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Detecting Social Distancing Violation Using Convolutional Neural Network

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***Abstract*— The paper describes an approach to detect violation of social distance between people. People are identified using a special object detection model YOLO which is based on Convolutional Neural Network and a pre-trained file yolo-weight. After the input video file and detecting human objects the distance between them is calculated by camera view calibration and coordinates assigned by object detection. The output video file contains the results where if the social distance is violated then it encounters a red frame, otherwise for safe distance it is represented by a green frame. As per standard guidelines the social distance is kept to be 6 feet or 2 metres. This model is tested on a pre-recorded video but it has a potential future application where it can be integrated to a live surveillance for real time detection.**

***Keywords*— social distance, YOLO, convolutional neural network, object detection**

I. INTRODUCTION

The world was stormed by Covid-19 pandemic, but necessary measures were taken by governments of every nation throughout the world to control its spread to save the lives of all human beings. This led to bringing normal daily activities to a complete standstill. Months into lock down, when we see the curve of death ratio knocking down in most nations around the world, the communities and health ministry grows restless. Relevant authorities like WHO have laid down certain guidelines and recommendations to minimize people's exposure to the virus. The centre for disease control and prevention, which is one of the public health bodies, has made it clear that the most effective way to gradually reduce the outbreak of the virus is by avoiding close contact with the people who might have been infected by the virus. Some safety measures people are encouraged to follow are wearing masks and keeping a distance of 6 feet, which is about 2 meters, from any other individual [1]. To implement social distancing, organization sports and congregations along with journeys, meetings, gatherings, workshops, and praying were banned for the duration of the quarantine period. The people are advocated to use telephone and electronic mail to manage and conduct occasions as much as possible to minimize the individual-to-individual touch. To similarly include the unfolding of the virus, people are also informed to carry out hygiene measures including often washing hands, wearing face masks and avoiding near contact with people who are ill. However, there may be a difference between understanding what to do to lessen the increasing virus and putting them into practice. In many nations the ministry of health has endorsed several disorder prevention measures for places of work, individuals, and families at domestic, colleges, childcare centres, and senior dwelling centres. These measures enclose imposing social distancing measures, increasing physical distance between workers on the place of job, heavy work schedules, reducing social contacts inside the administrative

centre, restricting massive paintings-associated gatherings, proscribing non-crucial work travel, performing normal health exams of workforce and visitors getting into homes, decreasing physical activities mainly for organizations which have group of workers within the excessive-chance category, and undertaking enterprise events or activities on line.

There are certain countries that have made Covid-19 norms as mandatory one by law and it has been found that its hard to ensure that people adhere to these norms which includes social distancing rule. To ensure effortless tracking of violators of norms an automated system is needed of the hour. According to the need we have developed a model that particularly suits to detect violation of norms in real time.

II. Related Work

Here we have discussed some of the related work with respect to object detection and neural networks. A lot of different models are present to perform object detection which uses different approaches and algorithms. This approach essentially comes under the domain of deep learning. This deep convolutional neural network has proven a higher efficiency in speed and accuracy when it comes to object detection, human description and real-time detection. The evolution in object detection started in 1986 with the introduction of HOG (Histogram of Oriented Gradients) which divides image into grad 8*8 cells and then finding histogram bins for each cell.

Some of the modern-day object detection algorithms consist of R-CNN [2], Faster R-CNN [3], SSD (Single Shot Detector) [4], Retia.Net [5], YOLO, etc. All of them have certain drawbacks and advantages over each other but YOLO using many layers of convolutional neural networks achieve higher efficiency and better real-time acquisition. Higher efficiency and higher accuracy are the biggest advantage of YOLO(You-Only-Look-Once). YOLO is a state of the art, object detection model where they have used COCO dataset. In this work we are typically using YOLOv3 which is extremely fast and more accurate. 4 times more speed can be achieved. It can process the video at 40-45 fps where it is compared with the SSD which can also work on the same fps. Using this technique and as application to covid-19 tools like face-mask detection has been developed. To advance this social distance detection tools are being developed but accuracy and correct identification of human objects in the frame is a task as in this type of detection multiple human objects would be present so detection of them with accuracy and measuring the distance between them using Euclid technique has become the top priority in the project. Thus, undertaking all the points, we present a highly efficient method where an input video frame can be given using an installed camera or webcam and the model provides an output video frame highlighting whether the distance between people is sufficient or not on the basis of standard norms.

