Masked Face Recognition Technique for Different Type of Occlusion Area on Face

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***Abstract*-. In response to the COVID-19 pandemic, wearing masks has become a common and necessary practice to prevent virus transmission. While effective for public health, masks obscure key facial features, complicating the task of facial recognition. Recognizing individuals wearing masks is particularly challenging due to the limited visibility of distinguishing facial characteristics. Recognizing and authenticating people wearing masks will be a long-established research area, and more efficient methods are needed for real-time MFR. This paper proposed methodology for masked face recognition using ResNet-50 model with MFR-2 dataset, aims to produce maximum accuracy. Pre-trained model ResNet-50 used MaxPooling layers to reduces the dimensionality of feature maps while retaining important information and ResNet-50 model Generated 0.82 accuracy for the identification of masked face**.

***Index Terms*- Convolutional Neural Networks (CNN), Corona virus disease 2019, Deep Learning, Masked face recognition.**

I-INTRODUCTION

Corona virus disease spreads viruses in the world.it is spreads widely due to its transparent behaviour. spreading of viruses never be stop, it can take different form in future. In order to protect us from the viruses, we must wear masks when going out, especially in places with many people, which poses a huge challenge for Masked face recognition. In personal identification scenarios of airports and stations, and in authentication scenarios of communities, schools, companies, etc. at this place have to improve of Masked face Recognition performance. In the occluded cases, an anchor-level attention, Face alterations and the presence of different masks make it too much challenging. Recognition of Masked faces is a popular and significant technology in recent years.

Masked face recognition is a branch of occluded face recognition with prior knowledge about the targeted face's occluded area. Therefore, a masked face recognition system might effectively focus on the analyses of features that can be extracted from the areas including the eyes, eyebrows and forehead, which are uncovered by the mask, of the subject. Different types of approach are used to extract feature, they have own method.

In attention-based approach, the masked features are given a lower weight, and features around eyes are given a higher weight. In cropping-based approach, the face images after removing the masked regions are used for model training. And the optimal cropping for each case is explored. The combination of deep learning and Local Binary Pattern (LBP) features to recognize the masked face by utilizing Retina Face, a joint extra-supervised and self-supervised multi-task learning face detector that can deal with various scales of faces, as a fast yet effective encoder. Masked-face recognition algorithm based on large margin cosine loss (MFCosface). It uses an algorithm based on the detection of key facial features to generate masked-face images as a training set; then it uses the large margin cosine loss to train the model; and finally, it adds an attention mechanism to the model to optimize the representations of facial features, which effectively solves the problem of low recognition rates with mask occlusion. In Deep learning-based method, use a pre-trained deep learning-based model in order to extract features from the unmasked face regions (out of the mask region). The first step is to remove the masked face region. Next, apply pre-trained deep Convolutional Neural Networks (CNN).

The key features to identify a person are decreasing by using various sorts of masks or occlusions. for disguising identities, terrorists and criminals are covered their faces with the mask. That's why the masked face is being one of the major concerned factors within the domain of face recognition. CNN can obtain different local essential features from the data, can select global training components, and have been successfully implemented to many disciplines of pattern recognition applications. The ability of the system to perform masked face

recognition in real-time makes it suitable to recognize people in CCTV footage in places like malls, banks, ATMs, etc. The deep learning technique can be used in schools and colleges for attendance, as well as in banks and other high-security zones to grant access to only the authorized ones without asking them to remove the mask.

II-ARTIFICIAL NEURAL NETWORK

The Artificial Neural Network uses a training algorithm to learn the datasets which modifies the neuron weights depending on the error rate between target and actual output. In general, ANN uses the back propagation algorithm as a training algorithm to learn the datasets.

Pattern recognition is the process of classifying input data into objects, classes, or categories using computer algorithms based on key features or regularities. Pattern recognition has applications in computer vision, image segmentation, object detection, radar processing, speech recognition, and text classification.

