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A Computer Vision Based Social Distancing Detector as a Safety Enhancement Tool for Educational Establishment in a Covid World

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ABSTRACT
The COVID - 19 pandemic has had a distressing effect on all irrespective of caste, creed, gender, and religion. Even with the advent of vaccine and people been vaccinated, the mutation of the virus is stillnegatively impacting the economy of the world as a whole. Hence, for education system to continue unhindered, there is need to develop a social distancingdetecting model, a key factor for combating this menace, especially in our educational sector which according to WHO should be made safe instead of closed. The model designed was built in two modules namely people detector and social distancing modules. The model used YOLO(You Only Look Once) object detection algorithm which is an extremely fast multi object detection algorithm which uses convolutional neural network (CNN) to detect and identify objects as well as the Euclidean distance measurement for the determination of a safe distance. From the model testing result we were able to accurately detect violators of this rule.

KEYWORDS: Object detection, Distance detection, CNN, YOLO, MobileNetV2, SSD

I. INTRODUCTION

Using computer vision to enhance safety of workforce in the educational sector in a covid world is a novelty. The spread of COVID-19 virus and the ensuing largescale lockdowns across the globe has given rise to an alarming situation Khandelwal et al (2020), which has resulted in the shutdown of activities of all sectors including the educational sector. While there is an urgent need to resume activity in this aforementioned sector, it is imperative to the safety of all participants (students and workers). World Health Organization (WHO) has recommended at 1.5m distance to be maintained between individuals. although what is being required by this organization is very simple, however social distancing can easily be flouted unconsciously within this sector due to its peculiarities. Therefore, it's imperative for the authorities of this institution to ensure social distancing starting from student's congregation in the classroom, to laboratory practical, to examination among others. Measuring participants commitment to this safety regulation can be very challenging, hence the need for the development of an automated vision-based approach for automated social distance violators detector.

All educational institutions are expected to possess Closed Circuit Television (CCTV) installed as part of their security system setup. These CCTV can be equipped with computer vision tools function that takes in their feeds and analyzed to detect violators due to the fact that it is a very challenging task to concurrently measure these feeds manually. These feeds when subjected to automated monitoring will provide a real time voice warning alerts to violators as well as equipping the authorities with data to measure the level of compliance.

II. RELATED WORK

Khandelwa et al. trained their model using TensorFlow Object Detection API and used 300 × 300 size input for SSD model with MobileNetV2 as backbone. For Distance Measurement the custom trained MobileNetV2 model was run for person detection on each frame. The output from the model is a list of coordinates of bounding rectangles on detected persons. The face mask monitoring module accepts individual frames and are treated as static images. The processing of these images was carried out in two steps; Face Detection and Mask Classification. The deep learning-based CNN models for face detection was used with the off-the-shelf pre-trained MobileNetV2 model and observed a model accuracy of 94.1%. Once a worker is detected who is not wearing a face mask, an alert is again triggered to the AE. The precision is 0.97 and the recall is 0.97 with mask being the positive class. The frames per second throughput of the model is 42.09.

Gad et al. proposes an approach to monitor social distancing, using cameras, and combining different computer vision algorithms. The approach utilizes the concept of inverse perspective mapping (IPM) together with the camera's intrinsic information to produce a bird's eye view with real-world coordinates of the frame being processed from a video source. The process starts with image enhancement, foreground detection using Gaussian Mixture Model (GMM) background subtraction, tracking using Kalman filter, computing real-world distance measurements between individuals, and detecting those who have been in less than 2 meters apart.

III. MODEL METHODOLOGY

The phone camera was used for the recording of the video streams. These feeds were for the testing of the model. Whenever violation is encountered, the public address will be triggered to warn prospective violators. The number of incidenceswere also recorded per video stream.

People Detector

People detection which is the first step is one of the modules of this model, it can be taken as a combination people locator and recognizer technique. This is accomplished using YOLO(You Only Look Once) object detection algorithm which is an extremely fast multi object detection algorithm which uses convolutional neural network (CNN) to detect and identify objects.. It forwards the whole image only once through the network This program can detect a wide variety of objects, but a filter is included for person recognition only. Once detection occurs, each person is represented by what's called a "bounding box," which is a rectangle whose coordinates surround the person. This algorithm uses the non-maximum suppression to predict the confidence that each bounding box actually encloses a person. The YOLOv3 is integrated with OpenCV's GPU DNN module.

The model was trained using the yolov3.weights file (containing the pre-trained network's weights), the yolov3.cfg file (containing the network configuration) and the coco.names file which contains the 80 different class names used in the COCO dataset. The input image to the neural network is called a blob. After a frame is read from the input image or video stream, it is passed through the blobFromImage function to convert it to an input blob for the neural network. In this process, it scales the image pixel values to a target range of 0 to 1 using a scale factor of 1/255. It also resizes the image to the given size of (416, 416) without cropping. The output blob is then passed in to the network as its input and a forward pass is run to get a list of predicted bounding boxes as the network's output. The image with the final bounding boxes is then saved to the disk using a video writer for the input video stream.

Social Distancing Detector

Social distance detection is a module of the model to detect the humans in each frame which is a shot of the video(shots of students in classroom as well as corridors) with yolov3 convolutional neural network, these frames when stitched together makes the video. From each detection a bounding box was created, using the boxes centroid the distance between each bounding box were calculated using the Euclidean distance measurement formula stated below:

$$d_{ij} = \|p_i - p_j\|$$

Each of the distance was compared to the set minimum safe (threshold) distance which is set at 50 inches to determine if there were violations or not. Whenever a violation is detected it triggers an alarm system that warns against such action or enjoined them to maintain a safe distance as required. An OpenCV function was used to write the output video which can be used to set up a databank for taking the statistic of violator per video shot. The output is the view which shows of the bounding boxes in red(unsafe) and green(safe).

IV. LIMITATION

The phone camera was used to do the recording due to the unavailability of CCTV at the institution where the video shots were recorded. Due to this the detector does not take into account the camera perspective, which resulted in the top-down transformation of the viewing angle not being applied, thereby leading to a non-proper implementation of better distance approximation of the populace of the school. Also, this social distancing detector was unable to leverage a proper camera calibration which should have yielded an improved result with the computation of actual measurable units rather than pixel usage.

V. RESULT

Shown below are selected screenshots of social distancing violators in a school environment

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