SOCIAL DISTANCE MONITORING SYSTEM

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Abstract

In this paper, we propose a Social Distance Monitoring System where we have used Computer Vision and Deep Learning techniques for object detection using the YOLO model with the pre-trained COCO data set to detect the people in a video stream. For the detected people in a video stream, we find or compute the pairwise distances between them by calculating the centroid, and based on the distances which have been computed, we have determined whether the social distance rule is being violated or not. We have used the automated self-monitoring system using already existing surveillance systems which include surveillance cameras which are also known to be CCTV, and dome cameras which take input and help in maintaining social distance in public places or public locations. This application or proposed model also aims to provide a mail system to alert the higher authorities whenever the number of violations is more than the threshold value given.

Keywords: Computer Vision, detection, YOLO model, COCO data set, self-monitoring system, mail system

Introduction

Covid-19 created great chaos around the world in early 2019 as it is an infectious disease which is caused by the Sars-2-cov virus and it greatly affected the entire nation concerning the global economy and the health of many people around the world. During the outbreak of a covid-19 pandemic, many countries have implemented certain measures of social distancing which include avoiding traveling or restricting traveling, shutting down the public places, and warning people to keep a minimum distance of 2–3 meters from each other when they have to go out.

So, many factors affect an individual's health and the economic breakdown of the nation. The WHO proposed to follow certain aQuantive measures to prevent the spread of disease which is caused through sneezing, coughing, touching hands-on surfaces, etc.

In this kind of situation, monitoring the people to keep a certain distance from each other through human supervision is nearly impossible as the people who are working to monitor such situation might also get infected as the disease spreads faster which causes great havoc, to prevent that from happening, the certain system has to maintain a social distancing in a public place with the help of online surveillance systems like CCTV which automatically finds out the number of serious violations and reduces the human effort.

Review of Literature

In 2001, viola and jones had come up with an approach for object detection using the AdaBoost learning algorithm. In the year 2005, N.Dalal and B.triggs used a feature descriptor for object detection named Histogram of Oriented Gradients (HOG). In the year 2008, P.Felzenszwalb et has proposed the model named DPM which is abbreviated as Deformable part models. In 2014, R.Girshick et al have come up with a model named R-CNN and in mid-2014, K.He et al proposed a model name SPPNet which is abbreviated as spatial pyramid pooling networks. In the year 2015, R. Girshick proposed an advanced version of R-CNN which is fast R-CNN.In the year 2016, SSD which is known as the single-shot detector has been proposed by W.Liu et al and in mid-2016-1017, the Yolo model has been proposed and founded by J.Redmon et al . In the year 2020, yew Cheong hou has provided with a model using CNN where it classifies and presents a methodology for social distancing and a detection tool had been developed to alert people to maintain a safe distance.

The models which have been proposed over the period 2001 – 2008 are supposed to be known as Traditional models and the models which are proposed between the period 2014 – to the present are supposed to be known as Deep Learning- based detection methods.

Proposed Model for Monitoring Social Distance

The complete scenario of social distance monitoring in the public or the community is presented in the below Fig. 1 as proposed. CCTV cameras available in public places or dome cameras which are available at any shopping malls, and business centers can be used for surveillance via a social distance monitoring system. The input video stream, which is received from these cameras is given to object detection and module tracking for detecting the presence of humans in a location.

An alert is produced when the color of the bounding box changes from green to red when the humans are detected. The bounding box color is shown as green until there is a safe or admissible distance between the persons. So, when the distance decreases, the color of the bounding boxes changes from green to red, which shows that the social distance violation is done.

