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Social Distancing Analyzer

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Abstract—With the spread of Corona Virus, a disastrous and infectious disease due to which there was loss of millions of lives and is still continuing to be a threat to human life. One of the effective measures that helped in stopping the transmission to some extent is social distancing, which is often known as physical distancing. It has been acknowledged internationally as a non- drug avoidance measure for COVID-19 transmission. This work proposes a system named Social Distancing Analyzer that can be used for alerting people to maintain a safe distance to stop the spread of disease with each other. The proposed system uses the video frame from camera calibrated into bird's view as input which is then used for person detection using YOLOv3 algorithm, an open-source object detection model. A centroid can be computed by following the subjects and calculating the distance between individuals. The distance obtained by the system is then used to determine whether the rules are being followed or not. If the distance between two people is above minimum threshold value, the individual is represented using green box which also mean that social distancing is being followed, if not then it is represented using red box and an alert is generated showing that social distancing is not being followed.

Index Terms—Machine Learning, Deep Learning

I.

INTRODUCTION

With the outbreak of COVID-19, social distancing proved to be one of the effective measures against the prevention of the infectious illness along with wearing mask and using hand sanitizers stopping the spread of virus [2]. If we look into the meaning of the name carefully, social or physical distancing means that individuals should maintain a physical distance between each other, minimising immediate contact and, as a result, reducing the transmission of a dangerous disease like coronavirus. Maintaining social distance helps to keep the virus from spreading in public places like shopping malls, school and university campuses, movie theatres, railway stations, and bus stops [3], [4], [5]. Even while we have methods like vaccinations and treatments to combat the corona virus, they do not provide complete protection against the disease [5,27]. So, even after having medical facilities we are not fully sure if a person can be transmitted with the disease or not. As a result, social separation is critical in avoiding illness transmission. The practice of social distance may continue in the coming years until the virus is totally eradicated. However, because people aren't used to preserving the required 2-meter spacing between each other, social separation is sometimes breached unintentionally. To lessen the risk of the virus spreading through physical touch, people are being encouraged to limit their contacts with one another.

A vision-based automatic warning system for detection of social distance status is presented in this study. The suggested framework may be used to identify critical variables and data for local and worldwide viral control in addition to

being an automated monitoring and warning system. In this case, distance calculation is crucial. In this paper, we have used Euclidian distance calculation method. This method uses two real-valued vectors to calculate distance. The rule is broken if the calculated distance is less than 6 feet or 2 metres, and a red box appears; if the rule is followed, a green box appears.

II. RELATED WORKS

This section shows some of the relevant efforts on deep learning-based object recognition and human detection. We find a lot of work and projects done recently in the field of classification of objects and detection. Full image classification is used for object recognition, whereas pixelwise classification is used for detection and segmentation in an image. Human detection or we can say person detection is a part of computer vision-based object detection [7]. Machine learning, deep learning and convolutional neural networks has been used to enhance visual recognition results [8], [20]. It's a multi- layered perceptron neural network with a lot of convolutional layers, fully connected layers, and sub-sampling layers, in it. It is a supervised feature learning approach that is effective in detecting different objects from various inputs. This model has had a lot of success in large-scale picture classification problems because of its remarkable performance in huge datasets like ImageNet [9], [10], [11].

In a neural network, layers are included in the input layer, one or more hidden layers, and the output layer [12], [21]. They master in detecting items and recognising patterns such as forms, colours, and textures. The hidden layers of the neural network are convolutional layers, which operates as a filter by receiving inputs, transforming it using a certain pattern/feature, and then sending it to the next layer for processing. When the number of convolutional layers increases, a new input is sent to the next convolutional layer each time, it is transformed in a different way. A number of algorithms can be applied to identify and recognize objects, such as RNN, fast-RNN, Retina-net, and YOLO. The YOLO algorithm is one of the approaches that is used to employ convolutional neural networks (CNN) to recognise objects like dog, cat, box etc. and human in real time [13], [22]. The algorithm only takes a single input propagation through a neural network to detect objects as the name suggests.

