Real Time Face Mask and Social Distancing Detection System Using Deep Learning

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Abstract— The rapid spread of Covid-19 is become a pandemic and has created abrupt changes in society. Outdoor work in industries, institutes, etc. is stuck up. The presented work consists of two parts. In the first part, the dataset is pre-process and labelled as faces with face mask and without face mask using deep learning solution that uses OpenCV and TensorFlow to train the model i.e. Convolution neural network is used. In the second part, the human body is detected and safe distance i.e. 2m, between two bounding boxes of human bodies is calculated and image data is created. This created image data is now matched with the existing image dataset. For this purpose, the YOLO v3 algorithm is used.

Keywords: Convolution neural networks, OpenCV, TensorFlow, YOLO v3 algorithm, Face Mask Detection, Social distancing, Deep learning, Human detection, Video processing

I. INTRODUCTION

The pandemic COVID-19 has ensured oversized scale imprisonment across the planet associate degreed has given rise to a horrifying scenario. The method of vaccination has begun, still, it'll take a protracted time to immunize each and every one. However, its associate degree imperative ought to restart operations at workplaces or organization. The government has obligatory associate degree consultative to follow correct safety measures in order that work will resume at places. By taking bound precautions it is often done however it's troublesome to observe everybody manually, there's a desire to implement such a reasonable system that is able to permit the U.S. to figure with all safely at workplaces.

The current study presents the work associated with an automatic time period mask detection and social distancing observance system. The given work consists of 2 main components. The primary half is expounded to mask detection. The second half is related to sleuthing safe distancing of 2m between human bodies in every frame. Also, there's a message alerting system, message is displayed on screen "Please follow social distancing" whenever there's a violation of rules. Our project presents the work related to the real-time face mask detection and social distancing monitoring system. The presented work consists of two main parts. The first part is related to detecting the face mask and the second part is related to safe distance detection between human bodies in frame.

For the first part of dataset creation, the dataset is pre-process and labelled as faces with face mask and without face mask using deep learning solution that uses OpenCV and TensorFlow to train the model i.e. Convolution neural network is used. For each labelled value, the relevant parameters are evaluated and finally, a one truth value of passed input frame is created, based on the trained model result is created. Using this mechanism, a mask detector is created. For the second part, the same procedure, mentioned in part one along with calculations of safe distance i.e. 2m, between two bounding boxes of human bodies is calculated and the image data is created. This created image data is now matched with the existing image dataset. For this purpose, the YOLO v3 algorithm is used.

1) The main objective of the detection system is to provide safety to people from pandemic like Covid 19 in which mask and social distancing are two main mandatory precautions.
2) To provide safety at crowded places where number of people gathered together like airports, hotels, hospitals, offices, work places, educational institutes, market, etc.
3) Authority at admin side can easily find the person who is breaking the rules and regulations imposed, by not wearing face mask and by not maintaining social distancing at place.
4) This will help to control the spread of virus in surrounding area.
5) To implement the system in the crowded places, provides real time detection and monitoring system by giving efficient and quick result.

II. RELATED WORK

Recently, in computer vision object detection techniques using deep models are potentially achieved spectacular progress more than shallow models in handling complex tasks. Models in deep learning for person detection focus on feature learning contextual information learning. In proposed system we are using Single Shot Detector MultiBox(SSD) which seems to be a good choice for real-time object detection and the accuracy trade-off is also very little. SSD uses the yolo model pre-trained on ImageNet as its basic model to extract useful image feature. At the top of YoloV3, SSD adds several convolutional feature layers of decreasing sizes. The YoloV3 object detection system can be trained to detect any object, but is especially common for body detection and is more accurate and faster. [1] In this research paper, the author has designed a safe environment in a factory workplace for workers to work in a post-covid-19 environment by using computer vision. Here MobileNet V2 model is used for person detection. [2] In this presented work, a deep learning and SSD framework is used for the detection of face mask and social distancing through a camera in a real-time system. [3] Evaluated a human face with mask and violation alerting system is designed in order to monitor safety environment in outdoor places so that one can resume their work in a pandemic situation also. This model uses on SSD framework and MobileNet V2 model and is based on

ROI. [4] This author has used sound waves in order to calculate the distance between two human bodies by using sensors. Here variation is determined using RSSI (received signal strength value). [5] In the Presented paper, there is the use of a smart AWS platform. A cloud-based infrastructure using AWS is presented. The first challenge they found is the delay processing time, not proper synchronization and action and reaction time rate is late in data. A small scale model is implemented.

