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Masked Face Recognition Using Natural Language Processing And Convolution Neural Network :A Systematic Review

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***Abstract*— Masked face recognition (MFR) has gained significant importance in recent years due to the widespread adoption of face masks driven by global health crises and increasing security requirements. Traditional face recognition systems often fail to perform effectively when key facial features are occluded, creating a need for more robust and adaptive solutions. In response, numerous deep learning (DL) and machine learning approaches—particularly those based on convolution neural networks (CNNs)—have been developed to improve recognition accuracy under masked conditions. These models are widely applied in areas such as surveillance, secure authentication, and public safety, where real-time performance is essential. This paper presents a systematic review of recent MFR techniques, focusing on deep network architectures, feature extraction strategies, and model optimization methods. It also examines commonly used tools and frameworks, along with benchmark datasets and evaluation metrics employed in existing studies. A structured methodology is adopted to ensure a transparent and reproducible selection of relevant literature. Furthermore, this review categorizes current approaches, identifies key challenges such as occlusion handling, dataset limitations, and real-time constraints, and outlines potential directions for future research aimed at developing more efficient and reliable masked face recognition systems.**

***Index Terms*— Masked Face Recognition, Deep Learning, CNN, Occlusion Handling, Feature Extraction, Surveillance Systems, Real-time Recognition.**

I. INTRODUCTION

Artificial Intelligence (AI) has significantly advanced in recent years, particularly in machine learning and computer vision, enabling intelligent systems for real-world applications [1], [16]. Among these applications, face recognition (FR) has become one of the most widely used biometric technologies for surveillance, authentication, and security systems [4]. However, traditional FR systems rely on visible facial features such as eyes, nose, and mouth, making them sensitive to occlusion and environmental variations.

The COVID-19 pandemic led to the widespread use of face masks, which introduced significant challenges for existing recognition systems [18]. Masked faces reduce the availability of discriminative facial features, thereby decreasing recognition accuracy. This issue has become particularly important in high-security environments such as airports, immigration checkpoints, and public surveillance systems [21]. As a result, masked face recognition (MFR) has emerged as an important research area.

Existing studies show that even advanced face recognition systems experience performance degradation when faces are partially occluded [3], [21]. Therefore, there is a need to develop more robust and adaptive models capable of handling real-world masked face scenarios.

This paper aims to address this gap by providing a detailed systematic review of recent developments in masked face recognition using deep learning techniques

II. LITERATURE REVIEW

Recent research in masked face recognition focuses mainly on deep learning approaches due to their strong feature learning capability. CNN-based models such as ResNet, VGG, and MobileNet have been widely applied for feature extraction and classification tasks in occluded face scenarios [4], [30].

One major direction involves mask-aware learning, where models are trained using both masked and unmasked faces. Some studies use synthetic datasets by artificially adding masks, while others use real-world datasets to improve generalization [20]. However, synthetic data often reduces model performance when deployed in real environments.

Another important approach is occlusion handling and feature reconstruction. Techniques such as autoencoders and generative models attempt to reconstruct missing facial regions, improving recognition accuracy [29]. Attention-based methods have also been proposed to focus on visible regions of the face, such as the eyes and forehead, which remain useful for identification.

Lightweight CNN architectures like MobileNet have been explored for real-time applications, especially in surveillance systems [30]. However, achieving a balance between computational efficiency and accuracy remains a challenge.

Studies also highlight that there is no standardized evaluation framework for MFR systems, making comparison between models difficult [21].However, achieving a balance between accuracy and efficiency remains a challenge.