III -LITERATURE REVIEW

In 2019 Masked face recognition using convolutional neural Network [1] proposed by Md. S. Ejaz, Md. R. Islam used to Feasible approach that consists of first detecting the facial regions. The occluded face detection problem has been approached using Multi-Task Cascaded Convolutional Neural Network (MTCNN). Then facial features extraction is performed using the Google Face Net embedding model. And finally, the classification task has been performed by Support Vector Machine (SVM). Experiments signify that this mentioned approach gives a remarkable performance on masked face recognition 99.63% accuracy rate.

In 2021 Masked Face Recognition method [2] proposed by H. Vu1, M. Nguyen, C. Pham with Convolutional Neural Networks and Local Binary Patterns. In this Research they proposed a method that takes advantage of the combination of deep learning and Local Binary Pattern (LBP) features to recognize the masked face by utilizing Retina Face, a joint extra-supervised and self-supervised multi-task learning face detector. extracted local binary pattern features from masked face's eye, forehead and eyebrow areas and combine them with features learnt from Retina Face into a unified framework for recognizing masked faces. Used self-collected dataset named COMASK20 from 300 subject. In the experiment, they were compared his proposed system with several state-of-the-art face recognition methods on the published Essex dataset and self-collected dataset COMASK20.With the recognition results of 87% f1-score on the COMASK20 dataset and 98% f1-score on the Essex dataset.

In 2021 MFCOSFACE: a Masked-Face Recognition Algorithm proposed by Deng, H.; Feng, Z.; Qian, G.; Lv, X.; Li, H.; Li, G Based on Large Margin Cosine Loss [3]. In this paper they solve the problem of low facial recognition accuracy with mask wearers during the COVID-19 epidemic, they propose a masked-face recognition algorithm based on large margin cosine loss (MFCosface). Due to insufficient masked-face data for training, they designed a masked-face image generation algorithm based on the detection of the detection of key facial features. The face is detected and aligned through a multi-task cascaded convolutional network; and then they detect the key features of the face and select the mask template for coverage according to the positional information of the key features.

In 2021 Masked Face Recognition method proposed by Yande Li, Kun Guo, Yonggang Lu, Li Liu with Cropping and Attention Based Approach [4]. Here, new method for masked face recognition is proposed by integrating a cropping-based approach with the Convolutional Block Attention Module (CBAM). The optimal cropping is explored for each case, while the CBAM module is adopted to focus on the regions around eyes. Two special application scenarios, using faces without mask for training to recognize masked faces, and using masked faces for training to recognize faces without mask, have also been studied. SVM was often used as a binary classifier to detect the occluded area in images. Attention Mechanism (AM), inspired by human attention mechanisms, is first known for its excellent performance in natural language processing. As a result, it showed the integration of the optimal cropping and CBAM module achieve the best recognition accuracy for MFR.

In 2021 Efficient Masked Face Recognition Method During the Covid-19 Pandemic proposed by W. Hariri [5]. In this Research paper, propose a reliable method based on occlusion removal and deep learning-based features in order to address the problem of the masked face recognition process. The first step is to remove the masked face region. Next, apply three pre-trained deep Convolutional Neural Networks (CNN) namely, VGG-16, AlexNet, and ResNet-50, and use them to extract deep features from the obtained regions (mostly eyes and forehead

regions. VGG-16: is trained on the ImageNet dataset which has over 14 million images and 1000 classes. Its name VGG-16 comes from the fact that it has 16 layers. AlexNet: has been successfully employed for image classification tasks. This deep model is pre-trained on a few millions of images from the ImageNet database through eight learned layers, five convolutional layers and three fully-connected layers. The last fully connected layer allows to classify one thousand classes. The fifth convolutional layer is used in this paper to extract deep features. ResNet-50: has been successfully used in various pattern recognition tasks such as face and pedestrian detection. It containing 50 layers trained on the ImageNet dataset. This network is a combination of Residual network integrations and Deep architecture parsing. Experimental results are carried out on Real-world Masked Face Recognition Dataset (RMFRD) and Simulated Masked Face Recognition Dataset (SMFRD). The proposed method improves the generalization of the face recognition process in the presence of the mask. Accuracy and time complexity is better. The proposed method can also be extended to richer applications such as video retrieval and surveillance.

