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AI Enabled Face Mask Detector

Shivraj Patil
BTech. , Computer Science, MIT World Peace University, Pune

***Abstract*—Covid-19 pandemic is causing a global health crisis. To battle against the virus everyone should wear a face mask. The face mask detector in this study is developed with a machine learning algorithm called MobileNetV2 which is an image classification method. The steps to build the model are collecting the data, pre-processing, split the data, testing the model and implement the model.**

Keywords- Face Mask Detector, Covid-19, MobileNetV2, Machine Learning

I. INTRODUCTION

Covid-19 is the greatest humanitarian challenge facing the world ever since World War II. The pandemic has spread widely, bringing the world to halt, as the number of cases continues to rise. India has been fighting the pandemic with great spirit, with the unlocking phases being in motion. There is a need to be more proactive than ever. Governments all around the world have recognized the power of Artificial Intelligence and Machine Learning in order to fight the pandemic. Since wearing a mask and avoiding crowded places is the only alternative until the whole population is vaccinated, Computer Vision in the form of a mask detector can be a reviving factor to get life back to normal. The face mask recognition in this study is developed using the Haar Cascade Classifier which is used for detecting the region of interest and MobileNetV2 which is used for classifying the region of interest into their specific categorical output. This method of real-time mask detection can surely help in monitoring issues in countries with large populations.

II. MOTIVATION

A. Let's say a person got infected yesterday, but he won't know it until next 14 days.
B. That person thinks he is healthy, but he is infecting 10 persons per day.
C. Now, these 10 persons go out and infect 100 others, assuming they are completely healthy.
D. These 100 persons think they are healthy, but they have already infected 1000 others.
E. No one knows who is healthy or who can infect you.
F. It is quite difficult to monitor social distancing in public places, especially in countries with large population.
G. We can monitor to completely ensure that masses wear their masks properly at all times when they go out in public.
H. Even if a single business or workplace ignore these norms, the situation might get back to where it started.
I. Technology powered with AI will help us to ensure social distancing at public places and mask detection models ensure the efficient use of the masks at public places.

III. TECHNOLOGIES USED

A. Machine Learning

1) Machine Learning is a subset of Artificial Intelligence that focuses on the study of computer algorithms that improve on their own through experience. These algorithms build a mathematical model based on training data, to make predictions without being explicitly programmed.
2) A wide variety of applications use Machine Learning such as email filtering and computer vision where it becomes difficult to develop
3) conventional algorithms to perform the required tasks.

Fig 1. Machine Learning Outlook

B. Computer Vision

1) It is a field that deals with how computers can gain a high level of understanding from images or videos.
2) It tries to automate tasks that human visual system can do.
3) Computer vision involves methods to process, analyse, and gain a high level of understanding of digital images, and extraction of high dimensional data from the images.
4) The image dataset can be of many forms, such as video sequences, or multidimensional data from a scanner.
5) As computer vision is a new technology, it seeks to apply the theories to models for building a computer vision system.

Fig 2. Computer Vision

C. Deep Learning

1) Deep Learning is a subfield of Artificial Intelligence that imitates human brain to process data and create patterns for decision making.
2) It aims at learning feature hierarchies extracted from the composition of lower-level features.
3) Automatically learning features allows a system to learn complex functions by mapping the input directly to the data.
4) Deep Learning algorithms make full use of the unknown structure in the input data in order to discover good representations, frequently at various levels, with higher-level features are described in terms of lower-level features.
5) It allows models that have multiple processing layers to learn representations of data with multiple levels of abstraction.

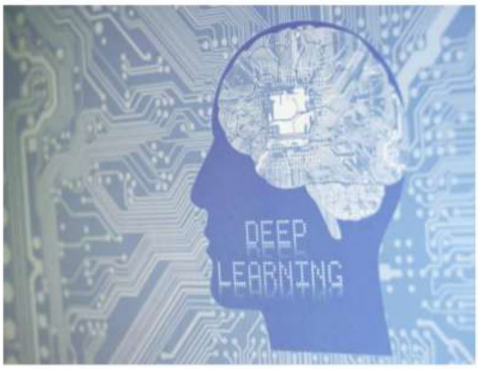

Fig 3. Deep Learning

D. OpenCV

1) Open Source Computer Vision Library was built to provide a common infrastructure for OpenCV applications to boost up the use of machine use in commercial products.
2) OpenCV algorithms can be used to recognize faces, classify human actions in videos, identify objects, remove red eyes from images, finding similar images from a database, etc.
3) Many companies like Yahoo, Google, Microsoft, Sony that make use of OpenCV.