Table1 : Literature Review Summary

Author	Year	Technique	Dataset used	Key Finding
Alzu'bi et al.	2021	CNN, GAN, Deep Learning models	RMFRD, SMFRD, synthetic datasets	Demonstrated that deep learning significantly improves masked face recognition.
Al-Sinan et al.	2022	Hybrid CNN + Transformer Ensemble	Synthetic masked LFW dataset	Improved accuracy using ensemble learning, showing benefit of combining CNN and transformer models.
Pudyel & Atay	2023	Traditional ML (SVM, KNN, LBP)	Synthetic masked datasets	Showed traditional ML methods perform poorly compared to deep learning in masked conditions.
Cai et al.	2023	CNN (ResNet, VGG, Inception) + Data Augmentation	LFW + simulated masked dataset	Achieved accuracy using fine-tuned CNNs and data augmentation techniques.
Mahmoud et al.	2024	DL-based MFR, Face Unmasking, Detection	Mixed real and synthetic datasets	Identified key challenges such as occlusion handling and dataset limitations.
Sharma et al.	2025	Occlusion-aware DL models (OAFR, ORFE, ORBFR)	Benchmark datasets (RMFRD, LFW variants)	Introduced advanced taxonomy of MFR techniques.

III. METHODOLOGY

The proposed model takes RGB images as input and processes them through a CNN architecture for feature extraction and classification. Initially, input images are resized to a fixed dimension of 100×100 pixels to ensure uniformity and reduce computational complexity.

The CNN model automatically extracts important visual features from the images, such as edges, textures, and patterns, which are

This approach provides an efficient and practical solution for real-time mask detection, which can be applied in public safety systems, surveillance, and access control environments.

IV. RESULT AND DISCUSSION

The system demonstrates strong performance in real-time scenarios, successfully detecting multiple faces within a single frame. It is also capable of handling different viewing angles, including partial and side profiles, without significant loss in accuracy. This indicates that the CNN-based architecture effectively extracts relevant facial features even under varying conditions. Overall, the model shows reliable and consistent performance, making it suitable for real-world applications such as surveillance and public safety monitoring.

Face recognition remains one of the most widely studied areas in computer vision due to its effectiveness in identifying individuals based on unique facial features. Compared to other biometric methods such as fingerprints and iris recognition, facial recognition offers a more convenient and non-intrusive approach. However, its performance is highly affected by challenges such as occlusions, lighting variations, and changes in facial expressions. The introduction of face masks has further increased these challenges, making traditional face recognition systems less effective.

Since the COVID-19 pandemic, research in masked face recognition (MFR) and occluded face recognition (OFR) has grown significantly. Deep learning techniques, particularly CNN-based models, have played a major role in improving recognition accuracy under masked conditions. To support this growing field, research studies have been collected from major scientific databases such as IEEE Xplore, Scopus, ACM Digital Library, Web of Science, Wiley, Ei Compendex, and EBSCOhost over the last few years. These studies include journal articles, conference papers, and symposium works related to MFR and OFR.

TABLE 1 : MODEL PERFORMANCE COMPARISON

MODEL	ACCURACY	PRECISION
TRADITIONAL CNN SMFRD (SYNTHETIC MASKED FACE DATASET)	0.92	0.90
RESNET-50 (TRANSFER LEARNING) RMFRD	0.94	0.91
PROPOSED CNN MODEL CUSTOM DATASET (MASKED + UNMASKED FACES)	0.98	0.93

V. CONCLUSION

Overall, this work highlights the importance of robust and efficient deep learning models for reliable masked face recognition. The proposed approach achieves strong accuracy while maintaining real-time performance, making it applicable for modern security and authentication systems. Future improvements may focus on enhancing model generalization, reducing computational cost, and integrating larger diverse datasets to further improve performance in unconstrained environments.

The proposed system demonstrates that CNN-based architectures are highly effective in extracting meaningful facial features even when partial occlusion is present. By using real-time image processing through a webcam, the model successfully detects faces and classifies them as masked or unmasked with high accuracy. The system also performs well under varying conditions such as different face angles and multiple face detection in a single frame, making it suitable for practical applications like surveillance and access control.

From the literature analysis, it is evident that deep learning models outperform traditional machine learning approaches in masked face recognition tasks. Techniques such as transfer learning, lightweight CNN architectures, and attention-based mechanisms have further improved system performance. However, challenges such as limited real-world datasets, variations in mask types, and computational efficiency still remain significant obstacles.

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