The entire image is presented and forecasted using a single time algorithm run as the algorithm suggests. Simultaneously, the Convolutional Neural Network is working to forecast and present various bounding boxes along with class probabilities to identify objects and humans [14], [23].

There are three techniques on which YOLO algorithm operates:

Bounding box regression Residual blocks

Intersection Over Union (IOU)

There are a large number of grid cells containing identical dimension in the YOLO model illustrated in figure 1. Grid cells are specifically used to detect objects and things that occur in each grid cell by each grid cell. Let us take an example of centre of item. If the centre of an item is enclosed within a certain grid cell's boundary that grid cell will be responsible for detecting it and forecasting. [14,23] [15].

The image is first separated into grid cells. Then, in each grid cell, bounding boxes B are projected, along with their confidence scores. The cells are used to estimate the class probability to determine the class of each item. Figure 2 shows how the YOLO model works. We offer a computer vision system for recognising humans using a camera positioned at the highway or at a workplace, based on the work [17], [24].

III. METHODOLOGY

Social distancing Analyzer is a project that is designed and developed for the detection and analysis of the social distance that is an essential measure for avoiding Covid-19 between each and every person in public places such as parks, train stations, bus stands, schools and colleges etc. to help control the spread of coronavirus. In this project, the YOLO method and computer vision methods are used to achieve the desired

results. Initially, the YOLOv3 algorithm-based model is used to develop an object detection network that will help in detection of the person in the video frame of the camera. The next step after we receive the detection result is that only the person will be used and other objects should be ignored. Therefore, the first step is to create bounding box that best fits after detection of each person on the street, then calculate and draw in the image, and the data received on doing the above steps for the detected people and the bounding box is then used for the distance measurement [18], [25].

The proposed structure performs for significant undertak- ings in the accompanying request:

a) The Person Detection inside the video frame.
b) Person Tracking using Bounding boxes.
c) Distance from Camera Estimation using Euclidian Dis- tance.
d) Violation alert message by red and green alert boxes.

A. Person Detection and Tracking

The first and the foremost task is to detect people walking around so we use YOLO model. The YOLO model is one of the most advanced models under the topic of object recogni- tion based on deep learning with considerable speed benefits that are ideal for real-time applications [26].

B. Camera Estimation

The image's area of interest (ROI), which concentrates on a person going down the street, will be converted into the desired top-down 2- Dimensional view of 480X480 pixels. Calibration of the camera view is done by computation and calculation of the transition of the perspective view that results into a top-down view [19]. In OpenCV in Deep Learning, a simple camera calibration technique that involves steps like in perspective view, we have to select four points and then it is required to map them in the 2D image view to the corners of a rectangle is called the perspective transformation of the image.

C. Distance Mesurément

Distance measurement is the step where for each person in the perspective view, we have to find the position of the bounding box (x, y, w, h) and transform them into a top- down view for the video frame. For every individual, the distance of every individual in the top-down view is analysed and calculated depending on the bottom-centre point of the bounding box. The difference in position between each pair of people should be evaluated from the top-down view and the difference between every person is precisely scaled by the necessary scaling factor calculated from calibration of the camera view.

After evaluating the position of two persons as present on the camera view in an image as (x1, y1) and (x2, y2) respectively, the distance between the two objects detected as person, dis, can be calculated with the given formula:

The architecture of the social distancing analyser system is as shown in the figure 3. Here, the first step is to detect person, then calculate distance between persons to check social distancing condition. Recent Social Distancing rules suggest of keeping a least distance of 6 feet or 2 meters. So known distance provide by the system is 6 feet. Then, compute the centroid tracker in the frame. For model determination, a correlation has been made on a few pre-prepared models with different informational collections like Open Images, YOLO, and Mobile Net DPM. When applied to other domains such as artwork, the YOLO algorithm outperforms existing detection methods such as DPM and R-CNN[28-32].

