How to Cite:
Agarwal, S., Patra, J. P., & Swarnkar, S. K. (2022). Convolutional neural network architecture based automatic face mask detection. *International Journal of Health Sciences*, *6*(S3), 623–629. https://doi.org/10.53730/ijhs.v6nS3.5401

Convolutional Neural Network Architecture Based Automatic Face Mask Detection

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***Abstract*---**The pandemic of COVID – 19 has affected the whole world very badly. It has rapidly affected the way of living as wearing a protective or surgical face mask is new normal. It is necessary to wear a mask before entering a shop or any public place to avail of their services. Therefore, there is a need for face mask detection to help society. In this paper, we are presenting a simplified technique that detects whether a person is wearing a mask or not automatically with percentage accuracy of the fitment of the mask over the face. This technology can be used to stop the entry or warn the person to wear a mask properly before or while entering a shop or any public place. This purpose is achieved using OpenCV, Keras packages and convolutional neural network architecture (MobileNetV2). The accuracy of the face mask detection system is 96.07%.

***Keywords*---**COVID-19, corona-virus precaution, face-mask detection, mobilenetV2, OpenCV.

Introduction

Coronavirus disease (COVID–19) pandemic originated in Wuhan, China[1]. It created a huge panic across all countries as it was declared a deadly disease on

March 11, 2021, by the World Health Organization (WHO). According to WHO's Report, COVID – 19 has affected around 352 million people causing around 5 million deaths as of January 21, 2022[2]. In addition to this, it can cause the common cold, severe acute respiratory syndrome (SARS), and the Middle East respiratory syndrome (MERS). The various symptoms of COVID-19 are fever, cough, tiredness, loss of smell, etc. The virus spreads through the air when an infected person sneezes, coughs, or talks the tiny droplets from infected person's mouth or nose travel through the air to another person's lungs and thus causing infection. Based on the guidelines of the World Health Organization wearing a clinical or surgical face mask is a key weapon to be protected against COVID -19. Wearing a face mask has been mandated by government [3]. Hence automatically detecting a face mask is a real-time and interesting problem using computer vision. This Automatic Face Mask Detection system first detects the face and then determines whether the face is covered with a mask or not. In addition to determining the mask on the face, it even tells whether the mask is properly worn (covering the mouth and nose) with the percentage of the mask covering the mouth and nose. Also, it can detect masks on multiple faces rather than a single face.

Background

We saw a model for detecting real-time face mask OpenCV and it was implemented through Haar classifier through Raspberry pi BCM2385 CPU processor which is a combination of SoC & GPU based architecture. The author provided the solution by basically identifying edge, line, and center-surround features (mouth, nose, eyes) and if these are hidden in a face it understands that the person has worn a mask [4]. Detecting COVID-19 Face mask using TensorFlow, Keras & OpenCV. This method categorizes the image depicting the presence of a face mask. It converts the RGB image to grayscale and reshapes it & uses CNN with a convolutional layer of 200 filters with a dense layer of 64 neurons and provides the image with 2 categories (wearing a mask and not wearing a mask) [5]. A model of Haar Cascades for Face Mask Detection which it uses a haar cascade algorithm to detect features of the face (like eyebrows, a bridge between both eyes & lips, etc.) The haar feature traverse from the top left of the image it finds the sudden change in color in the grayscale image[6]. Another method for Real-Time face mask detection using Deep Learning has been trained and compiled with 2 CNN for differential accuracy to choose the best for this type of model[7].

Methodology

The system uses the MobileNetV2 model which is a class of CNN (Convolutional Neural Network) and it is TensorFlow's first mobile computer vision model and is also open-sourced by Google. The main reason to use MobileNetV2 architecture it splits the convolutional into 3x3 depth-wise Conv and 1x1 point-wiseConv whereas in traditional CNN it has a single 3x3 convolutional layer followed by the batch norm & ReLU. Also, it reduces the number of parameters used compared to convolution with the regular network. Resulting in a light neural network.