IV. MASKED FACE RECOGNITION METHODOLOGY

In this research paper, a dataset was prepared with two classes: Masked and Unmasked images. To achieve the best model performance, a diverse set of images is required, so data augmentation was applied to obtain scaled images. In Figure [1], we can see the ResNet-50 model being used to extract important features from the images during model training. To optimize the model's performance, various optimizers and fine-tuning methodologies were applied, followed by model evaluation. The evaluation produced test results and identified valid images of masked faces."

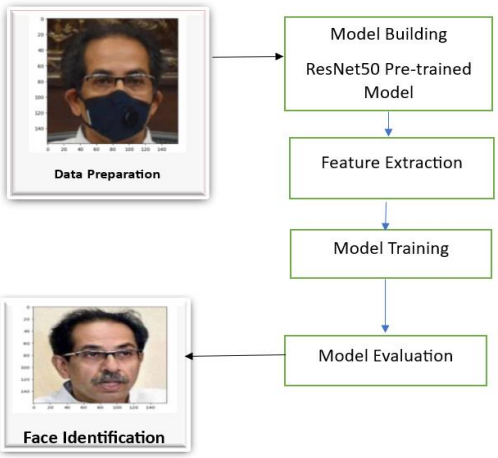

Figure 1-Masked Face Recognition Methodology Using ResNet50".

V-RESNET-50 ARCHITECTURE

ResNet-50 has 50 layers, consisting of convolutional layers, batch normalization layers, ReLU activations, and pooling layers, along with fully connected layers at the end. The network is built using a series of residual blocks. These blocks allow the model to learn identity mappings by skipping connections, enabling deeper networks to be trained effectively. The input to the ResNet-50 model is typically an image of size 224x224x3 (width, height, and three-color channels for RGB).

Conv1: A 7x7 convolution with 64 filters and a stride of 2, followed by batch normalization and ReLU activation. This is followed by a 3x3 max pooling layer with a stride of 2. This layer reduces the input size from 224x224x3 to 112x112x64.ResNet-50 is divided into four stages, each consisting of several residual blocks.

In each residual block, a skip connection adds the input of the block to its output. This operation ensures that the network can learn identity functions, making it easier to train very deep networks. ResNet-50 model architecture shown in below figure [2]. After the last residual block, a global average pooling layer reduces each feature map to a single number by averaging over all spatial locations. This layer reduces the dimensionality and helps prevent overfitting.

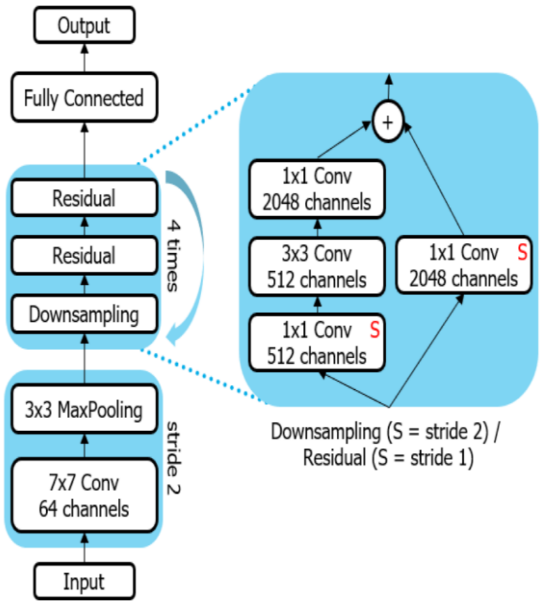

Figure 2-ResNet-50 Architecture

A fully connected layer with 1000 neurons is used in the original architecture to classify the output into 1000 classes (e.g., in the ImageNet dataset). The output of the fully connected layer is passed through a softmax activation to obtain probability distributions over the classes.