Fig. 1. Illustration of input image divided into grids [16]

TABLE I

DATA COLLECTED FOR REVIEWED PAPERS

S. No	Author Name	Date	Architecture	Accuracy
1	A. Zisserman and K. Simonian	2014	CNN	
2	T. Darrell, J. Malik R. Kirchick, J. Donahue.	2014	Computer vision and image processing.	
3	Joseph Redmon, Ross Kirchick, Santosh Divola, A Farhadi	9/05/2016	R-CNN + YOLO	72.6
4	Xiao gang Wang	2016	Object recognition, segmentation and detection.	
5	I. Ahmed, J. J. P. C., M. Ahmad, Rodrigues, Jeon, G., & Din, S.	2020		68.7
6	Sergio Sayonara, Alessio Gagliardi Abdulsalam Elha nashi	21/01/2021	Jetson nano (Hardware)	69.7
7	Hrishikesh Kur hade, Monika Maurya, Akshata Nagar, Prof. Dhanushri bhopat Rao	04/04/2021	Mask R-CNN	71
8	Yew Cheong Hou, Mohammad Zafri Baharuddin, Salman Yusuf	24/08/2021		67
9	G V Shalini, , S Subashree, M Kavitha Margret, M J Sufiyan Niraimathi	01/05/2021	OpenCV	71.1
10	D.T. Nguyen, W. Li, P.O. Ogbonna	2009	ImageNet	

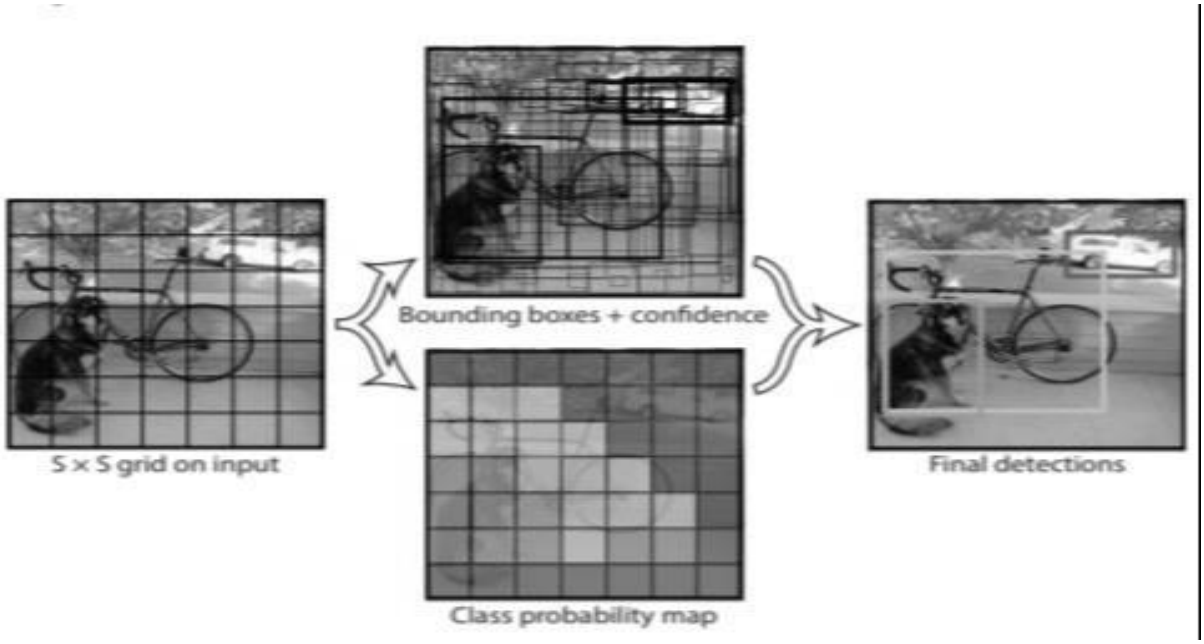

Fig. 2. Illustration of working of YOLO Model [15]

