National Conference on Advancements in Computer Science and Engineering
In association with International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)

Face Mask Detector with Deep Learning and MobileNetV2

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ABSTRACT

The corona virus COVID-19 pandemic is causing a global health crisis so the effective protection method is wearing a face mask in public areas according to the World Health Organization (WHO). The COVID-19 pandemic forced governments across the world to impose lockdowns to prevent virus transmissions. Reports indicate that wearing facemasks while at work clearly reduces the risk of transmission. An efficient and economic approach of using AI to create a safe environment in a manufacturing setup. A hybrid model using deep and classical machine learning for face mask detection will be presented. A face mask detection dataset consists of with mask and without mask images, we are going to use OpenCV to do real-time face detection from a live stream via our webcam. We will use the dataset to build a COVID-19 face mask detector with computer vision using Python, OpenCV, and Tensor Flow and Keras. Our goal is to identify whether the person on image/video stream is wearing a face mask or not with the help of computer vision and deep learning.

Keywords -- OpenCV, Tenser Flow, Keras, Computer Vision

I. INTRODUCTION

The trend of wearing face masks in public is rising due to the COVID- 19 corona virus epidemic all over the world. Before Covid-19, People used to wear masks to protect their health from air pollution. While other people are self-conscious about their looks, they hide their emotions from the public by hiding their faces. Scientists proofed that wearing face masks works on impeding COVID-19 transmission. COVID19 (known as corona virus) is the latest epidemic virus that hit the human health in the last century. In 2020, the rapid spreading of COVID-19 has forced the World Health Organization to declare COVID- 19 as a global pandemic. More than five million cases were infected by COVID-19 in less than 6 months across 188 countries. The virus spreads through close contact and in crowded and overcrowded areas[6]. The corona virus epidemic has given rise to an extraordinary degree of worldwide scientific cooperation. Artificial Intelligence (AI) based on Machine learning and Deep Learning can help to fight Covid-19 in many ways. Machine learning allows researchers and clinicians evaluate vast quantities of data to forecast the distribution of COVID-19, to serve as an early warning mechanism for potential pandemics, and to classify vulnerable populations[1]. The provision of healthcare needs funding for emerging technology such as artificial intelligence, IoT, big data and machine learning to tackle and predict new diseases. In order to better understand infection rates and to trace and quickly detect infections, the AI's power is being exploited to address the Covid-19 pandemic. People are forced by

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laws to wear face masks in public in many countries. These rules and laws were developed as an action to the exponential growth in cases and deaths in many areas. However, the process of monitoring large groups of people is becoming more difficult[5]. The monitoring process involves the detection of anyone who is not wearing a face mask. Here we introduce a mask face detection model that is based on computer vision and deep learning. The proposed model can be integrated with surveillance cameras to impede the COVID-19 transmission by allowing the detection of people who are wearing masks not wearing face masks. The model is integration between deep learning and classical machine learning techniques with opencv, tensor flow and keras. We have used deep transfer leering for feature extractions and combined it with three classical machine learning algorithms[1]. We introduced a comparison between them to find the most suitable algorithm that achieved the highest accuracy and consumed the least time in the process of training and detection.

II. MACHINE LEARNING

Machine learning (ML)is the study of computer algorithms that improve automatically through experience. Itis seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or infeasible to develop conventional algorithms to perform the needed tasks[3]. Machine learning is closely related to computational statistics, which focuses on making predictions using computers. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a related field of study, focusing on exploratory data analysis through unsupervised learning. In its application across business problems, machine learning is also referred to as predictive analytics[2].

Machine learning approaches are traditionally divided into three broad categories, depending on the nature of the "signal" or "feedback" available to the learning system:

- Supervised learning: The computer is presented with example inputs and their desired outputs, given by a "teacher", and the goal is to learn a general rule that maps inputs to outputs.
- Unsupervised learning: No labels are given to the learning algorithm, leaving it on its own to find structure in its input. Unsupervised learning can be a goal in itself (discovering hidden patterns in data) or a means towards an end (feature learning).
- Reinforcement learning: A computer program interacts with a dynamic environment in which it must perform a certain goal (such as driving a vehicle or playing a game against an opponent). As it navigates its problem space, the program is provided feedback that's analogous to rewards, which it tries to maximize.

Other approaches have been developed which don't fit neatly into this three-fold categorization, and sometimes more than one is used by the same machine learning system [6].

