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Social Distance Measurement using Deep Learning

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ABSTRACT

The project presents a methodology for social distancing detection using deep learning to measure the distance between people to prevent the impact of the coronavirus pandemic. The camera field-of-view covers the people walking in a particular space. The video frame from the camera was used as input, and the open-source object detection pre-trained model based on the YOLOv3 algorithm was implemented for pedestrian as human object detection. Later, the video frame was changed into top-down view for distance measurement from the 2D plane. Using the Euclidean distance, the detected bounding box centroid's pairwise distances of people are calculated. The proposed method was working fine on a pre-recorded video of pedestrians walking on the street. The proposed method is also able to determine the social distancing measures between many people in the video. The developed technique can be further developed as a detection tool in real time application for use in other environment such as office, restaurant, and school.

KEYWORDS: Weight, Trained model, Deep Learning, Boundary box, Threshold.

1. INTRODUCTION

At present we are not sure about extinction of coronavirus and also not certain about reemergence of other new viruses. To leverage the economic activities organizations, schools, companies have started working. And during this to maintain safety measures of post COVID situations is mandatory. Social distancing is one of the crucial norm. Thus our proposed model can be used to calculate social distance between people over a specific area.

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms, objectives and overall description. In Section 2 we discuss related work. In Section 3 we have the complete information about image processing tools. Section 4 shares information about the flexible YAML templating system created for it, its advantages and disadvantages. Section 5 tells us about the methodology and the process description. Section 6 tells us about the future scope and concludes the paper with acknowledgement and references.

2. RELATED WORK

In this project first step is to detect human object which is more important. Many computer vision techniques can be used to achieve this. Many researchs have been done and now deep learning is used for classifying and identifying multi class objects in computer vision tasks. Deep CNN is a deep learning algorithm with multilayer perceptron neural networks which contain several convolutional layers, sub-sampling layers, and fully connected layers. CNN has achieved

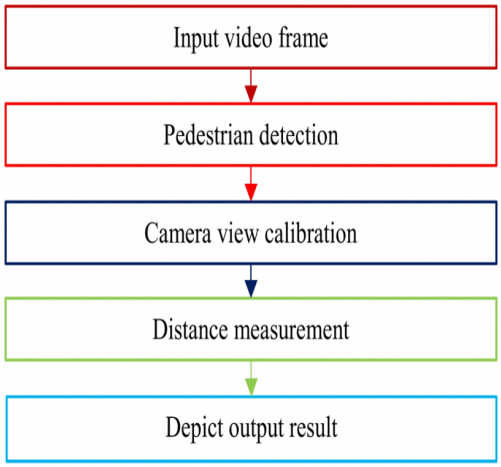
great success in large-scale image classification tasks due to the recent high performance computing system and large dataset such as Image Net [4].

Many CNN models for object detection with its object localization had been projected in terms of network architecture, algorithms, and new ideas. In recent years, CNN models such as Alex Net [3], VGG16 [5], InceptionV3 [6], and ResNet-50 [7] are trained to achieve outstanding results in object recognition. In an image there may be different aspect ratios for the object. So, the real-time algorithms of object detection using the CNN model such as R-CNN [8] and YOLO [9] had further developed to detect multi-classes in a different region in images had been developed. Taking the idea from the work [10], we present a computer vision technique for detecting people through a camera which is fixed at the workspace.

3. METHODOLOGY

Deep CNN method and computer vision techniques are used in this work. First, an open-source object detection network based on YOLOv3[11] algorithm was used to detect the human in the video frame. From the detection result, only human class was used and other object classes are ignored. Thus, the bounding box best fits for each detected human is drawn in the image, and these data of centroids of the detected pedestrians will be used for the distance measurement.

Block Diagram of Social Distance measurement :



A. Human detection:

In deep learning-based object detection, the YOLO model is considered one of accurate obj ect detectors which provide important speed advantages which are suitable for real-time application. The YOLO algorithm takes an input image i.e a video frame and simultaneously acquiring bounding box coordinates (tx, ty, tw, th), obj ect confidence and corresponding class label probabilities (P1, P2, …, Pc). The YOLO is trained on the COCO dataset which consists of 80 labels including human or pedestrian class. In this, the only box coordinates, object confidence score and pedestrain object class from detection result in the YOLO model were used for human detection.

B. Camera View Calibration:

Region of interest of an image focuses on the human walking street was changed into a top-down 2D view that contains 480×480 pixels . Camera view calibration is implemented which works by computing the transformation of the perspective view into a top-down view. In OpenCV, the perspective transformation is a simple camera calibration method where we select four points in the perspective view and mapping those points to the corners of a rectangle in the 2D image view. Thus, every human is assumed to be standing on the same level of flat plane. Original distance between humans corresponds to the number of pixels in the top-down view can be calculated.