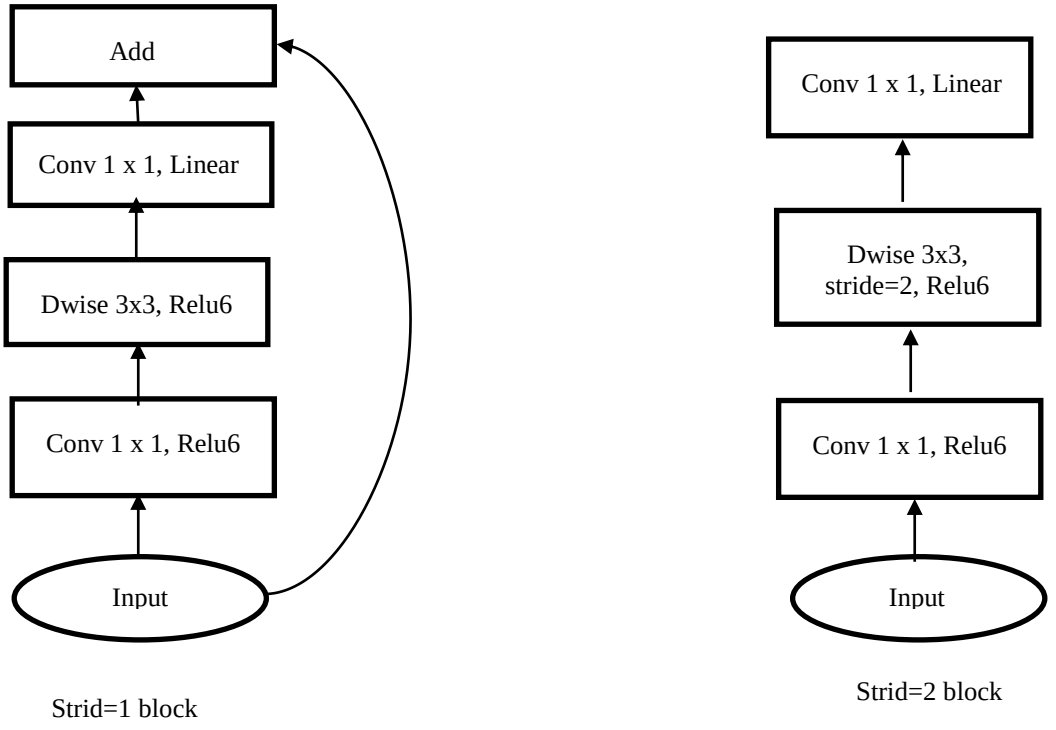

Fig 1 – MobileNetV2 Architecture

It has 53 convolution layers with an Inverted & Bottleneck Residual block. There are various layers added to the model:

- Max Pooling– This layer calculates the value for all patches in a feature map that is downsampled. The main reason to use Max pooling over average pooling it produces large pixel values (taking max values in some blocks rather than average values.)
- Flatten – This layer is used to convert the pooled feature map into a single column.
- Dropout – This layer prevents overfitting setting the input value to 0 on a random basis during training.
- The process through which this model is built and the result has been taken consists of various steps which include the first and foremost step in building any model or project is collecting the data to experiment on. For an automated face mask detection model with percentage accuracy, we have categorized data into two parts one with a mask and another without a mask. For the study, we took 2165 images of a person with masks and 1932 images without a mask and the image is cropped to such an extent that only the face part of the image is visible to train the model accurately with labeling the images according to their feature.
- Pre-Processing - After the collection of data, we need to perform some tasks on the images so that detection of face masks can be executed. We resized the image to 244 * 244 pixels so that the model can run more accurately on that particular dataset. The step after resizing is to convert them into an

array dataset this makes the dataset ready for MobileNetV2 architecture.The last and most important step was to perform hot encoding on the labeled dataset to treat categorical data parameters easily. It will make separate columns for both masks and not mask images and whenever there is an image with a face mask it will input it as 1 and if in the image there is no mask on the face it will input it as 0.In the next step after the processing the dataset is split into training and testing data, and in this case, it is done in 7:3 i.e. 70% data for training and 30 % of data reserved for testing purposes.

