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Face Mask Detection using MobileNetV2

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Abstract: The sudden surfacing of the global pandemic, COVID-19 created a commotion on great extent. The pandemic led everyone to take proper measure related to health and sanitation, where face-mask became an inseparable part of any human being. Despite there are violations in rules which adhere to COVID-19 protocols. The proposed research highlights a machine learning model to automate the task of detection of face-mask using MobileNetV2 which is a CNN. The entire process will be a real time detection where, it will check for, is the face masked or not. CCTV or a webcam will be used to for the given purpose. The masked or the unmasked results will be indicated in terms of percentage to the system.
Keywords: COVID-19, Facemask, Machine learning, MobileNetV2, Convolutional Neural Network (CNN), Raspberry Pi.

I. INTRODUCTION

ML is foundational block of the Artificial Intelligence (AI). Chatbots, Automated Query, etc are the examples of the artificial intelligence. The research uses the same technology to overcome the tedious task of local authoritys' i.e. to check whether a person is wearing a face-mask in public area. Since, many people don't obey the same very rule and endanger the lives of person next them; making them infected. This is main reason why the COVID-19 cases in India are escalating.

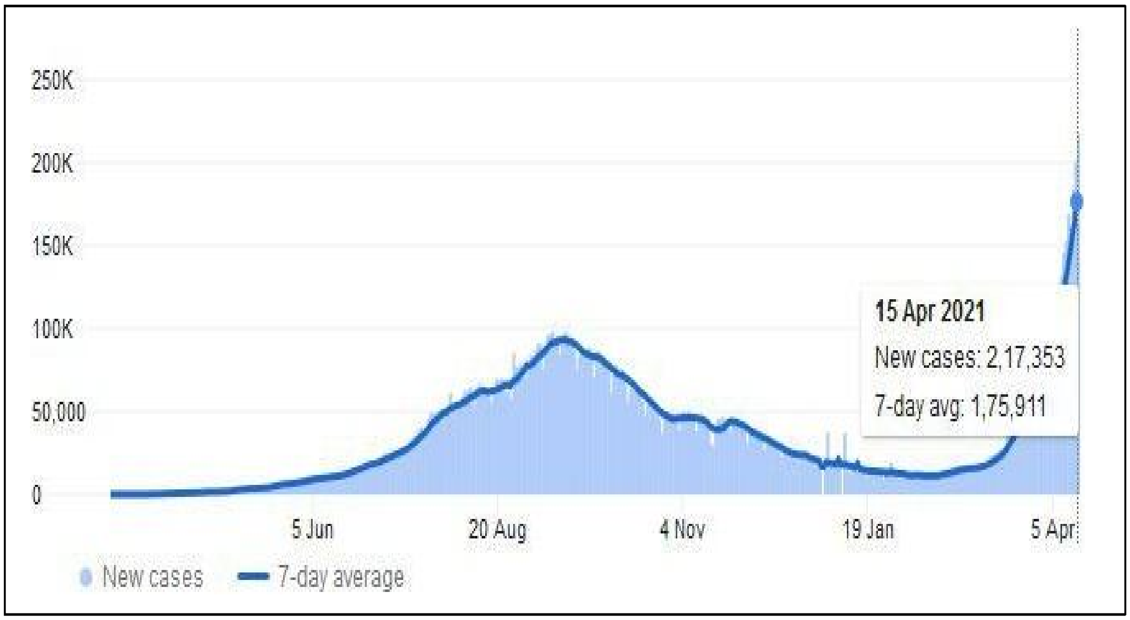

Fig 1: Daily Covid-19 Cases in India
Source: COVID-19 Statistics, Google, 16th April 2021.

From the latest given statistics of the covid-19 cases we see a sudden spike in people getting infected. One of the prime reasons is that, people avoid using the face-mask in public places and hence, increasing the risk factor of transmitting the virus. To bring such situations under control this ML model can be deployed at public places like Cinema, Parks and Vegetable Markets by amalgamating it with local CCTVs or webcams.

