International Journal of Advance Research and Innovation
Vol. 9(2), Apr-Jun 2021, pp. 103-107
Doi: 10.51976/ijari.922116
www.gla.ac.in/journals/ijari

Article Info

Received: 03 Feb 2021 | Revised Submission: 28 Mar 2021 | Accepted: 05 Apr 2021 | Available Online: 15 Jun 2021

Face Mask Detection using Convolutional Neural Networks

Amrit Singh , Chirag Wadhwa**, Ritik Kedia*** and A. K. Madan*****

ABSTRACT

COVID-19 pandemic has rapidly affected our day-to-day life disrupting the world trade and movements. Wearing a protective face mask has become a new normal. Soon, many public service providers will ask the customers to wear masks correctly to avail of their services. Therefore, face mask detection has become a crucial task to help global society. This paper presents a simplified approach to achieve this purpose using some basic Machine Learning packages like Tensor Flow, Keras, Open CV and Scikit-Learn. The proposed method detects the face from the image correctly and then identifies if it has a mask on it or not. As a surveillance task performer, it can also detect a face along with a mask in motion. The method attains accuracy up to 92.75%. We explore optimized values of parameters using the Sequential Convolutional Neural Network model to detect the presence of masks correctly.

Keywords: *COVID-19; Face mask; Haar cascade; Tensor flow; Open CV; Raspberry PI.*

1.0 Introduction

According to the World Health Organization (WHO)'s official Website, coronavirus disease 2019 (COVID-19) has globally infected over 160 million people causing over 3 million deaths. Individuals infected with COVID-19 have had a wide array of symptoms reported – going from levity manifestations to serious illness. People having asthma/lung disease are at a much greater risk compared to people not having such respiratory diseases. Elder people having lung disease can possess serious complications from COVID-19 illness as they appear to be at higher risk.

Some common human coronaviruses that infect people around the world are OC43, HKU1 and 229E. Before reaching to humans, viruses like 2019-nCoV, SARS-CoV infect wild animals and evolve to human viruses. Public with respiratory diseases can expose anyone near close contact to them to virus carriers. To subjugate the coronavirus, it is critical to always wear a clinical mask in public and maintain social distance. A Face Mask is a direct way of circumventing the virus.

1.1 Tensor flow

TensorFlow, an interface for expressing machine learning algorithms, is utilized for implementing ML systems into fabrication over a bunch of areas of computer science, including sentiment analysis, voice recognition, geographic information extraction, computer vision, text summarization, information retrieval, computational drug discovery and flaw detection to pursue research.

In the proposed model, the whole Sequential CNN architecture (consists of several layers) uses TensorFlow at backend. It is also used to reshape the data (image) in the data processing.

1.2 Keras

Keras is an API designed for human beings, not machines. Keras follows best practices for reducing

**Corresponding author; Department of Mechanical Engineering, Delhi Technological University, Delhi, India (E-mail: amrit1438@gmail.com)*
***Department of Mechanical Engineering, Delhi Technological University, Delhi, India (E-mail: chiragwadhwa23@gmail.com)*
****Department of Mechanical Engineering, Delhi Technological University, Delhi, India (E-mail: ritikkedia47@gmail.com)*
*****Department of Mechanical Engineering, Delhi Technological University, Delhi, India (E-mail: ashokmadan79@gmail.com)*

cognitive load. Keras gives fundamental reflections and building units for creation and transportation of ML arrangements with high iteration velocity.

It takes full advantage of the scalability and cross-platform capabilities of Tensor Flow. The core data structures of Keras are layers and models. All the layers used in the CNN model are implemented using Keras. Along with the conversion of the class vector to the binary class matrix in data processing, it helps to compile the overall model.

1.3 Open CV

OpenCV (Open-Source Computer Vision Library), an open-source computer vision and ML software library, is utilized to differentiate and recognize faces, recognize objects, group movements in recordings, trace progressive modules, follow eye gesture, track camera actions, expel red eyes from pictures taken utilizing flash, find comparative pictures from an image database, perceive landscape and set up markers to overlay it with increased reality and so forth. The proposed method makes use of these features of OpenCV in resizing and color conversion of data images.