Fast R-CNN creates considerably more background errors than YOLO. We gain a large speed increase by utilizing YOLO to remove background detections from Fast R-CNN. We can also look for proves if YOLO predicts a comparable bounding box for every bounding box that R-CNN predicts. If it happens, a boost is provided to the likelihood predicted by YOLO and the overlap between the two boxes provide that prediction. In this section of methodology, it is already assumed that each and every person in the video frame of the camera is walking on the same plane flat surface. The top- down view is achieved by transformation of the selected points of the plane that is four filmed points out of the frame. The top- down view is required for calculation of the location for each person. The distance between each person is then measured and scaled to know the threshold value. After calculation of the distance, the achieved results are tested for the required minimum distance, if the calculated distance comes out to be less than the threshold value distance input between any two individuals, it will be indicated using red boxes and these lines will serve as precautionary warnings to follow the social distancing rules. The project is implemented in the one of the most trending languages i.e., Python language.

One of the most used methods that can be used to improve distance calculation can be using LiDAR. It determines how long a light source takes to reach and reflect off an item. This isn't a brand-new technology; NASA has been utilising this technology for space missions for quite some time. LiDAR is also used by meteorologists to improve forecasting. This technique has recently been used to create three-dimensional mapping of the environment. It works similarly to a radar dish in that it sweeps the area physically and estimates distances.

IV. RESULT AND DISCUSSION

The individual in the video is seen going down a public roadway. The video frame in this piece is set at a certain angle to the street. Figure 4 depicts the detection of social separation in a video frame, as well as the outcomes of the same perspective. For the purpose of detecting social separation, the points represent each pedestrian. Pedestrians in the red boxes are those who are closer to another pedestrian than the legal distance or the minimum threshold distance, while those in the green boxes are at a safe distance from other pedestrians and above threshold distance. YOLO algorithm is an object detection algorithm that is faster and more precise, making it ideal and one of the best options for implementation in computer vision. We've used YOLO algorithm in this project, and it delivers a 75 percent accuracy rate.