This will ease the task of the governing bodies and authorities to keep a track of people who don't comply with rules of that particular place. This paper involves developing a system for face-mask detection using MobileNetV2. For security as well as surveillance purposes mask face detection is faster than other security systems since multiple faces can be analysed or detected at the same time. Working with theMobileNetV2 (CNN) gives higher accuracy to detect the mask face.

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II. LITERATURE REVIEW

In [1], system focuses on three aspects: Contact less Temperature sensing, Face Mask Detection and social distancing check using Arduino Uno.for temperature checking Infrared Thermometer or Thermal Imaging Camera is used. For Mask Detection Algorithm three opencv libraries are used: *haarcascade_frontalface_default*, *haarcascade_mcs_mouth* and *haarcascade_mcs_nose* to detect human face , human mouth and nose with provided frame. Original frame is reborn into gray scale image for haar cascade classifier and also create new black white version of original frame to crossed verify for the case when person wearing white mask. Both frames undergo face detection algorithm of haarcascade frontalface and turn out positive when human present within frame. If face is detected it's proceed for mouth detection followed by nose detection.if mouth is detected and co-ordinates are within area of face then it'll alert "Wear Mask" and if nose is detected then it'll offer warning "Wear Mask Properly". In [2] paper consists of system which used to identify person wearing facemask withhelp of Deep Learning Algorithm and adopts lightweight neural network MobileNetV2 and Single Shot Detector(SSD) with transfer learning technique to achieve balance in limited resources and high recognition accuracy. Camera video feeds from Network Video Recoder(NVR) and streamed with the help of RTSP and then frames undergoes preprocesssing wherever it's coverted into grayscale and size will be decreased. A very small learning rate is employed during the training of the architecture to ensure that the convolutional filters already learned and it have been carried out with OpenCV, TensorFlow using Deep Learning and Computer Vision. Single Shot object Detection (SSD) using MobileNet V2 and OpenCV, achieves 91.2% mAP, outperforming Faster than R-CNN model. In [3] author has completed Mask Detection project using Raspberry-pi. The system used two binary classifier based on MobileNetV2. Classifier-1 is trained with Data-set which contain 770 facial images which is of classes mask and without mask.Classifier-2 is also trained with data-sets which contains images with classes proper and improper mask wear. The face mask detection classifiers are trained with different learning rates 0.001 and 0.0001 with two different numbers of epochs 10 and 20 and training tasks have taken 34 minutes and 20 minutes respectively on Raspberry-Pi 4. The face detection and inference tasks for the given video frame have taken 0.3 seconds and 3.4 seconds respectively on average. Fluctuations in the accuracy and loss values were obtained due to model over fitting with more number of epochs.

III. PROPOSED SYSTEM

The proposed system concentrates on Identification and Classification. The system will trained through positive and negative datasets by using machine learning technique such as MobilenetV2.

