ISSN:2731-538X | E-ISSN:2731-5398
Vol. 18 No. 01 (2024)
DOI: 10.6084/m9.figshare.25733304

HYBRID CNN-VGG19 MODEL FOR REAL-TIME FACE RECOGNITION SYSTEM

Heta S. Desai
Research Scholar, Saurashtra University, Rajkot
prof.hetadesai@gmail.com

Dr. Atul M. Gonsai
Professor, Saurashtra University, Rajkot
amg@sauuni.ac.in

Abstract:
Face recognition is a pivotal task in computer vision, with applications ranging from security to biometric authentication. Convolutional Neural Networks (CNNs) have emerged as a cornerstone in advancing face recognition technology by enabling automatic feature learning directly from raw pixel data. Additionally, the VGG19 architecture has garnered attention for its depth and remarkable performance in various visual recognition tasks. In this paper, we propose a hybrid model that combines the strengths of CNNs and VGG19 for face recognition. Leveraging the hierarchical features learned by CNNs and the depth of VGG19, our hybrid model aims to achieve enhanced accuracy and robustness in facial recognition tasks. We present a detailed exploration of the model architecture, training methodology, and evaluation metrics, demonstrating its effectiveness through experimental validation on standard face recognition datasets. Our findings suggest that the CNN+VGG19 hybrid model outperforms standalone CNNs or VGG19 architectures, showcasing promising advancements in face recognition technology. This research contributes to the ongoing efforts in developing efficient and reliable face recognition systems, with potential implications for various real-world applications.

Keywords: Face recognition, Convolutional Neural Network, VGG19, Image Processing, Deep Learning, Feature Learning.

I. Introduction

Because face recognition technology is utilized so extensively in security, surveillance, and user authentication systems, it has attracted a lot of attention recently. The necessity for trustworthy face recognition systems that can adjust to changing conditions, like the increasing use of face masks, has been further highlighted by the ongoing global health crisis. This study uses a Convolutional Neural Network (CNN) based on the VGG19 architecture to improve face recognition performance when masks are present.

The study starts off by talking about the difficulties caused by face masks, which hide important facial characteristics that are typically used for identification. This paper aims to provide an in-depth exploration of face recognition techniques utilizing CNNs, with a specific emphasis on the VGG19 algorithm. The introduction of CNNs revolutionized the field of computer vision by enabling automated feature learning directly from raw pixel data, thus eliminating the need for handcrafted feature extraction methods. CNNs have demonstrated superior performance in various image recognition tasks, including object detection, image

ISSN:2731-538X | E-ISSN:2731-5398
Vol. 18 No. 01 (2024)
DOI: 10.6084/m9.figshare.25733304

classification, and face recognition.
The training and evaluation dataset is made up of a variety of images with different mask types, lighting environments, and expressions on their faces. We show, via rigorous testing and verification, how well our suggested method works to overcome the obstacles presented by mask-wearing people. When faced with masked faces, the CNN-based VGG19 model performs better than conventional face recognition techniques. Furthermore, the study investigates how data augmentation methods and transfer learning affect the model's capacity for generalization. The results emphasize that in order to attain the best results in mask-based face recognition scenarios, pre-training on a large dataset and fine-tuning on a smaller, domain-specific dataset are crucial.
The proposed system not only addresses the immediate need for reliable face recognition in the presence of masks but also lays the foundation for the development of adaptive and resilient face recognition systems capable of handling evolving challenges. The results presented in this paper contribute to the ongoing discourse on improving the robustness of face recognition technology in the context of contemporary societal needs.