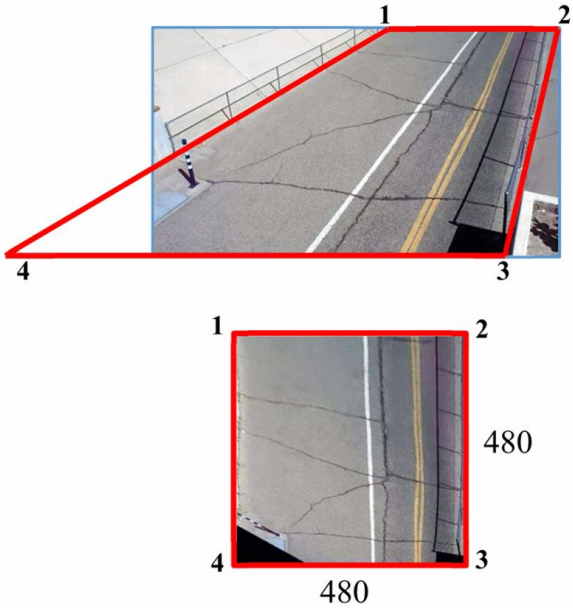


Fig. 1. Cosidering Quadrilateral Section

C. Distance Measurement:

Here,first the location of the bounding box for each person (x, y, w, h) in the perspective view is detected .Then changed into a 2D top-down view. For each human, the position in the top-down view is located

based on the centroid point of the bounding box. The distance between every centroid pair is computed from the top-down view using Euclidean distance formula and the distances is scaled by the scaling factor estimated from camera view calibration method. If the position of two pedestrians in an image are given as (x1, y1) and (x2,y2) respectively, then the distance between the two humans, calculated as:

$$d=\text{sqrt}((x2-x1)2+(y2-y1)2)$$

The pair of humans whose distance is below the minimum acceptable distance, is highlighted in red, and the others in green. A red line is also marked between the pair of individuals whose distance is under the pre-defined threshold.

4. RESULTS

As shown below the results for pre-recorded pedestrian video are achieved correctly. But the main constraint is correct fixation position of camera and can be monitored over a specific area only.

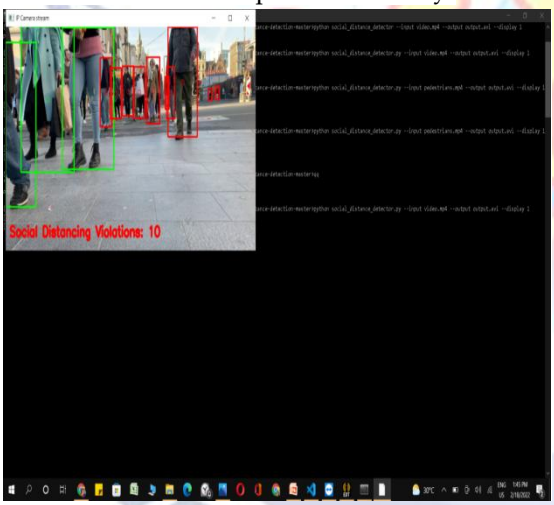


Fig. 2. Pre-recorded video-1 Result with camera placed at front to monitoring area

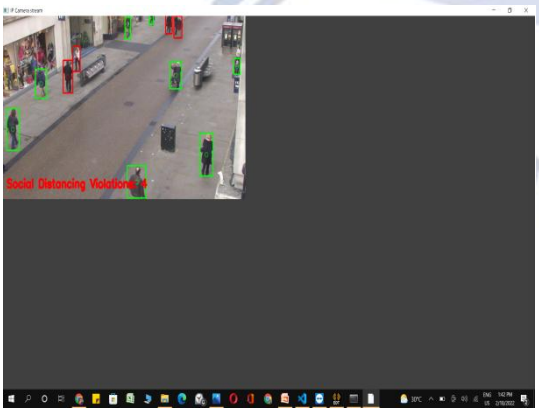


Fig. 3. Pre-recorded pedestrian video-2 Result With camera at elevation to the monitoring area

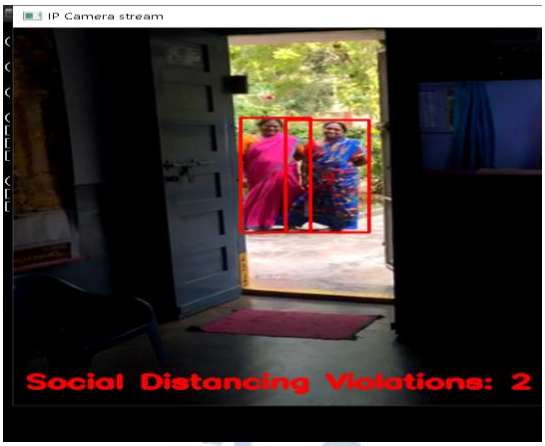


Fig. 4. Live time detection Result-1

Fig. 5. Live time detection Result-2 With camera at front to the monitoring area

However, there are also a number of detection errors. These errors are possibly due to the pedestrians walking in such a way until they are overlaid on the camera view. The precision of the distance measurement between pedestrians is also depends on the human detection algorithm that is YOLO.

- The obtained result is written to an output file as specified by the user or in default configuration.
- The output file is saved to a specified folder for the user to access.

- This flexible invoicing system would help minimize human interaction, which in turn will increase efficiency and reduce costs.

5. FUTURE SCOPE AND CONCLUSION

The observed results showed that the proposed method is capable to measure the social distancing measures between people which can be further extended development for use in other real time such as office, restaurant, and school. In addition, the work can be further improved by optimizing the human detection algorithm, adding other detection algorithms such as mask detection and human body temperature detection, improving the computing power of the hardware, and calibrating the camera perspective view.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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