III. DEEP LEARNING

Deep learning methods aim at learning feature hierarchies with features from higher levels of the hierarchy formed by the composition of lower level features. Automatically learning features at multiple levels of abstraction allow a system to learn complex functions mapping the input to the output directly from data, without depending completely on human-crafted features. Deep learning algorithms seek to exploit the unknown structure in the input distribution in order to discover good representations, often at multiple levels, with higher-level learned features defined in terms of lower-level features[4].

The hierarchy of concepts allows the computer to learn complicated concepts by building them out of simpler ones. If we draw a graph showing how these concepts are built on top of each other, the graph is deep, with many layers. For this reason, we call this approach to AI deep learning. Deep learning excels on problem domains where the inputs (and even output) are analog. Meaning, they are not a few quantities in a tabular format but instead are images of pixel data, documents of text data or files of audio data[7]. Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction [5].

IV. PROPOSED SYSTEM

The proposed system focuses on how to identify the person on image/video stream wearing face mask with the help of computer vision and deep learning algorithm by using the OpenCV, Tensor flow, Keras and PyTorch library.

Approach-

1. Train Deep learning model (MobileNetV2)
2. Apply mask detector over images / live video stream

Data at Source

The majority of the images were augmented by OpenCV. The set of images were already labeled "mask" and "no mask". The images that were present were of different sizes and resolutions, probably extracted from different sources or from machines (cameras) of different resolutions[7].

Data preprocessing

Preprocessing steps as mentioned below was applied to all the raw input images to convert them into clean versions, which could be fed to a neural network machine learning model.

1. Resizing the input image (256 x 256)
2. Applying the color filtering (RGB) over the channels (Our model MobileNetV2 supports 2D 3 channel image)
3. Scaling / Normalizing images using the standard mean of PyTorch build in weights
4. Center cropping the image with the pixel value of 224x224x3
5. Finally Converting them into tensors (Similar to NumPy array)

MobileNetV2

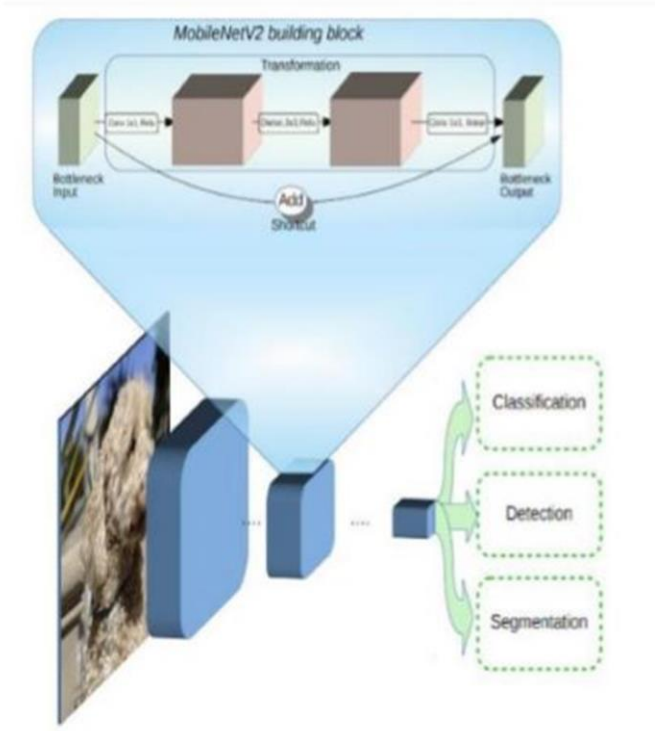
MobileNetV2 builds upon the ideas from MobileNetV1, using depth wise separable convolution as efficient building blocks. However, V2 introduces two new features to the architecture:

1) Linear bottlenecks between the layers, and
2) Shortcut connections between the bottlenecks.

The typical MobilenetV2 architecture has as many layers listed below. In Pytorch we can use the model library in TorchVision to create the MobileNetV2 model instead of defining/building our own model. The weights of each layer in the model are predefined based on the ImageNet dataset[6]. The weights indicate the padding, strides, kernel size, input channels and output channels. MobileNetV2was chosen as an algorithm to build a model that could be deployed on a mobile device. A customized fully connected layer which contains four sequential layers on top of the MobileNetV2 model was developed[4]. The layers are

1. Average Pooling layer with 7×7 weights
2. Linear layer with ReLu activation function
3. Dropout Layer
4. Linear layer with Softmax activation function with the result of 2 values.

The final layer softmax function gives the result of two probabilities each one represents the classification of "mask" or "not mask".