2.0 What is Face Detection?

The goal of face detection is to determine if there are any faces in the image or video. If multiple faces are present, each face is enclosed by a bounding box and thus we know the location of the faces.

Figure 1: Face Mask Detection

Human faces are difficult to model as there are many variables that can change for example facial expression, orientation, lighting conditions and partial occlusions such as sunglasses, scarf, mask etc. The result of the detection gives the face location parameters, and it could be required in various forms, for instance, a rectangle covering the central part of the face, eye centers or landmarks including eyes, nose and mouth corners, eyebrows, nostrils, etc.

The main aim of this paper is to develop an algorithm which could identify whether a person is wearing a face mask or not. This would not only help in curbing the disease, but also reduce human effort in identifying whether the visitor’s nose and mouth are covered or not. As we proceed with this paper, the next section covers a review of the existing literature, where we have identified how we can use this technology to create the above discussed model. Further, in the advancing sections we have discussed the dataset taken and the model in detail.

2.1 Literature review

This section identifies the papers in which a similar technology was used in different applications. This helped us not only find the advantages and limitations of the proposed methodology but also gave us an insight on the existing research which has been conducted in this domain.

Brimblecombe [1] in their study conducted a survey of some different approaches to facial recognition using Neural Networks. They discussed various parameters to confirm an optimal set of operational parameters. They concluded that the system developed by Sanner [2] was indicative of some more complex detectors. Facial recognition has now been extensively used in the industry. It has been used in cameras, to enhance the art of photography and used for security purposes. There exist apps like Snapchat, Instagram, which use this technology for creating filters to enhance images.

Kwolek [3] in their paper proposed a method for detecting facial recognition by combining a Gabor filter and a convolutional neural network. This approach presented better results compared to the ones obtained by the convolutional neural network alone.

Naufal [4] in their study depicted the comparison of classification of the various ML algorithms which can be integrated for image classification for face masks detection. They compared the performance of KNN, SVM and CNN in face mask detection. It was found that CNN has the best performance with highest accuracy. They concluded that even though KNN and SVM had faster execution times, but CNN is advisable as it has better performance and accurate results.

In a similar study published recently, 7 deep learning algorithms were used along with TensorFlow framework in OpenCV library which is quite like our study [5]. An overall 98% accuracy was obtained for their model.

The upcoming technology of neural networks and deep learning has also found its application in understanding cartoon emotion [6]. In this study, Deep Neural Network (DNN) approach has been integrated that deals with recognizing emotions from cartoon images. To classify emotions, VGG 16 outperforms others with an accuracy of 96%. Their proposed integrated DNN approach outperforms the state-of-art approaches.

During the pandemic, apart from face masks using sanitizers time to time is also necessary to avoid infection. A recent study proposed a model based on AI for face mask detection and sanitizer dispenser [7]. Their proposed model uses Machine Learning alongside the neural network to finalize the output whether the mask is present or not. Once the mask is detected, then the hand sanitizer is dispersed. Such models are necessary to curb COVID-19.

The motivation behind this study is to help the humanity fight the disease. Therefore, we have proposed a model to reduce human effort which is currently required to ensure that people are wearing masks in public places. Our model will allow entry to visitors in public places only when the mask is detected.

2.2 Dataset

Two datasets have been used for experimenting the current method. The first data set consists of 1,376 images in which 690 people wearing face masks and the rest are the people without a face mask. This set mostly contains front face pose with single face in the frame and with the same type of mask having white color only.

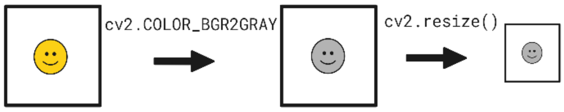
Dataset 2 consists of 853 images and its described as either a mask or without as mask. In this set, some face collections are head turn, tilt, and slant with multiple faces in the frame and different types of masks having different colors as well.