- Model - Before implementing the image augmentation of Image Data Generator class in Keras library which can produce real-time image augmentation. Image Augmentation is used for transforming images (alteration, rotation, random shifts, zooming, flipping, etc.) which ultimately helps to train deep learning models. We use the Image Data Generator to scale and normalize the data/images.After the creation of the Image data generator, the base model MobileNetV2 is created. All the data which is created using an image data generator is put into the model for training of the model.

Training– Once the model is ready after the compilation of data, we train the model using the dataset. As mentioned, we used 70 % of the data for training. After the training is completed, we test the model with the rest of the data which is 30% of the data.After this step, the model is ready for evaluation.

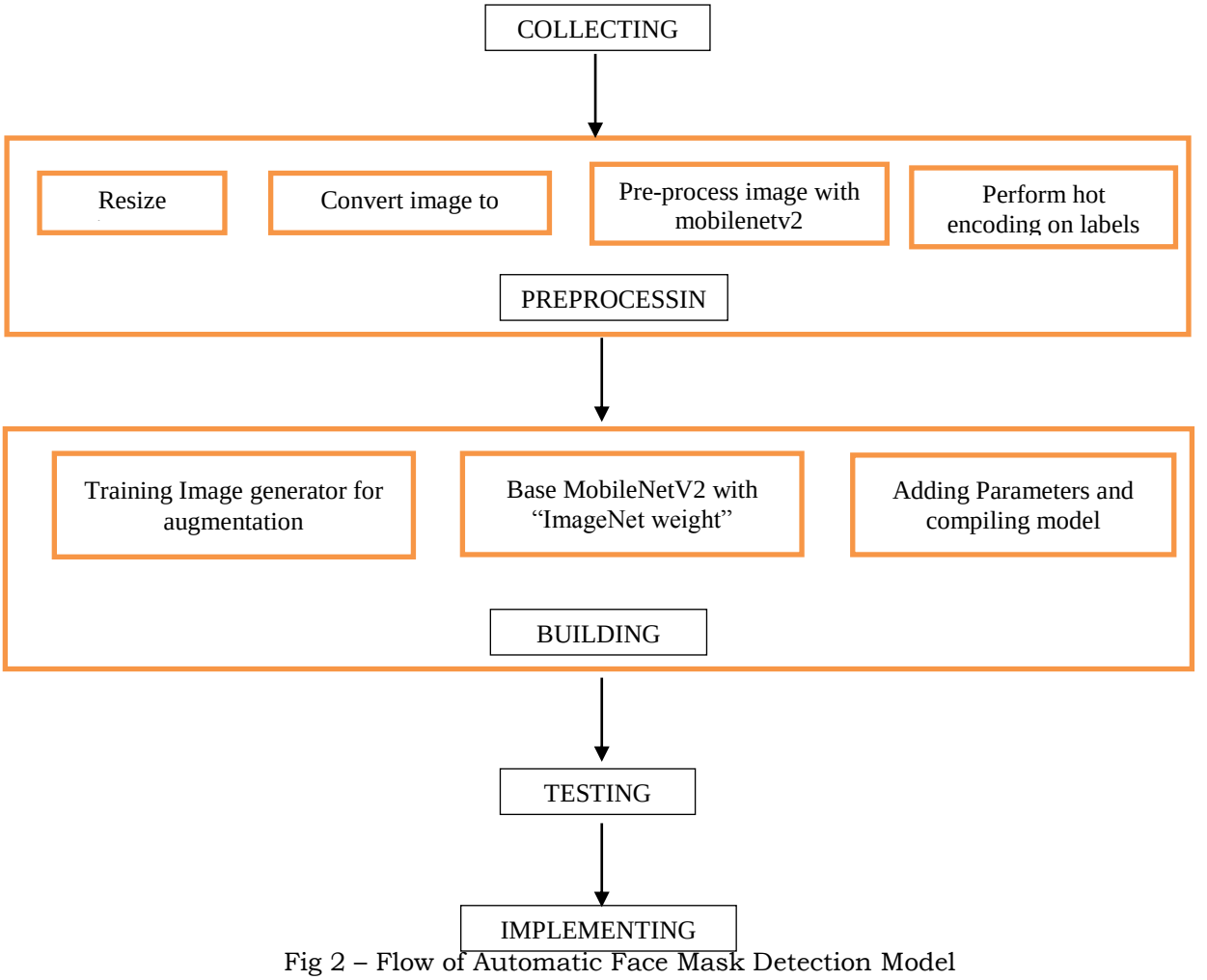

Fig 2 – Flow of Automatic Face Mask Detection Model

Implementation

The proposed model focuses on detecting the mask on the face of a person with the percentage accuracy with which the mask is worn (covering the mouth and nose properly) using MobileNetV2 architecture. The model reads the face from the video frame by frame and this video stream comes from a webcam. First, it detects the face from the video frame through OpenCV and adds a bounding rectangle around the detected face. After the detection processing of the image will be carried out in which it will be resized &converted into an array. The final step is detecting the face mask from the built model. After the prediction, the result will be shown above the rectangular mark on the video frame as shown in Figures 3 & 4.