III. PROPOSED SYSTEM

It is not possible to monitor individually each person whether he is wearing a face mask or not and is maintaining social distancing in crowded places. So we are implementing a system that uses computer vision to monitor real-time safety measures.

The proposed approach uses a deep learning Multi-Task-Cascaded Convolutional Neural network model solution that uses OpenCV and TensorFlow, to train the model. We combine the deep learning model for a fast and efficient deep learning solution for real-time human detection in video streams.

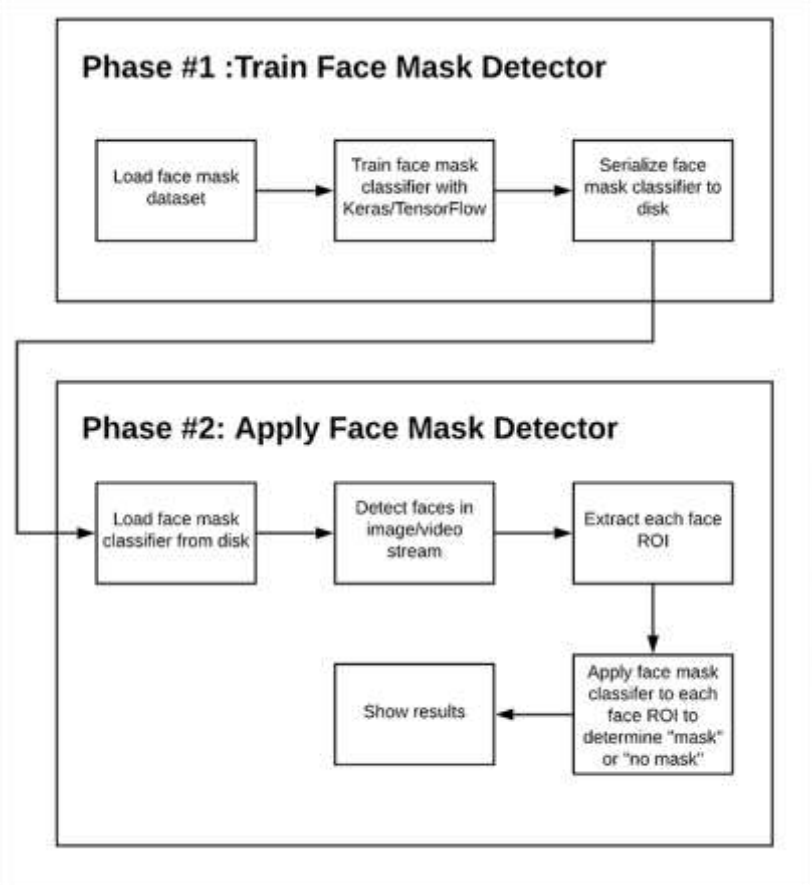


Fig. 1: Flow diagram for face mask detection

In Fig 1. The face mask detection system framework is shown. The system design has two phases of operations that do the image dataset creation, train face mask detector, and apply face mask detection model.