VI-EXPERIMENTAL WORK

In this research paper, proposed methodology prepared dataset in to two different class. To train the model, we used two class masked and unmasked image of MFR-2 dataset. For training, images are randomly rotated, shifted, zoomed, and flipped to create a diverse set of images. This helps the model learn better. Validation and test images are only normalized (scaled) to fit within a range of 0 to 1. Rescale images by 1/255 for training, validation, and testing datasets. figure [3] representing the two different class of images masked and Unmasked.

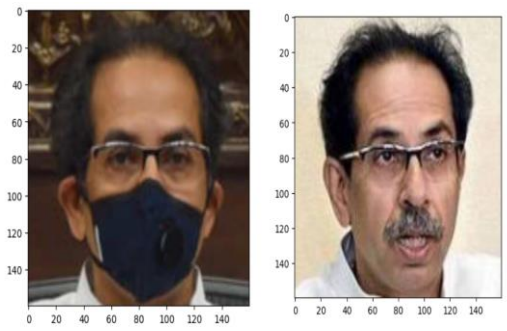

Figure 3-Masked and Unmasked Class of Images.

Pre-trained Model: We use ResNet50, a powerful model already trained on a large dataset (ImageNet). We remove its last few layers to customize it for our task. Includes layers like MaxPooling2D, GlobalAveragePooling2D, and Dense layers for the feature Extraction. Add Dense layer with softmax activation for multi-class classification.

Adding Custom Layers: We add layers on top of ResNet50 to make it suitable for masked face recognition. This includes pooling layers to reduce the size of the data and fully connected layers to make predictions.

At the process of model training, we did Fine-Tuning at the last 20 layers of ResNet50 are set to be trainable, meaning the model will learn to adjust these layers specifically for our task.The model is trained using the augmented data. We also use a learning rate scheduler to adjust how fast the model learns as training progresses. Compile the model using Adam optimizer, categorical cross-entropy loss. Below Figure [4] showing the user identification accuracy in the form of graphical representation with MFR-2 dataset.

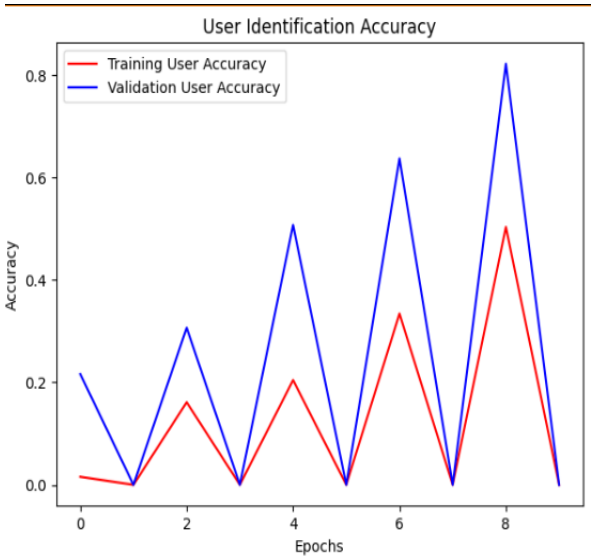

Figure 4-Masked face Identification accuracy

After training, the model is tested on the test dataset to see how well it can recognize faces with masks. We calculate accuracy, create a classification report (showing precision, recall, etc.), and generate a confusion matrix to evaluate how well the model is performing. Model Evaluation produced test result and finally get the actual image with identification of masked face. In table [1] The classification report includes key metrics that help us evaluate how well our model is performing in distinguishing between different classes, correctly identifying individuals with or without a mask.

Table 1- Classification Report for Masked Face Recognition

Index	Precision	Recall	f1-score	Support
0	1.00	1.00	1.00	4
1	1.00	1.00	1.00	5
2	1.00	0.50	0.67	4
3	1.00	0.67	0.80	3
4	1.00	1.00	1.00	6
5	1.00	1.00	1.00	4
6	1.00	0.50	0.67	2
7	1.00	1.00	1.00	6
8	1.00	0.83	0.91	6
9	0.39	1.00	0.56	7
10	1.00	1.00	1.00	6
11	1.00	1.00	1.00	5
Accuracy			0.82	254
Macro avg	0.83	0.77	0.78	254
Weighted avg	0.86	0.82	0.82	254