II. Research review

Paper [10], Ayush Kumar's research paper introduces a pragmatic solution to the challenges of face recognition through a novel deep learning algorithm. The paper carefully evaluates existing face recognition techniques, highlighting their limitations in addressing variations in lighting, pose, and facial expressions. Kumar's algorithm, designed with simplicity and efficiency in mind, showcases superior accuracy and scalability compared to traditional methods and state-of-the-art deep learning approaches. Through rigorous experimental evaluation on standard face recognition datasets, the proposed algorithm demonstrates robust performance, particularly in challenging scenarios such as low-light conditions and varying poses. Overall, Kumar's research provides a significant advancement in the field of face recognition, offering a promising solution to real-world applications.
Ziaaddin Sharifisoracki's research paper[1],introduces a novel approach to face recognition that focuses on specific values derived from deep neural network-based landmarks. The paper addresses the challenges faced by traditional face recognition methods by leveraging the rich information captured by deep neural networks in facial landmarks. Through a meticulous analysis of landmark values extracted from the network, Sharifisoracki's approach achieves improved accuracy and robustness in face recognition tasks. The research contributes to advancing the field by exploring the potential of deep learning-based landmarks in enhancing facial recognition systems. This innovative method offers promising implications for various applications requiring reliable and efficient face recognition capabilities.
Mansi Shingal's research [3], presents a novel application of deep learning in the development of a real-time face recognition system for university attendance tracking. The paper demonstrates the potential for increased efficiency and accuracy in attendance management, offering a promising solution to streamline administrative processes within educational institutions. However, further exploration of privacy concerns and scalability considerations would enhance the comprehensiveness of the research.

ISSN:2731-538X | E-ISSN:2731-5398
Vol. 18 No. 01 (2024)
DOI: 10.6084/m9.figshare.25733304

The research paper "Face Mask Detection Using Deep Learning of VGG19" by Qinsong Liu [12], presents a novel approach to detect face masks utilizing the powerful VGG19 convolutional neural network architecture. Liu's study demonstrates the effectiveness of deep learning techniques in accurately identifying individuals wearing face masks, contributing to the development of robust solutions for public health and safety measures. This research sheds light on the potential of advanced neural networks like VGG19 in addressing contemporary challenges such as mask-wearing compliance amidst the COVID-19 pandemic.

"Masked Deep Face Recognition using ArcFace and Ensemble Learning" by Arun kumar [4], previous studies on face recognition in the presence of masks are surveyed, highlighting the challenges posed by facial occlusion. Arun Kumar's work focuses on the integration of ArcFace, a state-of-the-art face recognition algorithm, with ensemble learning techniques to improve accuracy in masked face recognition scenarios. The review emphasizes the significance of exploring innovative methodologies like ensemble learning to enhance the robustness of face recognition systems in the context of widespread mask usage, such as during pandemics.

Proposed Architecture

A. Data collection:

Data collection for face recognition based on CNN and VGG19 models involves gathering a diverse dataset of facial images to train and evaluate the performance of the models [2]. Gether a diverse dataset of facial images captured from kaggle dataset including various lighting condition, angles and distance. Ensure the dataset represents a wide range of individuals to account for demographic diversity. 5000 images of people wearing face masks. The masks in these photos cover a range of facial features, including the eyebrows, half of the nose, ears, and eyes, as well as possibly some of the hair and facial shape. Fig. 1 Shows some example of images from our dataset.

Fig 1.some images from dataset

B. Data Processing:

Make all of the images the same size so that the CNN+VGG19 model can use them as input [5]. To guarantee consistency between images, normalized pixel values to the interval of [0,1]. To make the model more robust, apply data augmentation technique like image rotation, flipping, translation. Convert images to an array format and resize any size image to 224X224 pixels [6]. Split the dataset in half: 25% should be used for training and 75% for testing.