2.3 Algorithm

The proposed method consists of a cascade classifier and a pre-trained CNN which contains two 2D convolution layers connected to layers of dense neutrons.

This helped us not only find the advantages and limitations of the proposed methodology but also gave us an insight on the existing research which has been conducted in this domain.

Figure 2: Converting Image to Gray Scale and Resizing



2.3.1 Input

Dataset consisting of faces with and without mask

2.3.2 Output

Categorized image depicting the presence of face mask for each image in the dataset do

- Dividing the image in two types and label them.
- RBG image to greyscale image
- Images resize to 400x400
- Image Normalization to a 4D Array end for building the CNN model do
- Add a convolution layer of 200 filters.
- Add the second convolution layer of 100 filters.
- Insert the flatter layer to the network classifier.
- Add a dense layer of 64 neurons.
- Add the final dense layer with 2 outputs for 2 types.

3.0 Methodology

To train a custom face mask detector, we need to break our project into two distinct phases, each with its own respective sub-steps (as shown in the figure above):

(1) Training: Here we will focus on loading our face mask detection data set from disk, training a model (using Keras/TensorFlow) on this data set, and then serializing the face mask detector to disk.

(2) Deployment: Once the face mask detector is trained, we can then move on to loading the mask detector, performing face detection, and then classifying each face as with mask or without mask

Allow 12 pts spacing between the table title and the table (or between the figure and its caption). The equal spacing is allowed between the table or figure and the following text.

Figure 3: Adding Convolution Layers

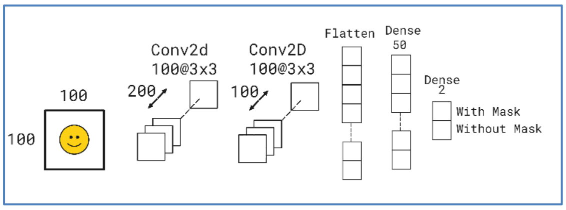


Figure 4:Process in a Nutshell

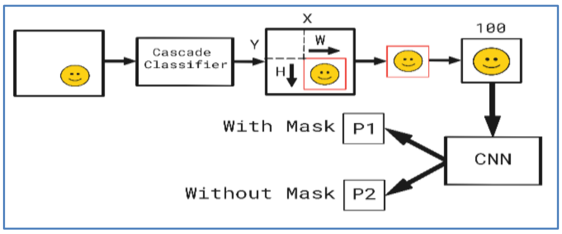
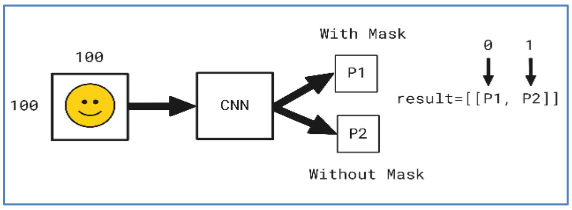


Figure 5: Output



6.0 Hardware Used

The following hardware was used in the proposed model.

- Raspberry Pi 3 Model B
- Raspberry Pi Camera Module
- Non-Contact Infrared Temperature Sensor Module
- Computer Monitor
- Basic Peripherals (Keyboard, Mouse)