III. Proposed Method

The suggested system, detecting social distance violation tool, was developed using convolutional neural network (CNN), Open computer vision (OpenCV), python and other deep learning algorithms to calculate the distance between people to maintain safety. The YOLOv3 model is used which is based on deep convolutional neural network. The YOLOv3 (You Only Look Once) is a real-time object detection algorithm that identifies specific objects in videos, live feeds, or images. The flow of detection is as shown in Fig. 1.

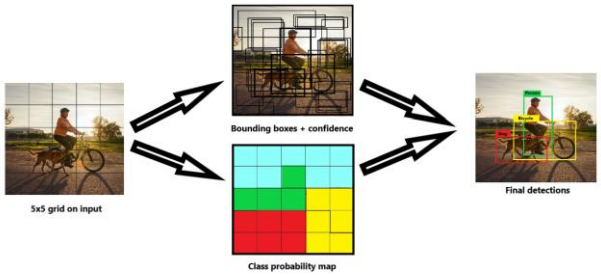

Fig. 1 Flow of object detection using YOLO

Working of YOLOv3 Algorithm for detecting objects (In this case, pedestrians)-

YOLO is a Convolutional Neural Network for performing object detection in real-time. The main advantage of CNN compared to other deep learning algorithms is that it automatically detects the important attributes without any human supervision. For example, if we provide an image of rabbits and cats it learns distinctive attributes for each class by itself. YOLO has the edge of being much faster than other networks and still maintains precision.

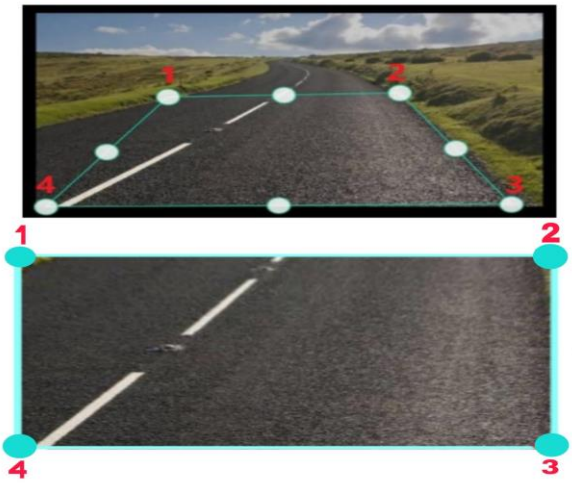

Fig. 2 View after camera calibration

Firstly, the YOLOv3 algorithm is based on the COCO dataset. The COCO dataset contains 80 labels such as people, animals, landmarks and firefighting equipment, aircraft, automotive-like vehicles and much more. Grids are separated from the image using YOLOv3. Each and every grid cell predicts a certain number of boundary boxes around objects which determines some confidence score of how accurate the prediction should be and as per boundary box, detects only one object. In this way object detection occurs. There are various algorithms similar to YOLO like R-CNN (Region-based Convolutional Neural Network made in 2015) [6], Fast R-CNN (improved version of R-CNN made in 2017) and Single Shot Detector (SSDs) [7] that can carry out the same intention. But unlike them, YOLOv3 (developed in 2018) is trained to do bounding box regression and classification at the same time. After detecting the objects(pedestrians), measuring the distance between them comes into the picture- After detecting people in video frames, the next step is to determine the centroid of each detected pedestrian bounding box for calculating the distance between people. The detected bounding box coordinates(x,y) are used to evaluate the centroid of bounding boxes. After evaluating, centroid, a unique ID is provided to each detected bounding box. In the following step, we calculate the distance between each detected centroid using Euclidean distance. If C1 is centroid of 1st object (bounding box of pedestrian) having coordinates (x1, y1) and C2 is centroid of 2nd object having coordinates (x2, y2) then the Euclidean distance between these two points will be calculated as

$$d = \sqrt{[(x2 - x1)^2 + (y2 - y1)^2]} \quad (1)$$

The information of each centroid is stored and on the basis of distance values, a threshold is defined to examine if any two people are less than N pixels apart or not. And on the basis of that threshold evaluation, we can show if the people are violating the social distance or not similar to the Fig.3 shown below.