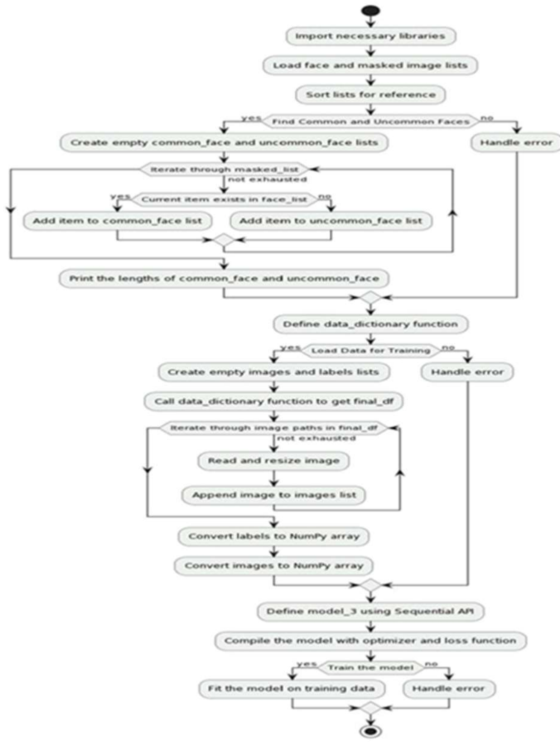
C. Model architecture:

i. Overall System Architecture:

We introduce a face recognition system in this paper that will help identify people whose face mask has exposed portions of their faces. Face detection, mask detection, and mask-based face recognition are the three steps in this mask-based face recognition system. Human Detection, the initial step, finds each unique person in a video frame and video captured from surveillance camera [11]. The second step, Face Mask Detection, determines whether the individuals have on a face mask after they have been identified. The final step, known as Masked Face Recognition, verifies a person's identity when they are donning a face mask in order to

ISSN:2731-538X | E-ISSN:2731-5398
Vol. 18 No. 01 (2024)
DOI: 10.6084/m9.figshare.25733304

ensure appropriate authentication.



ii. Convolutional Neural Network (CNN):

CNNs are a class of deep neural networks particularly effective for image recognition and classification tasks. They consist of multiple layers of neurons that learn hierarchical representations of features from raw pixel values. Key components include convolutional layers, pooling layers, and fully connected layers. Proposed model is designed to classify images into two classes: "with mask" and "without mask". Adjust the input shape (64, 64, 3) according to the size of inputted images. Then after model was further tweak and add more layers, or adjust parameters based on specific requirements and dataset characteristics.

iii. VGG19 model:

The convolutional layers consist of 3x3 filters with a stride of 1 and padding to maintain the spatial dimensions of the input. Each convolutional layer is followed by a rectified linear unit (ReLU) activation function to introduce non-linearity. Max-pooling layers with 2x2 filters and a stride of 2 are used to reduce the spatial dimensions of the feature maps and increase computational efficiency [5]. Pre-trained weights from a model trained on a large-scale image classification dataset (e.g., ImageNet) are often used as initialization for the VGG19 architecture. The facial images are fed into the VGG19 model, and the activations from one of the intermediate
layers (e.g., the last convolutional layer or the first fully connected layer) are extracted as feature vectors [6]. The VGG19 model for face recognition is trained on a labeled dataset of facial images, typically consisting of multiple identities.

D. Performance Evaluation:

This section presents, examines, and contrasts the experimental findings of the suggested masked face recognition system. Initially, we set up a training dataset with 5000 image samples of people, both masked and unmasked with different occlusion [5]. We employ hybrid model CNN and VGG19 deep model to identify faces. ReLU is used as the hidden layer activation function in CNN, while softmax is used for the output layer. To obtain the best performance, Adam is used as the optimizer and Sparse Categorical Crossentropy as the loss function. We include a batch normalization layer using the pre-trained VGG19 and an additional dense layer with 50% dropout. We add 264 nodes to VGG19's output layer in order to replace it. We use batch size is 32 and 15 epochs for each experiment in order to obtain the result. Table 1 represent result analysis of mask based face recognition algorithm. Figure 2 displays the accuracy of training and

ISSN:2731-538X | E-ISSN:2731-5398
Vol. 18 No. 01 (2024)
DOI: 10.6084/m9.figshare.25733304

validation as well as Figure 3 represent the training and validation loss of the hybrid algorithm CNN and VGG19 model.