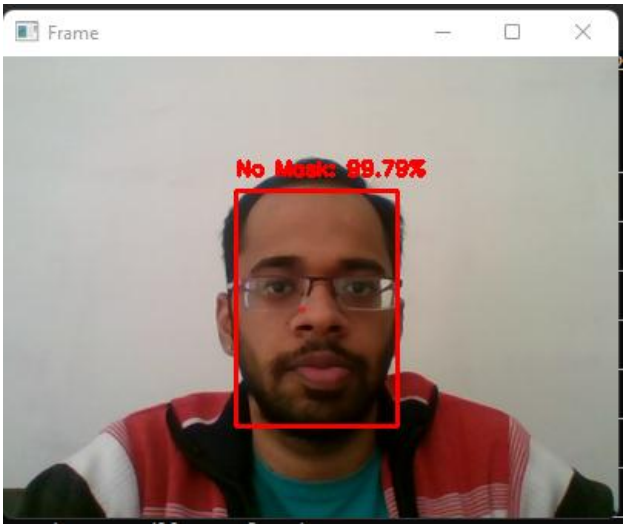

Fig 3 - Face without a mask

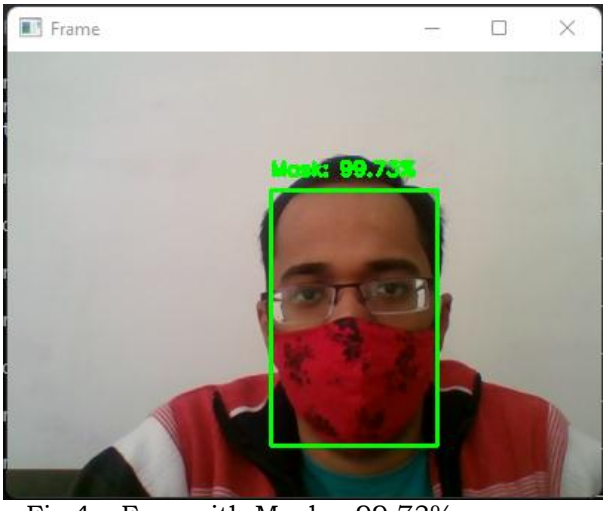

Fig 4 – Face with Mask – 99.73% accuracy

The frames are extracted from video live streaming. In these figures, you can see a rectangle which is the mark around the face (detecting the face in the live feed) showing a person without a mask with a red mark rectangle to show warning (not wearing a mask) and another figure shows the person with wearing a face mask with 99.73 % accuracy with green mark rectangle showing (mask worn properly).

Conclusion and Future Scope

In automatic face mask detection with percentage, accuracy shows the result as above though there are some limitations the system shows a little lag on the video live streaming so that needs to be improved by optimizing the code. I will also work in the - future to make the system more accurate Currently, the system determines the mask on multiple faces using the computer camera or webcam as it is built over MobileNetV2 architecture we can integrate it on embedded systems

which will alert and also open the door in the shop or allow in any public place (open and close the door using an embedded system like Raspberry Pi, Arduino, etc.) only if the user is wearing a mask with around 80% accuracy and if the mask is not working properly it will not open the door and also display the message to the user to wear it properly. This will not only help in curbing the COVID-19 panic situation but also reduce the manpower which currently checks and ask people to wear the mask and then only the person will be allowed in the shop or public place.

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