Fig. 3 Detection of social distancing violation

Summarizing the methodology for better understanding-

1. First of all, we take the input video sequences.
2. Then we split the data set into training and testing and convert the video into frames. Fig. 2 shows how we use calibrate our camera frame to get top down view.
3. Then these video frames are processed under the algorithm which works on a convolutional neural network called YOLOv3 pre-trained on COCO dataset.
4. The YOLOv3 algorithm detects the bounding box (in our case, pedestrians) and then computes the pairwise distance between centroids of each detected bounding box.
5. Then we check the distance matrix for people if it is less than N pixels or not.
6. If two people are too close, then we add them in the violated set and if not then we add them in the non-violate set.
7. Then all these detected person bounding boxes are initialized with the colour green. If the current index exists in a non-violation set then the colour remains green otherwise the colour is updated to red for that bounding box.
8. After that we used a centroid tracking algorithm to track each detected human based on the colour of the bounding box and display information of the total number of social distancing violations. Fig 4 shows the Pipeline for the methodology.

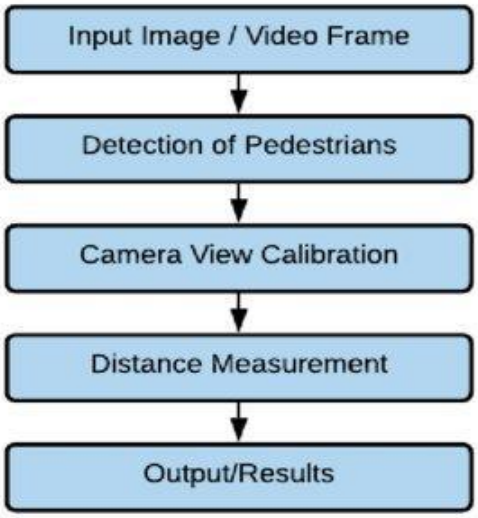

Fig. 4 Pipeline for the methodology

IV. Results, Conclusions And Future Scope

A method is proposed to detect the social distance between people using object detection and thus it will be used to identify the violation of social distance among people. This is depicted using red and green frames for violation of social distance and safe distance respectively, also a counter for number of violations is included.

This method is successfully tested on a pedestrian video frame where random people are walking on the street.

An output frame as shown in Fig. 5 consisting of the detection is generated successfully. This method has wide applications and future works such as real-time detection using a CCTV or web-cam. Other Covid-19 norms and precautions like wearing a mask can be included as face mask detection. Efficiency and accuracy in measuring the distance can be enhanced.

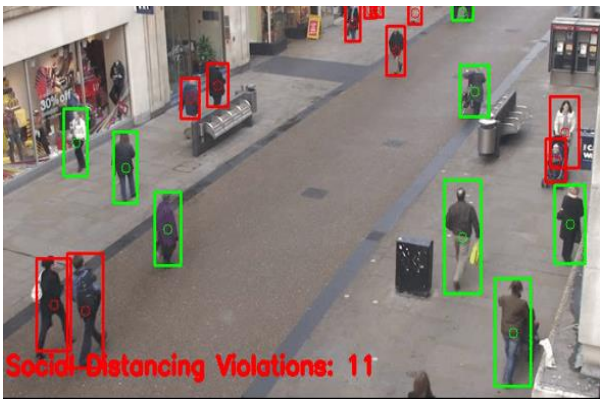

Fig. 5 Comparison to other detectors

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