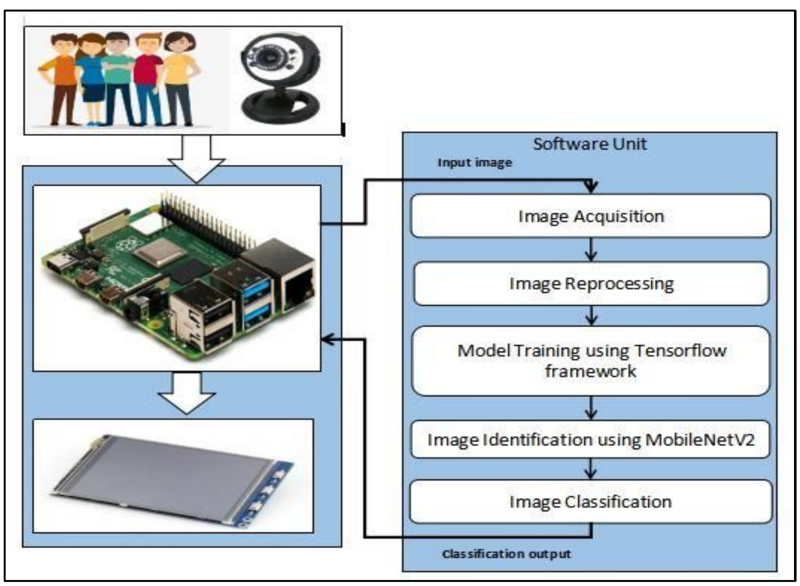

Fig. 2: Diagram of System Proposed for Facemask Detection

From figure 1 we see that it captures raw video using the webcam. Once the acquisition takes place then, video is converted into many image frames, which can be passed for recognition of image. System is trained using Tensorflow Framework with relying on large datasets; framework can recognize the picture and plan significant labels and classifications. Trained data used to classify image in two categories Mask and No Mask.

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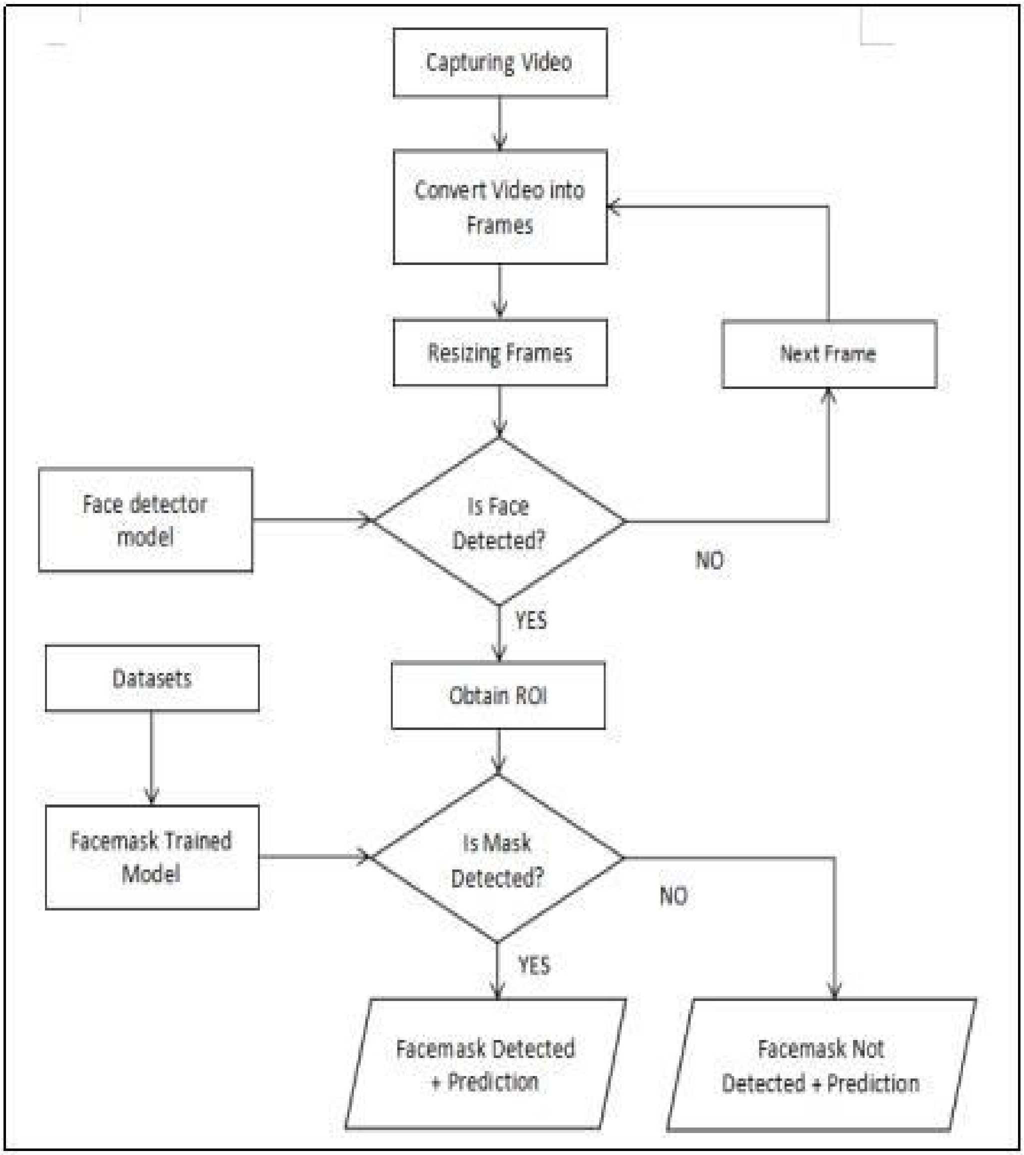