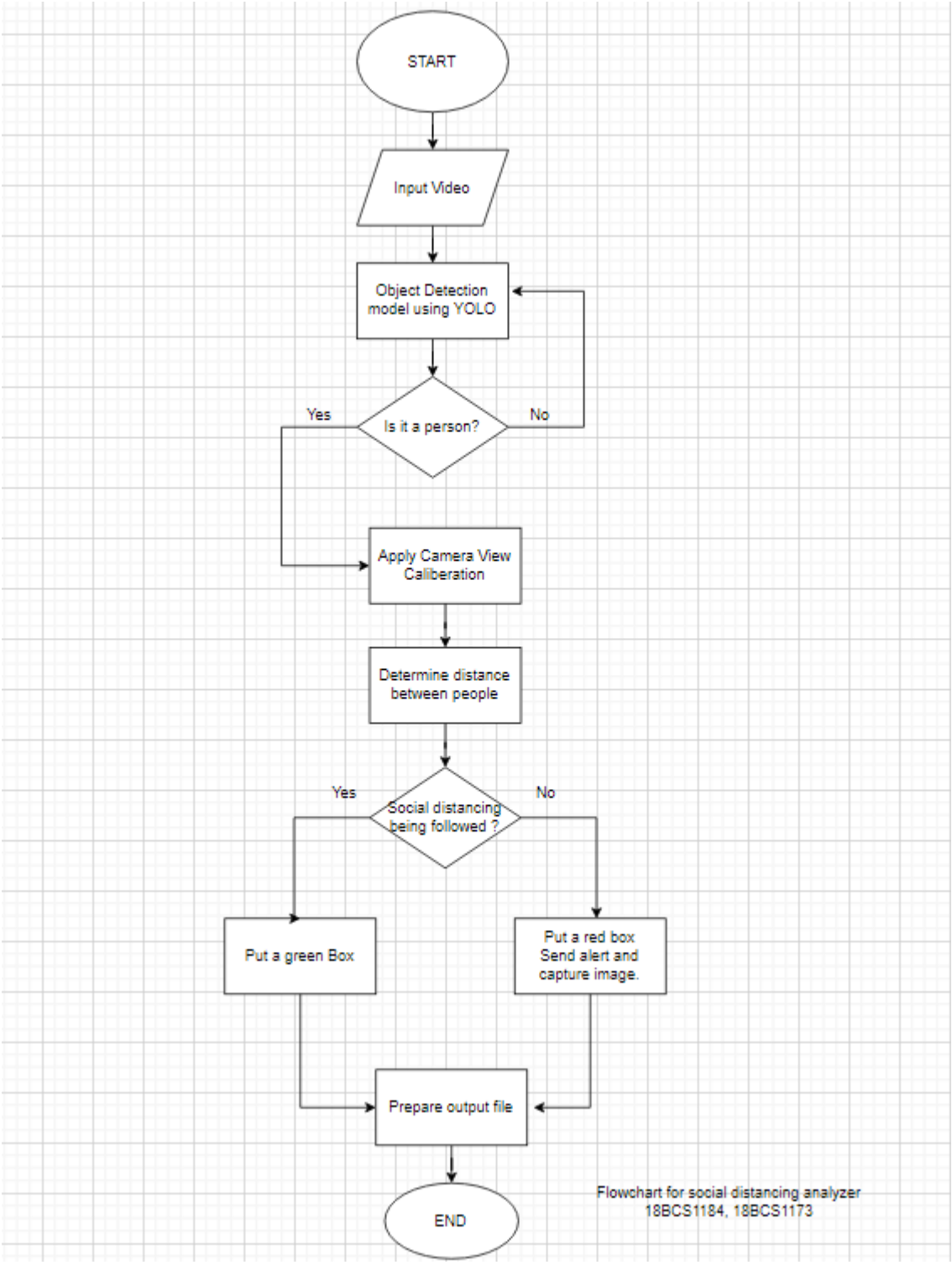

Fig. 3. Flowchart

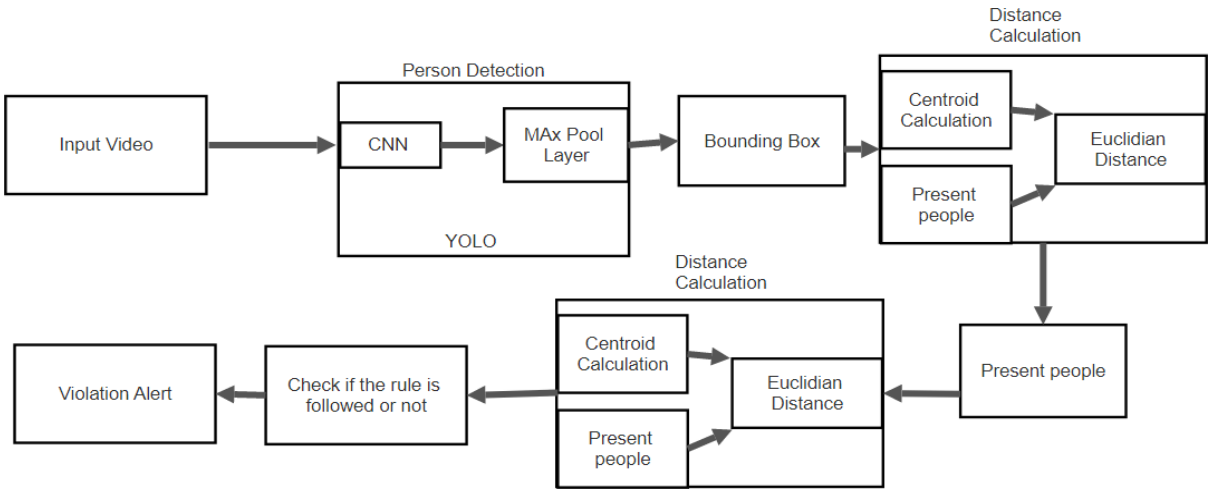

Fig. 4. System architecture

However, as illustrated in Figure 5, there are some detection problems in the system. The walkers strolling too close to another pedestrian until they are superimposed on the camera image may be causing these issues, distance measurement precision. The pedestrian detection method plays an important role in measuring distance between pedestrians. The YOLO method can also recognise the half body of the person walking on the road as full person and then detect it as a desired object by forming the required bounding box; however, the position of the person detected that is walking on the road being used in camera, pointing to the mid-point of the camera's bottom line, is then computed using the achieved bounding box in the previous steps, which might be exact lesser than desired. The suggested approach in the paper was enhanced by adding a new rectangular box for monitoring the designated and required region in a picture, as illustrated and shown in Figure 6, to overcome detection mistakes. As a result, for people density measurement, only people walking on the road within the designated zone will be counted and used for analyses.

V. CONCLUSION