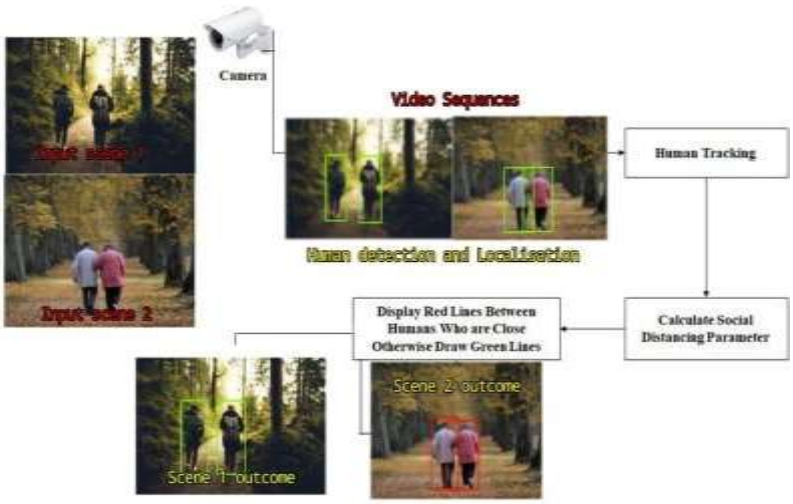

Fig. 1. Proposed Social Distance Monitoring System

YOLO model is an approach that can be used for object detection where it is an algorithm that is based on regression, so it predicts classes in one run of an algorithm and bounding box for the whole image. It is generally possible that the image which is divided into particular blocks or sizes containing part of the object introduces many bounding boxes all over the object. To avoid this problem, Non-max suppression is used and then the algorithm finally produces an output sowing details of the bounding box of the particular class.

Proposed YOLO Model with COCO Data set

We have known many famous algorithms and architectures for object detection. With the help of these algorithms, some problems have been solved but they fail on one most important thing which is Speed for object detection in real-time.

To understand the YOLO model, we need to know what we are predicting, so we aim to predict the bounding box of an object's location and predict the class of an object. So, the bounding box can be described using the center of the box and by width and height. YOLO splits the given image into cells, basically of a 19 *19 grid where each cell is responsible for the prediction of n-bounding boxes. The height and width are calculated to the image size given. During the forward propagation of one pass, the YOLO model decides the probability a cell contains a certain class,

The equation is:
Score(class ,I) = probability(class) X class(I)

The class with the max probability produced is taken and assigned to the grid cell of that class where it is present. The same process takes place for all cells of a particular grid present in an image. After predicting the class probabilities of an image, we have to perform Non-Max Suppression which helps the algorithm to discard unnecessary bounding boxes. We can observe there are numerous bounding boxes which makes us difficult to predict based on class probabilities. To avoid this problem, Non-max suppression is used where it helps the algorithm to get rid of unnecessary boxes and eliminates the boxes that are close by performing Intersection of Union (IOU), so accordingly the bounding boxes are rejected whose value is greater than the threshold value given. The one having low probability scores for the same image is eliminated. Once completed, the algorithm which is defined finds the bounding boxes with the highest probability class and does the same process all over again, then the algorithm produces the final output with the details of the bounding box of a particular class.