Figure 6: Setup Circuit

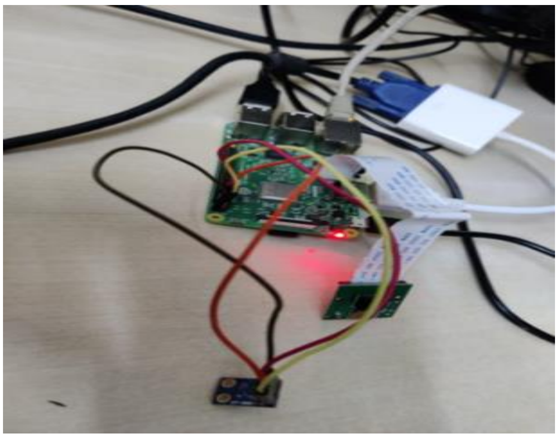
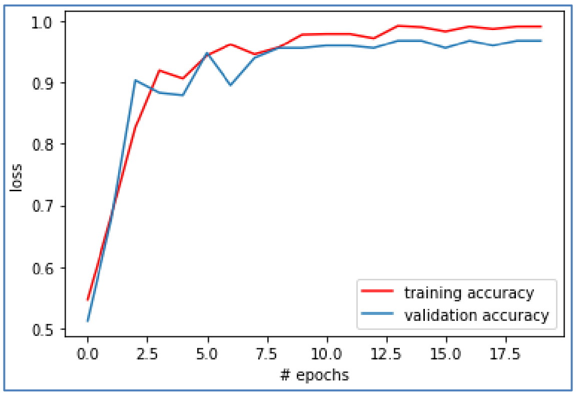


Figure 7: Loss and Accuracy



7.0 Conclusions

The training accuracy of the proposed model is up to 92.75% in different scenarios. Although, we have noticed that for the correct detection of the human face, it should be somewhat close to the capturing device with suitable lighting present in the room where the setup is situated. We strive to find the optimum distance required by the capturing device to check the presence of face mask at once in future research by fine tuning some parameters.

It is high time now we should design and fully bring an automated coronavirus testing robot in the market as the cases are rising day-by-day. Our primary goal is to get rid of the manual testing of people with symptoms and our secondary goal is to restrict or isolate the spread of the virus, if not that at least minimize the spread. Large-scale testing is an essential solution to combat this pandemic, but it must be done safely and effectively. The robot can test around the clock doing the dangerous job, preventing cross-infection, and helping to open borders and reboot the economies safely. It will help fight highly infectious diseases in the future also if there is another pandemic which is highly likely focusing on the ongoing lifestyle of humans. Allowing large-scale specimen collection safely in places like airports, borders, or medical, institutions will help contain infections and re-opening the economies and bring back to normal lives in the world. Large-scale testing requires hundreds of medical staff, the robot can reduce putting personnel at risk, so the medical systems does not collapse.

As the vaccination drive is going on at a full scale, people will start being ignorant about social distancing and Face Mask. Hence, deploying the proposed model in public places will ensure safety.

Nomenclature

API	Application Programming Interface
CNN	Convolutional neural network
ML KNN	Machine Learning K-Nearest Neighbours
SVM	Support Vector Machine
VGG	Visual Geometry Group
DNN	Deep Neural Networks
2D	Two Dimensional
4D	Four Dimensional

References

[1] P Brimblecombe. Face detection using neural networks. H615–Meng Electronic Engineering, School of Electronics and Physical Sciences, URN, 1046063, 2002.

[2] S Sanner. Rowley-Baluja-Kanade Face Detector. http://www.cs.toronto.edu/~ssanner/ Software/Vision/Project.html

[3] B Kwolek. Face detection using convolutional neural networks and Gabor filters. In International Conference on Artificial Neural Networks 9, 2005, 551-556.

[4] MF Naufal, SF Kusuma, ZA Prayuska, AA Yoshua, YA Lauwoto, NS Dinata, D Sugiarto. Comparative Analysis of Image Classification Algorithms for Face Mask Detection. Journal of Information Systems Engineering and Business Intelligence, 7(1), 2021 56-66.

[5] V Pellakuri. Image Analysis on Individual Identification of Face Mask Monitoring Using Convolutional Neural Network. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12(9), 2021, 31-36.

[6] N Jain, V Gupta, S Shubham, A Madan, A Chaudhary, KC Santosh. Understanding cartoon emotion using integrated deep neural network on large dataset. Neural Computing and Applications, 2021, 1-21.

[7] V Mano, I Priya Tharini, M Rajkumar, M Eswaran, K Yadhari. AI based face mask detection and sanitizer dispenser. International Research Journal of Modernization in Engineering Technology and Science, 3(4), 2021, 989-994.