Face Mask Detection in webcam stream

The flow to identify the person in the webcam wearing the face mask or not. The process is two-fold.

1. To identify the faces in the webcam
2. Classify the faces based on the mask

Identify the Face in the Webcam

To identify the faces a pre-trained model provided by the OpenCV framework was used. The model was trained using web images.

Floating-point 16 version of the original Caffe implementation[5].

2.8 bit quantized version using Tensor flow The Caffe model in this face mask detector.There has been a lot of discussion around deep learning based approaches for person detection. This encouraged us to come up with our own algorithm to solve this problem. Our work on facemask detection comprises of data collection to tackle the variance in kinds of face masks worn by the workers. The face mask detection model is a combination of face detection model to identify the existing faces from camera feeds and then running those faces through a mask detection model[3].

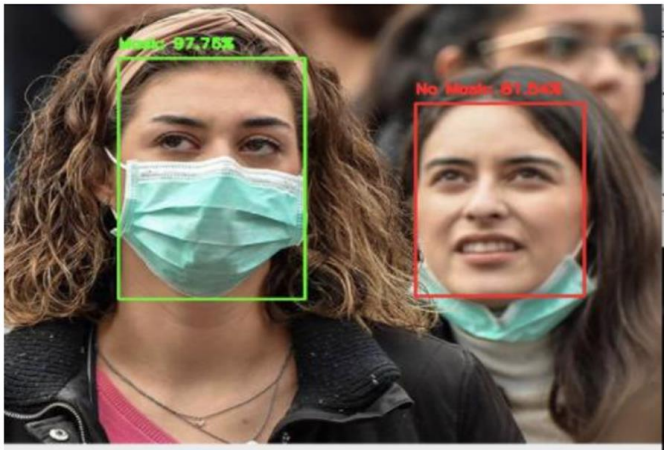


Figure 1: Detection of "Mask" and "No Mask"

V. IMPLEMENTATION

We are still developing the face mask detector project. As of now we have implemented the code for detecting face, pre processing it, loading mobilenetv2 and converting images to numeric arrays. In coming days we'll be training the complete model which will be able to detect "mask" and "no-mask" faces as well.

1. Implementation of image loading, pre processing and converting images into numeric array

```
for img in os.listdir(path):
    img_path = os.path.join(path, img)
    image=load_img(img_path,
    target_size=(224, 224))
        image = img_to_array(image)
        image = preprocess_input(image)
        data.append(image)
        labels.append(category)
```

2. Loading MobilrNetV2 network

```
# load the MobileNetV2 network, ensuring the head FC layer sets are
baseModel = MobileNetV2(weights="imagenet", include_top=False,
input_tensor=Input(shape=(224, 224, 3)))
```

VI. LITERATURE REVIEW

Covid-19 Facemask detection with Deep Learning and Computer Vision by Vinitha and Velantina from IRJET- Volume 07 and Issue 08 ; have proposed a hybrid model using deep and classical machine learning for face mask detection. They have identified whether the person on image/video stream is wearing a face mask or not with the help of computer vision and deep learning.

The proposed model can be integrated with surveillance cameras to impede the COVID-19 transmission by allowing the detection of people who are wearing masks not wearing face masks. The model is integration between deep learning and classical machine learning techniques with opencv, tensor flow and keras. They have used deep transfer leering for feature extractions and combined it with three classical machine learning algorithms. They've also introduced a comparison between them to find the most suitable algorithm that achieved the highest accuracy and consumed the least time in the process of training and detection. The face mask detection model is a combination of face detection model to identify the existing faces from camera feeds and then running those faces through a mask detection model.

VII. CONCLUSION

As the technology are blooming with emerging trends the availability so we have novel face mask detector which can possibly contribute to public healthcare. The architecture consists of MobileNet as the backbone it can be used for high and low computation scenarios. In order to extract more robust features, we utilize transfer learning to adoptweights from a similar task face detection, which is trained on a very large dataset. We used OpenCV, tensor flow, keras , Pytorch and CNN to detect whether people were wearing face masks or not. The models were tested with images and real-time video streams. The accuracy of the model is achieved and, the optimization ofthe model is a continuous process andwe are building a highly accurate solution by tuning the hyper parameters. This specific model could be used as a use case for edge analytics. Furthermore, the proposed method achieves state-of-the-art results on a public face mask dataset. By the development of face mask detection we can detect if the person is wearing a face mask and allow their entry would be of great help to the society.

VIII. REFERENCES

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