E. Tensor Flow

1) It is an open-source software library for differentiable programming for a range of tasks.
2) It is a math library used for machine learning applications such as neural networks.
3) Tensor Flow is available on Linux, macOS, Windows, and some mobile computing platforms like Android and IOS.
4) Tensor Flow is flexible as it allows for the easy deployment of computation across various platforms like CPUs, GPUs, etc.
5) The name Tensor Flow is derived from neural network operations performed on multidimensional arrays which are referred to as tensors.

F. Keras

1) Keras is an API designed for reducing cognitive load.

2) Keras contains commonly used neural network building blocks such as layers, activation functions, objectives, optimizers to make working with image and text easier for writing simplified deep neural network code. It can seamlessly execute on GPUs and CPUs.

G. PyTorch

1) It is an open-source library based on the Torch library, used for computer vision and natural language processing, developed by Facebook's AI Research Lab (FAIR).

2) PyTorch uses a class called Tensor(torch.Tensor) to store and operate on homogenous multidimensional rectangular arrays of numbers.

IV. PROPOSED SYSTEM

The systems main aim is to identify a person in an image or a video stream if he is wearing a face mask or not with the help of Computer Vision, Deep Learning, MobileNetV2 and the Haar Cascade Classifier.

A. Approach

1) Train the MobileNetV2 model using labelled data (mask and no mask).

2) Use Haar Cascade Classifier to detection the region of interest from the image.

3) Apply the mask detector over images and live video stream.

B. Flowchart

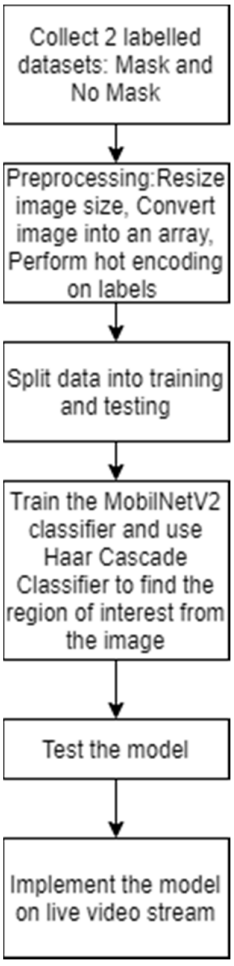

Fig 4. Flow of the model

V. METHODOLOGY

A. *Data Collection*

1) The first step of the model begins with collecting the data.
2) The model will be trained on data of people who wear masks and those who do not.
3) Then the model will be able to differentiate between people wearing masks and not.
4) The collected data now needs to be labelled and sorted into two groups.
5) The example of data is as below:

Fig 5. Image with a face mask

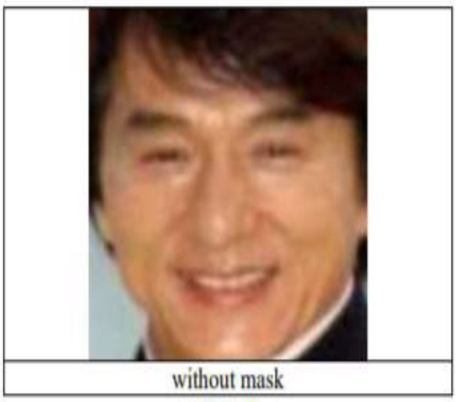

Fig 6. Image without a face mask

B. *Data Pre-processing*

1) In the pre-processing phase these are the steps which are resizing image size, covert the image into an array, and the last is performing hot encoding on labels.
2) Here we are going to resize the image into 224*224 pixels. Smaller the image, better the model will run.
3) The next step is to convert all images into an array by calling them by the loop function.
4) The last step is to perform one hot encoding on labels as the model cannot operate on data labels directly. There is a requirement for all the input and output variables to be numeric.

C. *Split the Data*

Once the pre-processing phase is over, the data is split into two parts: the training set namely 80 percent and the resting is testing set.

D. *Building the Model*

Now the MobileNetV2 classifier is trained on the training set and the Haar Cascade Classifier will be used to find the region of interest and feed that to the MobileNetV2 to classify the image.