VII-RELATED DATASET

The MFR2 dataset is widely used in research focused on developing robust masked face recognition systems. Researchers often use this dataset to fine-tune pre-trained models, adapting them to better handle masked faces. Masked faces in real world for face recognition (MFR2) is a small dataset with 53 identities of celebrities and politicians with a total of 269 images. The MFR2 dataset contains a large and diverse collection of face images, including both masked and unmasked faces. This diversity is crucial for training models that need to generalize well across different individuals, environments, and mask types. We can see some images of MFR-2 dataset in figure [5].

Figure 5 -MFR-2 Masked and Unmasked dataset

The dataset is divided into two main classes: Masked and Unmasked images. This binary classification setup allows researchers to train and evaluate models on the specific challenge of distinguishing between faces with and without masks. Each image in the MFR2 dataset is labelled according to whether the subject is wearing a mask or not. This labelling is essential for supervised learning tasks where the goal is to classify or recognize faces based on these labels.

VIII-CONCLUSIONS

Masked face recognition is a highly challenging task due to the lack of facial feature information. Recognizing and authenticating people wearing masks has been a long-established research area, and more efficient methods are needed for real-time MFR. In this research paper, the pre-trained ResNet-50 model used MaxPooling layers to reduce the dimensionality of feature maps while retaining important information. The ResNet-50 model achieved an accuracy of 0.82 in identifying masked faces. This proposed method can also be extended to richer applications such as video retrieval and surveillance.

REFERENCES

[1] Md. S. Ejaz, Md. R. Islam, “masked face recognition using convolutional neural network,” International Conference on Sustainable Technologies for Industry, 4.0(STI),(2019-Dhaka, Bangladesh) ,pp.1-6,(2019).

[2] H. Vu1, M. Nguyen, C. Pham, “Masked face recognition with convolutional neural networks and local binary patterns”, Applied Intelligence, pp. 1573-7497,(2021).

[3] Deng, H.; Feng, Z.; Qian, G.; Lv, X.; Li, H.; Li, G, “MFCosface: A Masked-Face Recognition Algorithm Based on Large Margin Cosine Loss”. Appl. Sci., vol. 11, 7310, (2021).

[4] Yande Li, Kun Guo, Yonggang Lu, Li Liu, “Cropping and attention-based approach for masked face recognition,” Applied Intelligence, vol.51, pp.3012–3025, (Feb 2021).

[5] W. Hariri, “Efficient Masked Face Recognition Method during the COVID-19 Pandemic,” Signal, Image and Video Processing, vol.11, pp.1-8 (Nov 2021).

[6] Ejaz, M. S., Islam, M. R., Sifatullah, M., & Sarker, A. (2019, May). Implementation of principal component analysis on masked and non-masked face recognition. In *2019 1st international conference on advances in science, engineering and robotics technology (ICASERT)* (pp. 1-5). IEEE.

[7] N. Choudhary, P. Singh Rathore, L. Kumar, R. Rajaan, A. Sharma and D. Sinha, "ResNet-50 Powered Masked Face Detection: A Deep Learning Perspective," *2024 IEEE 9th International Conference for Convergence in Technology (I2CT)*, Pune, India, 2024, pp. 1-5, doi: 10.1109/I2CT61223.2024.10543563.

[8] Golwalkar, R., & Mehendale, N. (2022). Masked-face recognition using deep metric learning and FaceMaskNet-21. *Applied Intelligence*, *52*(11), 13268-13279

[9] Shukla, R. K., & Tiwari, A. K. (2023). Masked face recognition using mobilenet v2 with transfer learning. *Computer Systems Science & Engineering*, *45*(1).

[10] Nyarko, B. N. E., Bin, W., Zhou, J., Agordzo, G. K., Odoom, J., & Koukoyi, E. (2022, June). Comparative analysis of AlexNet, Resnet-50, and Inception-V3 models on masked face recognition. In *2022 IEEE World AI IoT Congress (AIIoT)* (pp. 337-343). IEEE.