Fig. 3: Flowchart of Machine Learning Model's Execution

Initial stage is to trained Facemask model with help of large datasets consists of Positive and Negative images to obtain accurate result. Then model is load in deployment process.

Working of System to Recognize Face and Detect Facemask:

1) Live Video is captured using Pi-cam and it transmits to Raspberry-pi System.
2) Video is converted into frames.
3) System will detect the human face using Face Detector Model.
4) Face will be detected and extract each face ROI.
5) Pretrained Facemask model algorithm will be deployed on detected face ROI.
6) CNN will detect mask and take input as an array of pixel values of detected face.
7) It then determines Features which correlates most with classnames. Thus image will be classified.
8) Result of classified image will be shown with prediction i.e. Mask or No Mask.

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IV. METHODOLOGY

Depth-wise Separable Convolution Filter is the core layer in which MobileNet is built. The model will transfer the features that has learned from large datasets and performed the same operation.

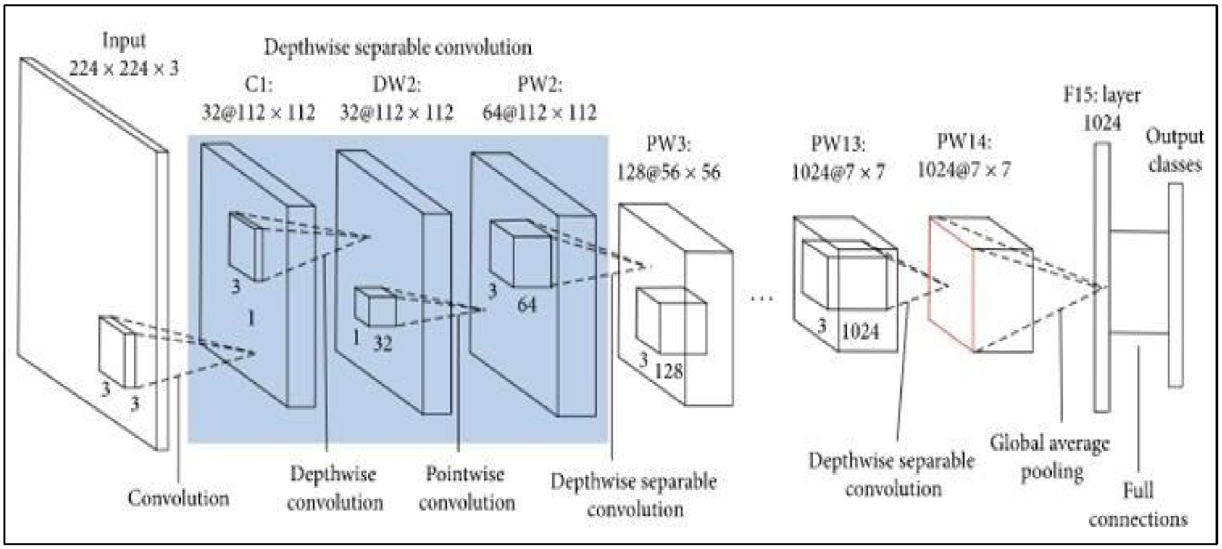

Fig 4: MobileNetV2 Architecture

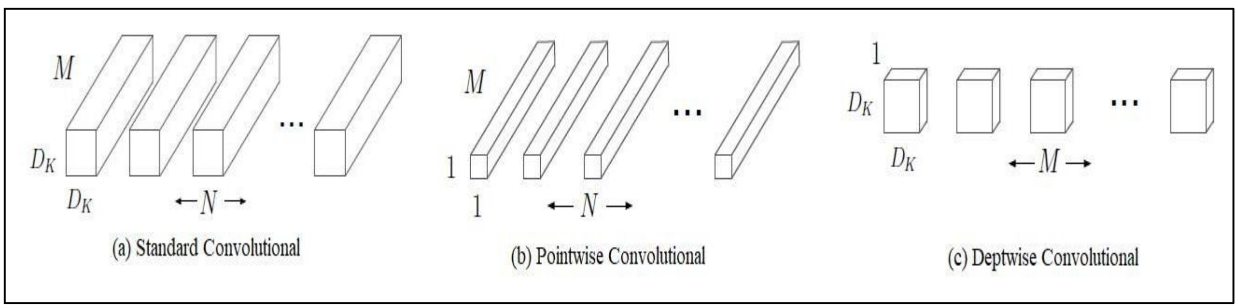

Fig 5: Depth-wise Separable filters

A. *Standard Convolution Filter*

It takes input as array of pixels value. For Convoluting it multiplies the value in filters with original pixels value and it is summed. MobileNet uses Standard Convolution filter on only first layer.

Computation Cost = $D_K * D_K * M * N * D_F * D_F$ Where: D_F= Dimension of Input Feature Map

D_K = Kernel Size

M = Input Channel

N = Output Channel

B. *Depthwise Separable Convolution*