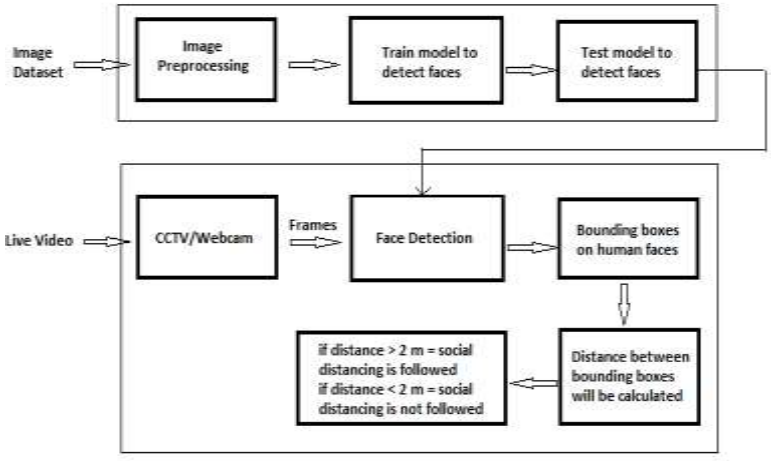


Fig. 2: Block diagram for social distancing detection

Fig 2. A block diagram elaborates the social distancing model working. The system design consists of a framework that preprocesses the image dataset and used this dataset to train the model to detect the faces. Here human face detection model is a test and a bounding box is made on the detected face. The flow given is first we are taking input video stream i.e. real-time data from webcam/CCTV then human faces are detected within the streams and a bounding box is formed. Previously a threshold value is set for a safe distance. The distance between the centroid of two bounding boxes is measured. This calculated distance is compared with the threshold value if it is less than the set value then it is not a safe distance i.e. violation of social distancing is observed.

Mathematical Formulation

Let the people between whom the distance is being measured be: Person 1 and Person 2, that stand at positions (x1, y1) and (x2, y2) in a given image. These coordinates are detected at the feet of the individuals. Through Fig 4, using similarity, we can show that-

$$Sensor\ Dimension = \frac{Field\ dimension}{Focal\ length\ distance\ to\ field}$$

To find the depth of an object in a photograph, the following formula can be obtained from equation 2:

$$d = \frac{actual\ ht\ of\ object(mm) \times focal\ length(mm)}{ht\ of\ object\ on\ sensor(mm)}$$

We can use the following formula to obtain the height of the object in the image on the sensor in millimeters. Here, the height of an actual human is assumed to be 1.6m in this model, since the average height of a human is estimated to be that much.

Object ht on sensor (mm) = object ht in image (px.)×pixel size

Where px is measurement in number of pixels

To measure the approximate distance between these two people in the image, the difference of their x-coordinates are taken to be the social distance width.

Social distancing width (mm) = (|x1 − x2|) × pixel size

We can hence find out the actual field width using eqn. 2

w = sensor width × social distancing width (mm) focal length(mm)

Euclidean distance,

$$\sqrt{(X,Y) = \sqrt{(x1 - x2)2 + (y1 - y2)^2}}$$

$d(P,Q) = min(E(p1,q1),E(p1,q2),E(p2,q1),E(p2,q2))$ where $P = [p1,p2]$ and $Q = [q1,q2]$ are set of ground points.

If person 1 is assumed to be at (0, d1) and person 2 at (w, d2)

Social distance = p (w − 0)2 + (d2 − d1)2

From each individual dij distance matrix D is computed. D is a zero-diagonal symmetric matrix

$$D = [d11 \ldots d1n{:}dpq{:}dn1 \ldots dnn]$$

Thereafter the minimum of the four distances is chosen and compared to threshold distance "t" which is the assumed safe distance.

IV. Experimental Results

A. Experimental Setup

Experimentation is carried out by using a collection of 1225 images for face mask detection model. All the experiments are carried out in Anaconda Navigator using Jupyter notebook. System configuration used for the experimentation is as follows:

1) *Hardware Specification:*

- Processor: Intel(R) Core(TM) i3-2350M CPU @ 2.30GHz, 2300 Mhz, 2 Core(s), 4 Logical Processor(s)
- RAM : 4GB
- CCTV/Webcam

2) *Software Specification:*

- MS Windows 10
- Anaconda Navigator
- Jupiter Notebook
- Scikitlearn
- Numpy
- Tenserflow
- Opencv
- Keras
- Matplotlib
- Argparse

V. Experimental Result

A. Face Mask Detection System Results:-

We successfully setup IDE(integrated development environment)and installed all the requires libraries.

- Firstly, we have successfully trained our first model to detect various human faces from images and live video stream, by making a color bounding box around faces.