The flowchart of the model can be seen below in Fig. 2

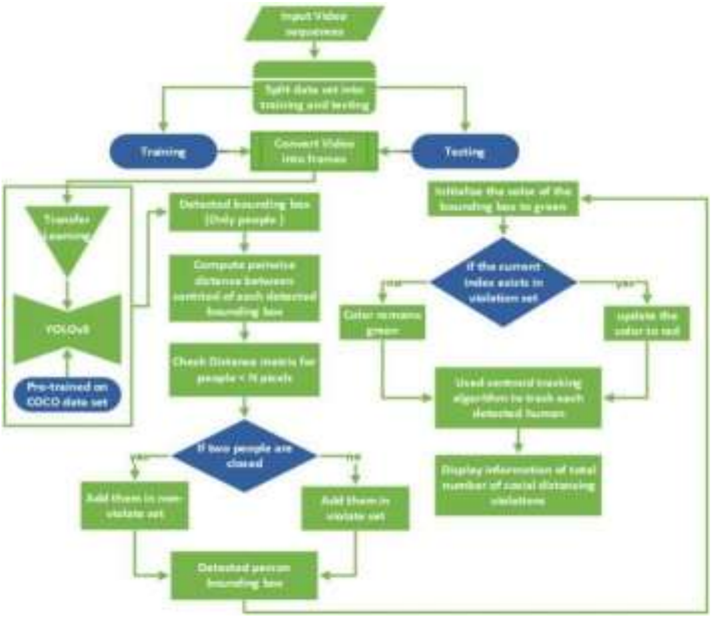

Fig. 2. Flow Chart of Social Distance Monitoring System

So this is all about the YOLO algorithm, still, some improvements are being made in the algorithm which follows a regression advent, we currently have the versions of the YOLO v1,v2,v3,v4 and recently v5 has been introduced with much-added features.

Proposed Algorithm for Social Distance Monitoring System

It is the next phase after the development of the YOLO model. So, the algorithm for social distance monitoring contains two functions where

Function 1- helps in finding out an object's location in an image where it uses a detection algorithm and provides the location of the human in the form of coordinates that contains values like top Y(A), bottom Y(B), right X(B) and left X(A), from the above coordinate values, based on different centroid values objects are identified and the evaluation of centroid value is shown as

2. X=(X(A) + X(B)) / 2
3. Y=(Y(A) + Y(B)) /2

Here X and Y are the coordinate values of a centroid, after this, it is passed onto Function 2 for measuring social distancing.

Function 2 –Here, we find out the distance between the two objects which decides the proximity between them using Euclidean Distance, the formulae are stated above

4.Euclidean distance(D)=

$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}.$$

So, after knowing the proximity between them, we compare the distance vector with the already defined threshold value. If the Euclidean distance is less than that of the threshold value given, then it is presumed that these objects are not following the criteria of social distancing, Now an alert is generated or made to the security people by showing the red rectangle(bounding box) around the objects. Therefore, the person who violates the rules is asked to maintain social distance, or serious action is taken against them.

Experiment and Analysis

In this paper, CNN-based techniques have been developed to detect the presence of humans. In addition, the practice of social distancing is performed from these proposed techniques. All the experimentations have been performed on Intel(R) Core(TM) CPU @ 1.80GHz 1.99 GHz processor of the 64-bit type system and Visual Studio Code in Python. We have used the MS COCO dataset for training purposes. The MS COCO (Microsoft Common Objects in Context) dataset is large-scale object detection, segmentation, key- point detection, and captioning dataset. The dataset consists of 164K images split into training (118K), validation (5K), and test (41K) sets. The YOLO model we used is pre-trained on the Coco dataset.

In the proposed model we load the COCO class labels our YOLO model was trained on, and derive the paths to the YOLO weights and model configurations. We then load our YOLO object detector trained on the COCO dataset (80 classes) by determining only the output layer names that we need from YOLO. It then tries to grab a reference to the camera or video file. The model keeps capturing the frames from the live feed until it has reached the end of the video stream and resizes the frames to detect only people in it.

The model now grabs the dimensions of the frame, constructs a blob from the input frame, and then performs a forward pass of the YOLO object detector, giving us our bounding boxes and associated probabilities. For each of the layer outputs, we loop over each of the detection and extract the class ID and confidence of the current object detection. We filter the detection by ensuring that the object is detected as a person and that the minimum confidence is met. The model now scales the bounding box coordinates back relative to the size of the image, keeping in mind that YOLO returns the center (x,y) coordinates of the bounding box followed by the box's width and height. It then uses the center coordinates to derive the top and left corner of the bounding box and updates the list of bounding box coordinates, centroids, and confidences. Now, we apply Non-maxima suppression to suppress weak, overlapping bounding boxes.