It is Combination of two layer: Depthwise convolution and pointwise Convolution.

1) *Depthwise Convolution:* It maps only one convolution on each channel input and output image will have same dimension as input image.

$$\text{Computation Cost} = D_K * D_K * M * D_F * D_F$$

2) *Pointwise Convolution:* It is similar to the 1X1 filter of regular convolution. It merges all the features generated by Depthwise convolution which produce new features.

$$\text{Computation Cost} = M * N * D_F * D_F$$

Combination of Depthwise Convolution Computation and Pointwise Convolution Cost Computation Cost is Depthwise Separable Convolution Computation Cost.

Depthwise Separable Convolution Computation Cost = $(D_K * D_K * M * D_F * D_F) + (M * N * D_F * D_F)$

$$\frac{\text{DSC Computation Cost}}{\text{Std. Convolution Computation Cost}} = \frac{(D_K * D_K * M * D_F * D_F) + (M * N * D_F * D_F)}{D_K * D_K * M * N * D_F * D_F}$$

$$= \frac{1}{N} + \frac{1}{D_K * D_K}$$

C. Width Multiplier

Width Multiplier(α) is used to thin a network uniformly at each layer. For given layer M (Number of Input channel) becomes αM and Number of output channel becomes αN.

DSC Computation Cost with Width Multiplier = $(D_K * D_K * \alpha M * D_F * D_F) + (\alpha M * \alpha N * D_F * D_F)$ Width multiplier α ranges from 0 to 1 i.e $\alpha \in (0, 1)$

D. Resolution Multiplier

Resolution Multiplier (ρ) is used to reduce size of image from 244px, 192, 164px and 128px. Computation Cost of DSC with width Multiplier and Resolution Multiplier:

$(D_K * D_K * \alpha M * \rho D_F * \rho D_F) + (\alpha M * \alpha N * \rho D_F * \rho D_F)$ Resolution Multiplier (ρ) varies from 0 to 1; $\rho \in (0, 1)$