B. Output: -

Fig 5.1: Detecting human faces from static images

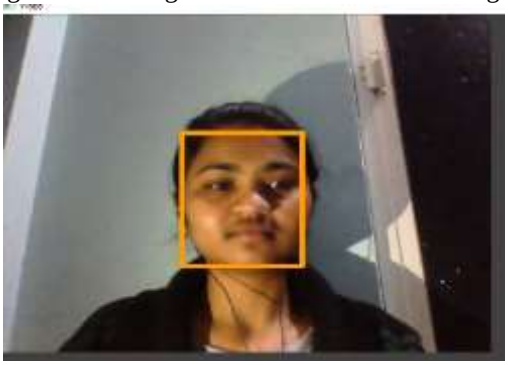
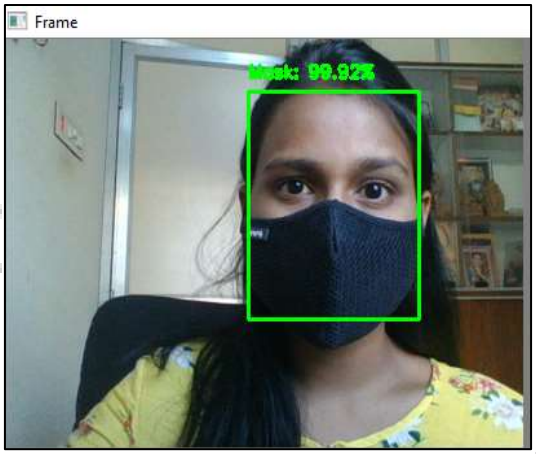


Fig. 5.2: Detecting human faces fromlive video/webcam

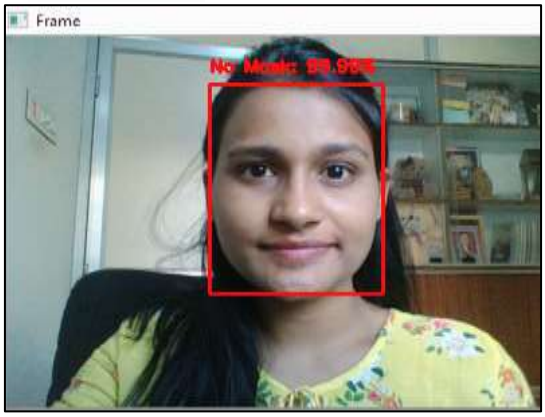
A graph is plot to check the accuracy of trained model. Sometimes due to faulty data or large amount of data can cause model to predict wrong result. Hence, a Training Loss/Acurracy Vs epoch graph is plot.

C. Output:

Fig. 5.3
Real-time face mask is detected in video stream



Final Output 1
Real-time human face without face mask is detected in video stream



Output 2
Real-time human face with improper face mask is detected in video stream

Output 3

D. Social Distancing Detection System Results:-

Output 1-

Fig. 5.4: Output when social distancing is not violated i.e. no alert

Fig. 5.5: Output with alert message and red bounding box when social distancing is violated

VI. CONCLUSION

In this dissertation, we have developed an approach to prevent the spread of the virus by monitoring in real time if person is following safe social distancing and wearing face masks in public places.

The proposed approach facilitates of an efficient computer vision based approach focused on the real-time automated monitoring of people to detect both safe social distancing and face masks in public places by implementing the model to monitor activity and detect violations through camera.

The proposed system favors the society by saving time and helps in lowering the spread of corona virus. Such

an approach can be used for several public places like school, colleges, malls, temples etc. The results may sometimes be a little less accurate subject to the crowd, camera resolution and type of masks. We have developed an approach to prevent the spread of the virus by monitoring in real time if person is following safe social distancing and wearing face masks in public places. Such an approach is useful in monitoring at several public places like school, colleges, malls, temples, etc by using computer vision rather than manual work.

VII. FUTURE WORK

This section presents the possible future directions to extend the presented work.

In future the experimentations can be carried out by using the coughing and sneezing detection. Chronic coughing and sneezing is one of the key symptoms of COVID-19 infection as per WHO guidelines and also one of the major route of disease spread to non-infected public. Approach based on Deep learning can be proved handy here to detect & limit the disease spread by enhancing our proposed solution with body gesture analysis to understand if an individual is coughing and sneezing in public places while breaching facial mask and social distancing guidelines and based on outcome enforcement agencies can be alerted.

Temperature Screening elevated body temperature is another key symptom of COVID-19 infection, at present scenario thermal screening is done using handheld contactless IR thermometers the proposed use-case can be equipped with thermal cameras based screening to analysed body temperature of the peoples in public places that can add another helping hand to enforcement agencies to tackle the pandemic.

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