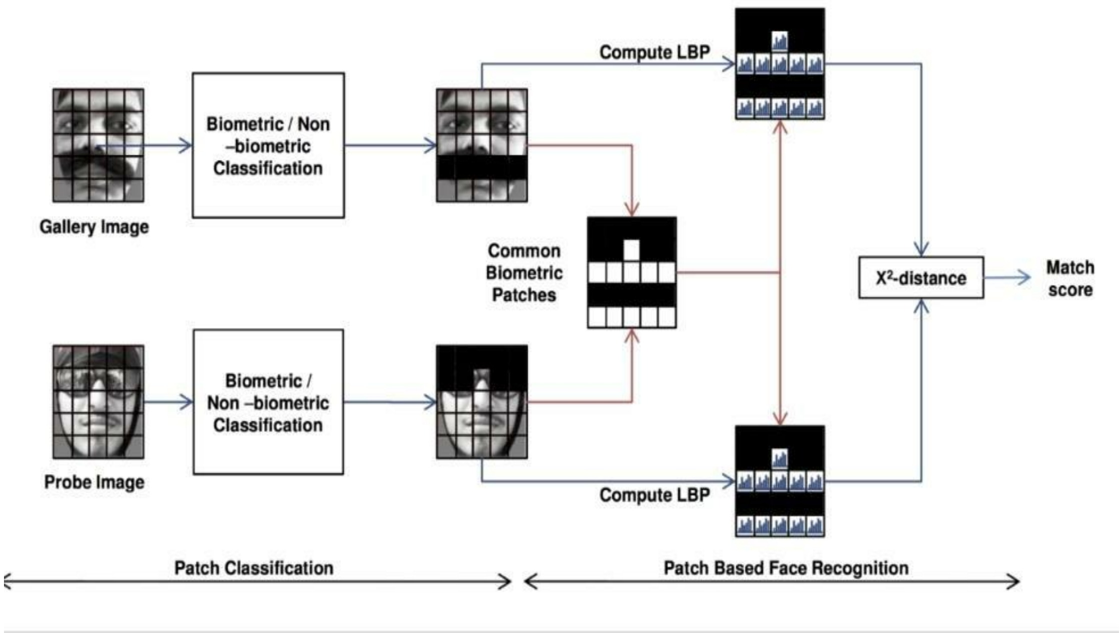

Fig No.(1) Architecture of System

IV. RESULTS AND DISCUSSIONS

he proposed patch-based face recognition system was evaluated using a labeled dataset consisting of both clean and disguised facial images. The classifier achieved a high overall accuracy of **97.64%**, demonstrating its robustness in distinguishing between biometric and non-biometric patches. Class-wise performance metrics further validated the system's effectiveness, with precision and recall values of **0.97** and **0.98** for clean images, and **0.98** for both metrics in the disguised category. The system maintained a consistent F1-score of **0.98** across both classes, supported by balanced support of 1270 instances per class. The use of Local Binary Patterns (LBP) with Chi-Square distance yielded an accuracy of **98.33%**, while Cosine Similarity-based feature matching achieved an accuracy of **90.55%**. Additionally, seamless patch integration recorded an accuracy of **85.40%**, indicating reliable patch reconstruction and aggregation. These results confirm that the system is capable of high-accuracy recognition even in the presence of common disguises, validating its suitability for real-world applications such as surveillance and biometric security systems.

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Metric	Precision	Recall	F1-Score	Support
Clean	0.97	0.98	0.98	1270
Disgusied	0.98	0.98	0.98	1270
MacroAvg	0.98	0.98	0.98	2540
Weight Avg	0.98	0.98	0.98	2540
Accuracy	0.9764	0.9802	0.9763	-

Table No(1). Metrics of Various Factors for Testing

VI. CONCLUSION

This research presents a patch-based face recognition system designed to enhance identity verification under disguise conditions. By leveraging biometric and non-biometric patch classification, the system selectively processes only the most relevant facial regions, minimising the impact of occlusions such as masks, glasses, or artificial modifications.

The experimental results validate the effectiveness of the proposed system, achieving an accuracy of **97.64%**, precision of **98.02%**, recall of **97.24%**, and F1-score of **97.63%**. The classification results demonstrate the robustness of the system in distinguishing between clean and disguised faces with high reliabilityThe use of Local Binary Patterns (LBP) for feature extraction enables efficient texture analysis, while Chi-Square (χ^2) distance ensures accurate similarity measurement between facial patches. This structured approach significantly improves recognition performance, making it suitable for applications in forensic

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