V. RESULT ANALYSIS

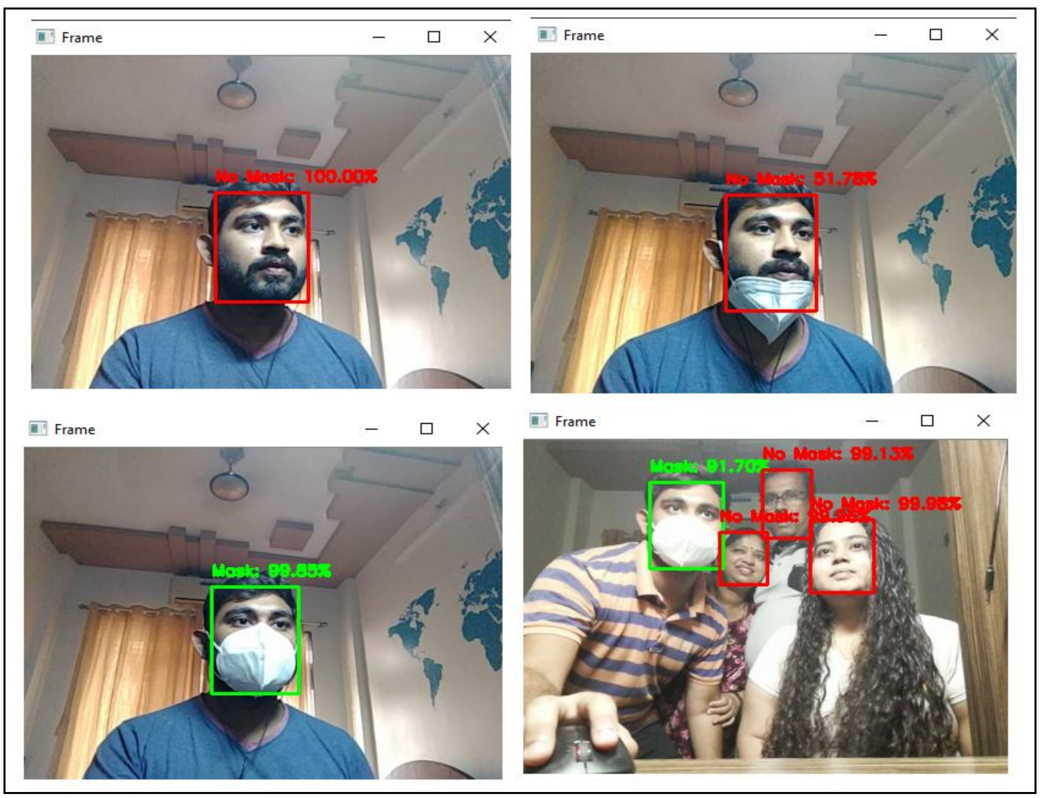

Fig 6: Experimental Results

After the complete development of the model it yielded following output. Here the system achieved the accuracy of more than 95% in detecting the face mask; shown in Fig 6.

The further analysis was done on the basis of distance of detection. The model worked properly even detecting faces which are at distant from the webcam. Continuous trials of the research led to tabulate the data of accuracy in terms of distance and detecting efficiency.

Table I
Face Mask Detection Efficiency With Variable Distance

Distance (in feet)	Mask (in %)	Without Mask (in %)
2Ft	99.92	100
4 Ft	99.51	99.93
5Ft	98.52	99.78
6Ft	96.2	97.23
7Ft	90.4	91.5
8Ft	85.23	88.32
9 Ft	81.23	84.56

VI. CONCLUSION AND FUTURE SCOPE

After summing up all the research done in development phase we conclude that the, 'Face Mask Detection using MobileNetV2,' is an efficient surveillance-cum-detector, which would definitely stand on its terms and serve its purpose thereby reducing the workload on the local authorities for surveillance if, it is integrated with the local CCTVs on the street and, it will also help in to monitor the enforced rule of wearing a mask in public places.

In future scope of this research more efficient techniques and algorithms can be developed and implemented which would definitely reduce the existing computational task thereby, reducing the processing time and save memory of the device.

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