A deep learning model is constructed to provide a solu- tion for social distance detection. The group of people not practicing social distancing will be highlighted with a red frame i.e., the ones that do not follow the rule and a red line using computer vision. A video of pedestrians strolling along the street was used to validate the suggested strategy. The computed results of visualization have revealed that the suggested approach is capable of computing social distance measures between individuals and people walking on the road, and that the project may be further refined for usage in various settings and public places that has chances of social distancing violation like in the school, park, office and restaurant. In addition, the project may be enhanced or improved by refining and improving the person or human detection algorithm, indulging additional detection methods such as face detection, a person wearing mask can be detected and a person's body temperature can be detected, which leads to increase in the computational capacity of the used hardware in the system, and joining the achieved results using camera perspective view.

Fig. 5. Output

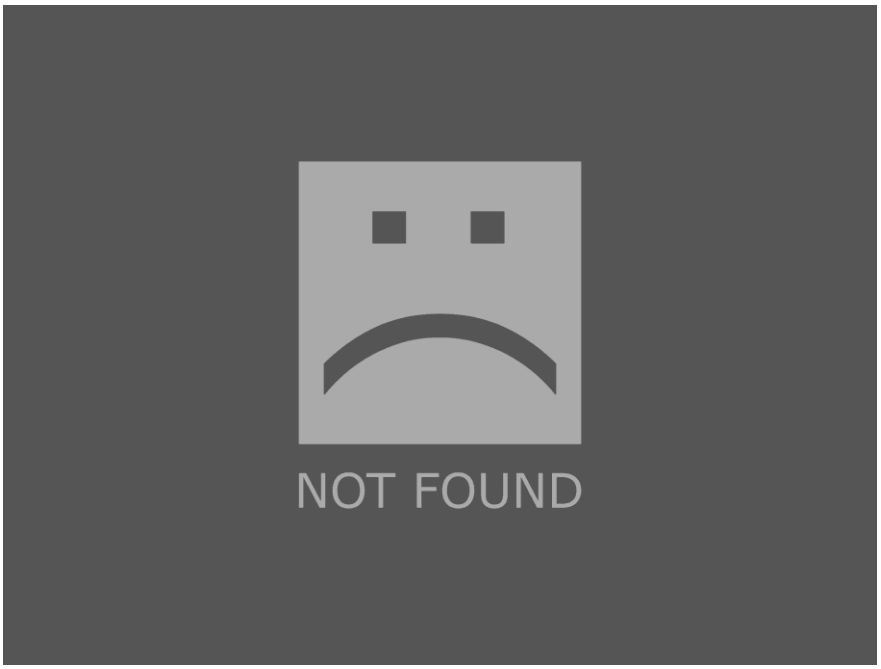

Fig. 6. Detection errors

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