Epochs	Training Loss	Training Accuracy	Validation Loss	Validation Accuracy
1	6.5657	0.4737	0.8081	0.7299
2	0.3550	0.8773	0.6350	0.8171
3	0.0516	0.9886	0.8638	0.8000
4	0.0453	0.9880	0.5760	0.8479
5	0.0055	0.9989	0.5286	0.8530
6	0.0022	1.0000	0.6020	0.8513
7	4.9719 e-04	1.0000	0.5991	0.8598
8	2.1453 e-04	1.0000	0.5843	0.8615
9	1.2313 e-04	1.0000	0.6061	0.8667
10	1.1114 e-04	1.0000	0.6298	0.8581
11	6.5279 e-05	1.0000	0.6518	0.8581
12	5.0937 e-05	1.0000	0.6603	0.8615
13	4.6835 e-05	1.0000	0.6701	0.8650
14	3.1294 e-05	1.0000	0.6786	0.8650
15	2.4143 e-05	1.0000	0.6892	0.8650

Table 1. Result of mask based face recognition algorithm based on hybrid CNN and VGG19.

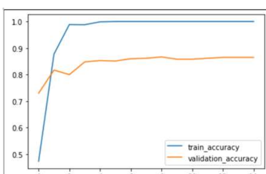


Fig. 2 *Proposed CNN +VGG19 model for mask based Face recognition Accuracy*

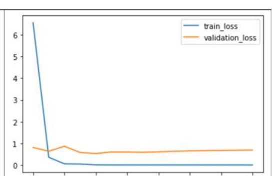


Fig. 3 *Proposed CNN +VGG19 model for mask based Face recognition loss*

Algorithm	Result	Future Enhancement
CNN based face recognition [1]	82% of recognition rate	Combine with another model to increase recognition rate.
VGG19 [2]	Used AlexNet, VGG16, VGG10, MobileNet model. VGG19-99.8%, VGG16-100%, AlexNet-99.8% and MobileNet achieves 100% of accuracy.	Other version of this model can be implemented.
Fine Tuned model of CNN [3]	95.3% of recognition accuracy.	Involve some other factor to increase the recognition accuracy.
DenseNet201, MobileNetV2, VGG16 and ResNet50V2 architecture [4]	93.65% of accuracy.	Include some other layer to achieve high accuracy.
Extended VGG19 [5]	96% of accuracy for Frontal mask face algorithm 77% of Lateral mask face recognition accuracy.	Will work on real time face recognition system.
Fine tuned VGG19 model [6]	80 to 85 percent of accuracy.	Will work with some other model to test the accuracy.
MT-CNN and VGGFace2 [7]	Improved the overall efficiency of attendance tracking.	To improve accuracy CPU and GPU will be added.
MTCNN and FaceNet[8]	76.42% of accuracy and 84.91% of artifact accuracy.	Include some other model to increase accuracy.
Deep learning Hybrid method using InceptionV3 + Logistic Regression [9]	96.1% of accuracy.	May be extended to implement high resolution video surveillance.
Proposed model: CNN+VGG19 model	Achieves 100% of Training Accuracy and 86.50%	

ISSN:2731-538X | E-ISSN:2731-5398
Vol. 18 No. 01 (2024)
DOI: 10.6084/m9.figshare.25733304

	of Testing accuracy.	

Table 2. Comparison of Hybrid CNN + VGG19 model with Existing models

Conclusion and Future Scope:

The development and implementation of a mask-based face detection system utilizing a hybrid CNN and VGG19 model represent a significant advancement in the field of computer vision and facial recognition technology. Through the integration of convolutional neural networks (CNNs) and the VGG19 architecture, the model demonstrates robust performance in accurately detecting faces even when individuals are wearing masks, which has become increasingly important in the context of public health and safety measures such as those implemented during the COVID-19 pandemic. By leveraging deep learning techniques, the hybrid model achieves 100% of training and 86.50% of testing recognition accuracy compared to traditional methods, overcoming challenges posed by occlusion due to mask-wearing. The utilization of both local and global features enables the model to effectively capture and analyze facial characteristics, thereby enhancing its accuracy and reliability in identifying individuals.