The model now initializes the set of indexes that violate the max/min social distance limits by computing the Euclidean distances between all pairs of centroids. It checks to see if the distance between any two centroid pairs is less than the configured number of pixels, updates the violation set with indexes of the centroid pairs, and also updates the abnormal set if the centroid distance is below the maximum distance limit.

Finally, the model extracts the bounding box and centroid coordinate to define the color of the bounding box. If the index pair exists within the violation set then the color is red, if the index pair exists in the abnormal set then the color is yellow else the color is green indicating a safe condition.

The proposed model now outputs the total number of serious violations, total number of abnormal violations, number of people detected in the video stream, the set threshold limits, and an alert message when the number of serious violations crosses the threshold limit with different colored bounding boxes for each person detected as they keep moving.

Results

The figures Fig.3 and Fig.4 below represents the frames captured by the model from the input test video file detecting people in the input stream and finding the bounding boxes for each of the detected people. The color of the bounding box is decided by the distance between the centroids of each person. Red color indicates serious violations , yellow represents abnormal violations ,while green represents safe condition.

Fig. 3 Social distance rule violated

Fig. 4 Social Distance rule not violated

The figures Fig. 5, Fig. 6 and Fig. 7 below represent captures taken during live stream through webcam, representing the number of people detected with their respective colored bounding boxes indicating serious ,abnormal or safe conditions.

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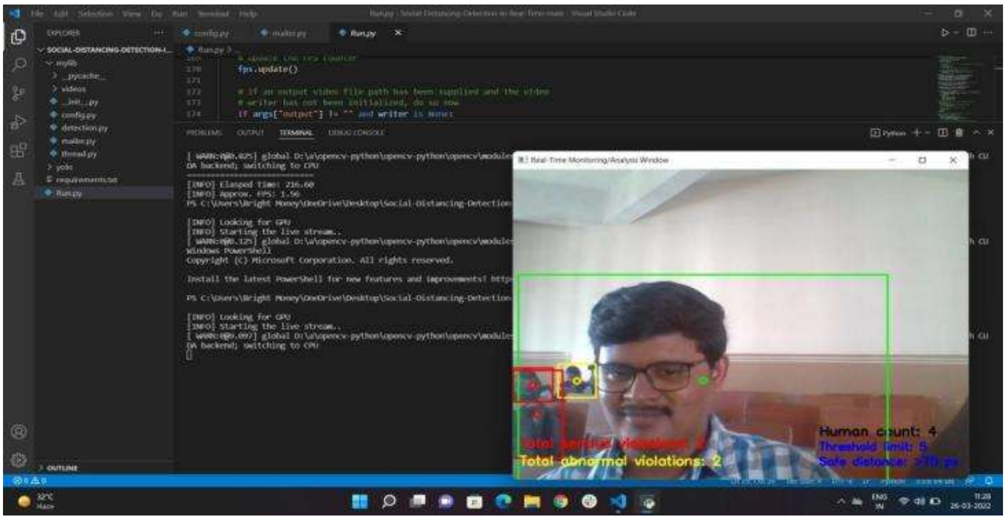

Fig. 5 Social distance rule violated representing serious and abnormal violations