E. Testing the Model

Now the model is tested by making predictions on the testing set.

F. Implementing the Model

1) The webcam reads the video from frame to frame, and then the face detection algorithm works.
2) After detecting frames containing faces, pre-processing will be carried out including resizing image size, converting to an array.
3) The next step will be to predict the input image using the current model.
4) The video frame will also be labelled that the person is wearing a mask or not.
5) The model can now predict if a person is wearing a mask or not on a live video stream.

Fig 7. Image of face mask detected

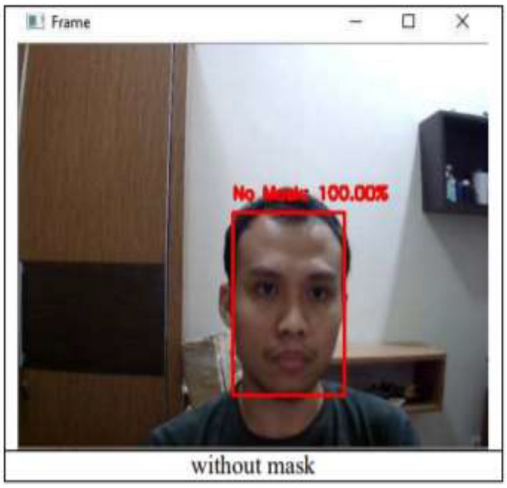

Fig 8. Image of face mask not detected

VI. ALGORITHMS USED

A. MobileNetV2

1) It is a convolutional neural network architecture that performs well on mobile devices.
2) It is based on an inverted residual structure where the residue connections are between the bottleneck layers.
3) The intermediate layer also called as expansion layer uses lightweight depth wise convolutions to filter features as a source of non linearity.
4) This architecture contains the initial fully convolution layer with 32 filters, followed by 19 residual bottleneck layers.

B. Haar Cascade Classifier

1) These are used in real time face detectors.

2) This algorithm is used for identifying the region of interests from an image.

3) The algorithm can be explained in four stages:

a) Calculating Haar Features:

- Haar feature is basically calculations performed on adjacent rectangle regions at a specific location in the window.
- Here in the calculation it involves summing the pixels of each region and taking the difference of the sums.
- Some examples of haar features:

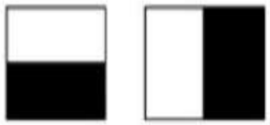

Fig 9. Edge Features

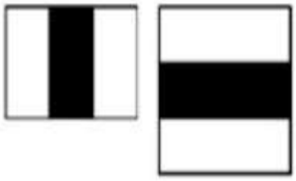

Fig 10. Line Features

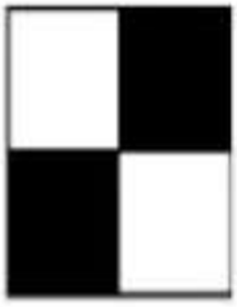

Fig 11. Four-rectangle Features

b) Creating Integral Images:

In this step instead of performing computation for every pixel, it creates array sub-rectangles and array references for each of the sub rectangles.

c) Using Adaboost:

- This step chooses takes all the best features and trains the classifier by using them.
- It makes use of weak classifiers to create a strong classifier.

d) Implementing Cascading Classifiers:

- The classifier is made up of collection of stages, where each stage is a collection of weak learners.
- To train weak learners we can make use of boosting, which allows us to make a highly accurate classifier from the mean prediction of all weak learners.
- Depending on the prediction, the classifier will either indicate if an object was found(positive) or move to the next region(negative).

C. Convolutional Neural Networks

1) A convolutional neural network is an algorithm that takes an image input and helps to classify them so that we can differentiate them.

2) The architecture of CNN is similar to the Neurons of the human brain which was inspired by the Visual Cortex.

3) The CNN architecture has several layers that implement extraction and then classification. The image is split into fields that are fed into a CNN layer, which then extracts features of the image.

4) The next step performed is pooling, where a down- sampling operation is performed that reduces dimensions and computation, while retaining the important information.

5) The next step is flattening, here the pooling output is put into a one dimension matrix.

6) The next step is a fully connected layer, which is formed when the flattening output is fed into a neural network so it can classify images.