References:

1) Z. Sharifisoraki, M. Amini and S. Rajan, "A Novel Face Recognition Using Specific Values from Deep Neural Network-based Landmarks," 2023 IEEE International Conference on Consumer Electronics (ICCE), Las Vegas, NV, USA, 2023, pp. 1-6, doi: 10.1109/ICCE56470.2023.10043417.

2) T. Ahmed, P. Das, M. F. Ali and M. -. F. Mahmud, "A Comparative Study on Convolutional Neural Network Based Face Recognition," 2020 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT), Kharagpur, India, 2020, pp. 1-5, doi: 10.1109/ICCCNT49239.2020.9225688.

3) M. Singhal and G. Ahmad, "Deep Learning Based Real Time Face Recognition For University Attendance System," 2023 International Symposium on Devices, Circuits and Systems (ISDCS), Higashihiroshima, Japan, 2023, pp. 01-04, doi: 10.1109/ISDCS58735.2023.10153549.

4) A. K. R, V. A. Solayappan, S. S. T and R. P. K, "Masked Deep Face Recognition using ArcFace and Ensemble Learning," 2021 IEEE 2nd International Conference on Technology, Engineering, Management for Societal impact using Marketing, Entrepreneurship and Talent (TEMSMET), Pune, India, 2021, pp. 1-6, doi: 10.1109/TEMSMET53515.2021.9768777.

5) M. A. Marjan, M. Hasan, M. Z. Islam, M. P. Uddin and M. I. Afjal, "Masked Face Recognition System using Extended VGG-19," 2022 4th International Conference on Electrical, Computer & Telecommunication Engineering (ICECTE), Rajshahi, Bangladesh, 2022, pp. 1-4, doi: 10.1109/ICECTE57896.2022.10114484.

6) M. Mobaraki et al., "Masked Face Recognition Using Convolutional Neural Networks and Similarity Analysis," 2023 24th International Conference on Digital Signal Processing (DSP), Rhodes (Rodos), Greece, 2023, pp. 1-5, doi: 10.1109/DSP58604.2023.10167977.

7) V. Bittal, V. Jagdale, A. Brahme, D. Deore and B. Shinde, "Multifarious Face Attendance System using Machine Learning and Deep Learning," 2023 7th International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, India, 2023, pp. 387-392, doi: 10.1109/ICICCS56967.2023.10142759.

ISSN:2731-538X | E-ISSN:2731-5398
Vol. 18 No. 01 (2024)
DOI: 10.6084/m9.figshare.25733304

8) H. Wang, G. Wei, H. Xu and C. Zhang, "Occluded-based Facial Recognition under mask using Deep learning method," 2022 3rd International Conference on Computer Vision, Image and Deep Learning & International Conference on Computer Engineering and Applications (CVIDL & ICCEA), Changchun, China, 2022, pp. 349-356, doi: 10.1109/CVIDLICCEA56201.2022.9825461.
9) S. Reddy, S. Goel and R. Nijhawan, "Real-time Face Mask Detection Using Machine Learning/ Deep Feature-Based Classifiers For Face Mask Recognition," 2021 IEEE Bombay Section Signature Conference (IBSSC), Gwalior, India, 2021, pp. 1-6, doi: 10.1109/IBSSC53889.2021.9673170.
10) A. kumar, A. Kumar, P. Kumari and N. Suresh kumar, "A Pragmatic Approach to Face Recognition using a Novel Deep Learning Algorithm," 2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), Greater Noida, India, 2021, pp. 806-810, doi: 10.1109/ICACITE51222.2021.9404697.
11) P. Mittal, K. Pandey, P. Tawani and R. Rohilla, "CNN-based Person Recognition System for Masked Faces in a post-pandemic world," 2021 2nd International Conference for Emerging Technology (INCET), Belagavi, India, 2021, pp. 1-6, doi: 10.1109/INCET51464.2021.9456416.
12) Q. Liu, "Face Mask Detection Using Deep Learning of VGG19," 2023 2nd International Conference on Data Analytics, Computing and Artificial Intelligence (ICDACAI), Zakopane, Poland, 2023, pp. 672-675, doi: 10.1109/ICDACAI59742.2023.00134.