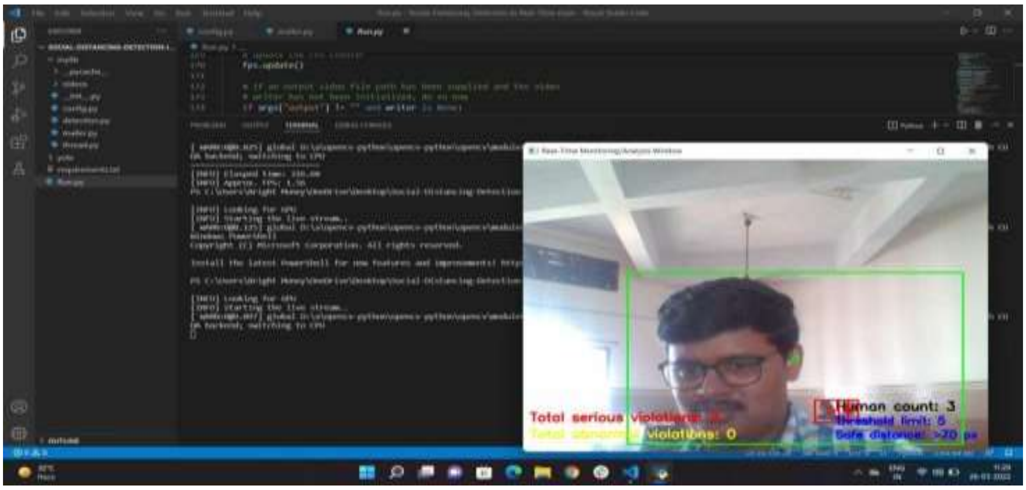

Fig. 6 Social distance rule violated representing serious violations

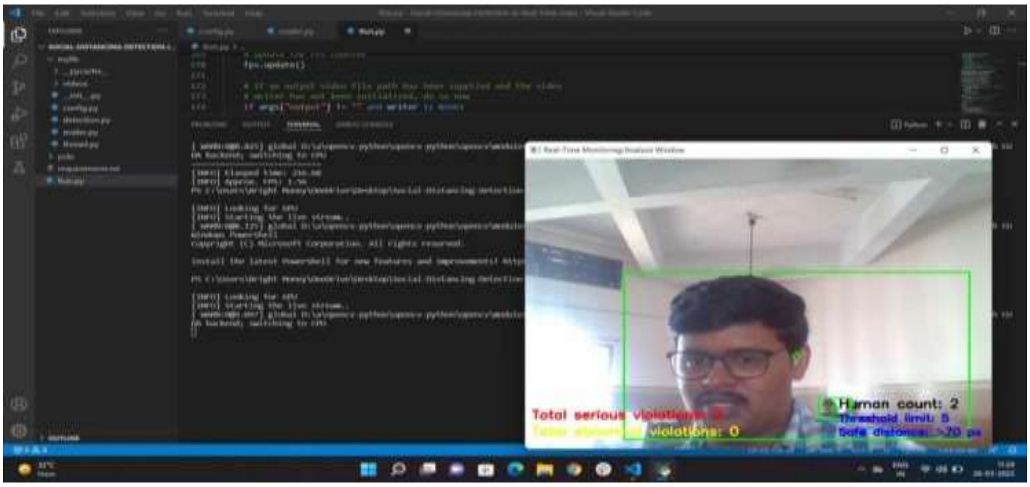

Fig. 7 Social distance rule representing safe condition with no violations

Conclusion

This paper tells or suggests to us the detection techniques for social distance monitoring in real-time surroundings. The YOLO model that has been used is used to measure the distance among people. These evaluated criteria of distancing decide whether two people who are close to each other are following social distancing rules or not. The experiments were done by Yolo-based object detectors. In experiments, it had been found that Yolo-based object detection gives better accuracy and much faster result when compared to other algorithms, sometimes it may produce some false assumptions and output while dealing with video sequences. They are many object detectors namely R CNN, Faster R CNN, SSD, R FCN, and YOLO. In this project, we have implemented YOLO which is an already pre-trained model on the COCO dataset to increase the accuracy of detection and reduce false instances in a produced model. Therefore, the proposed YOLO algorithm produces more accuracy and provides more efficiency with the ability to capture 45 frames per sec. In the future, object detectors with the latest version like YOLOv5 may be deployed with the self-created dataset to increase detection accuracy and reduce false-positive instances. Additionally, a single viewpoint obtained from a single camera can't reflect the result more effectively. Therefore, the proposed algorithm may be set for different views through many cameras in the future to get more accurate results. As a future enhancement, we could also integrate a sound system for immediate alerts and direct the results to police control rooms to take immediate actions.

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