VII. CONCLUSION

As the world fights the Covid-19 pandemic, we have developed a novel solution for detecting a person in real-time is wearing a face mask or not. This study presents a model using machine learning for face mask detection. After data collection, pre-processing, splitting the data, building, testing, and implementing the model. Our solution makes use of MobileNetV2, Haar Cascade Classifier, Convolutional Neural Networks, TensorFlow, Keras, and OpenCV. Shortly soon, all people may be obliged to wear face masks in the future, considering the Covid-19 crisis. Many public service providers will ask all their customers to weak masks to avail their services. The deployed model will contribute immensely to the health care system.

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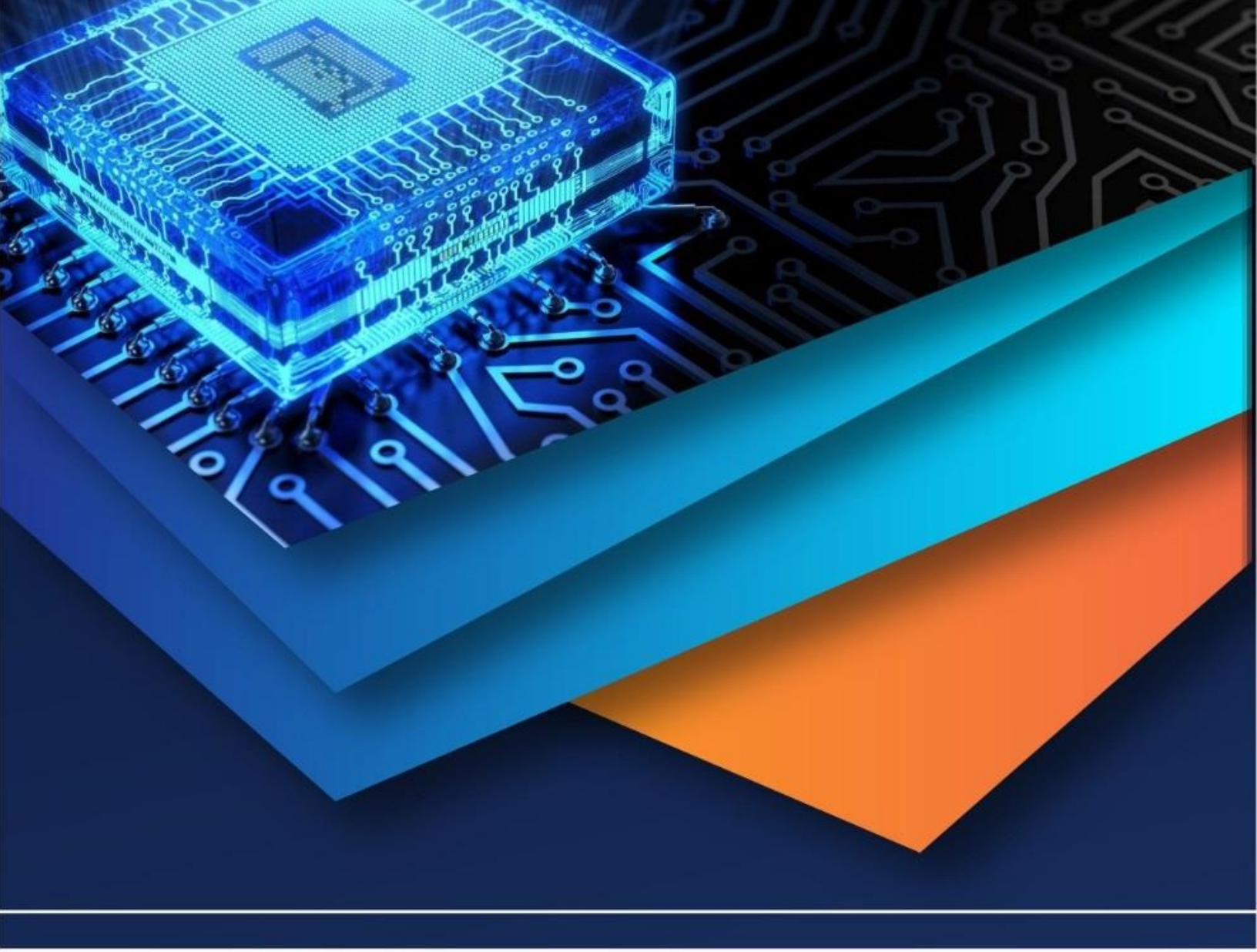

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