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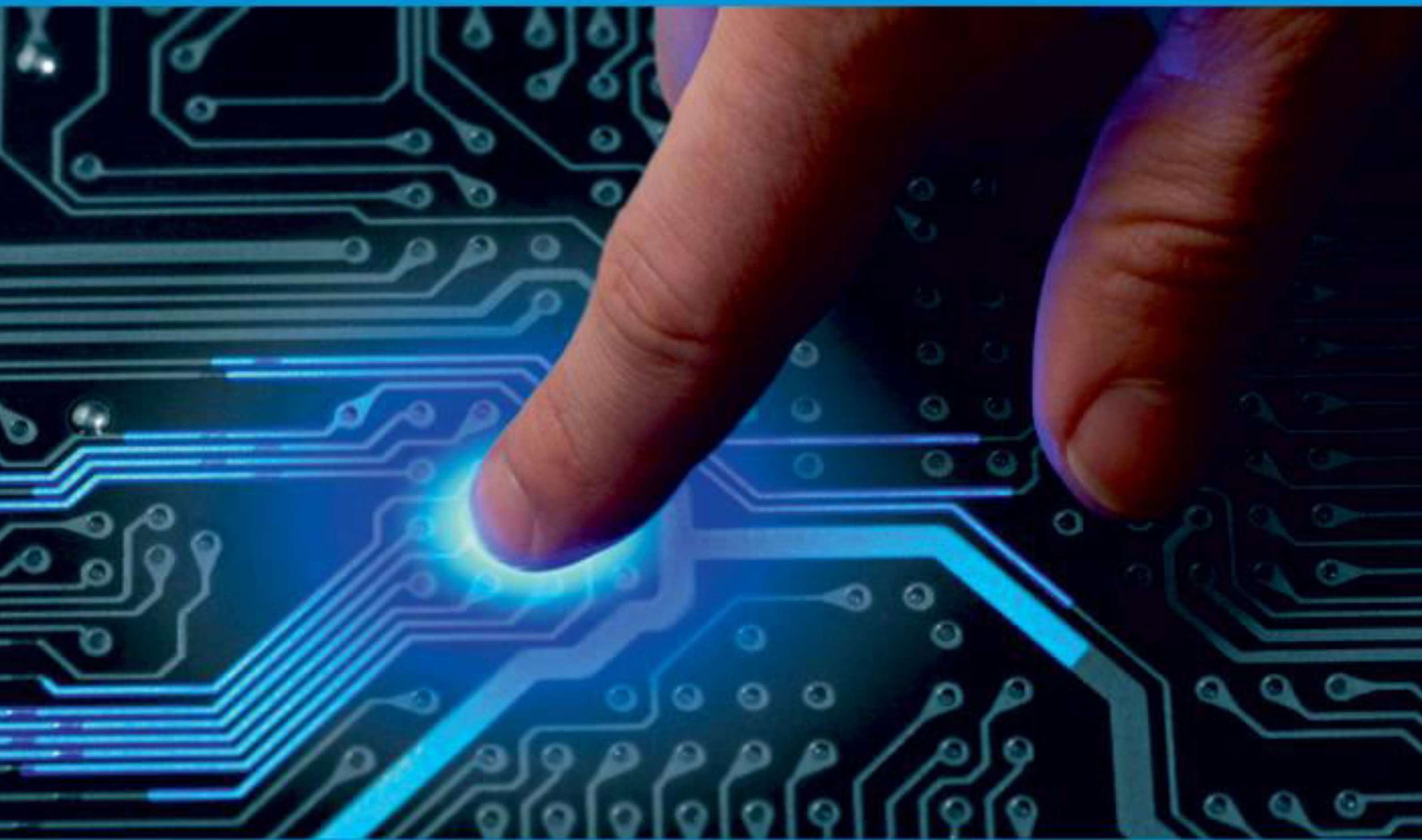

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Real-time Monitoring of Social Distancing

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ABSTRACT: The Covid-19 pandemic has affected humanity drastically and has infected more than 400 million people worldwide. The fear and danger of COVID-19 virus still stands large. In this critical situation, social distancing has proven to be an effective measure to minimize the spread of the virus. Motivated by this notion, we propose an efficient computer vision-based approach which focuses on the real-time monitoring of people to detect social distancing in public places. This system utilizes input from the live video through surveillance cameras (webcam/CCTV) that is fed into the YOLOv3 model which is a pre-trained object detection model to identify humans from the video stream. Identified people are tracked using bounding boxes and Non-Maxima Suppression is used to reduce overlapping bounding boxes to only a single bounding box. The Euclidean distance is calculated between every pair of individuals and based on the result, the count of social distance violators are tracked. As the violation exceeds the threshold value(maximum violations limit), an alert message is sent automatically to a particular phone number or email address used for this very cause in addition to which alarm sound is also generated. Findings indicate that the system successfully distinguishes individuals breaching social distance.

KEYWORDS: COVID-19; Social distancing; YOLOv3; Non-Maxima Suppression; Euclidean distance;

I. INTRODUCTION

When it comes to dealing with the worldwide Covid-19 pandemic, flattening the curve for coronavirus cases will be challenging if people do not take steps to stop the spread of the virus. Keeping a safe distance between individuals in public is one of the most critical tactics. Social distancing refers to strategies for preventing the transmission of a virus by limiting human physical contact in public areas (e.g., shopping malls, parks, schools, universities, airports, and workplaces), avoiding crowds, and maintaining a safe distance between individuals. Distancing oneself from others is vital, especially for those who are already at higher risk of serious sickness due to COVID-19. The spread of the virus and the severity of the infection can be considerably reduced by reducing the probability of virus transfer from an infected person to a healthy person. The detection of persons with social distance monitoring is presented in this work as a preventive approach in limiting physical contact between people. The proposed system intends to encourage social distancing by offering an analyzer tool that can be used to monitor public spaces, businesses, schools, and universities in order to evaluate and detect any violations of social distance and issue warnings in the form of alarm sound and alert messages.

II. RELATED WORK

Since the onset of the coronavirus pandemic, many countries have used technology-based solutions to inhibit the spread of the disease[1,2]. For example, some of the developed countries, such as South Korea and India, use GPS data to track the movements of infected or suspected individuals in order to find any possible exposure among the healthy people. The Indian government uses the Aarogya Setu program to find the presence of COVID-19 patients in the adjacent region, with the help of GPS and Bluetooth. This may also help other people to maintain a safe distance from the infected person[3]. To detect large-scale rallies, certain law enforcement organisations utilize drones and surveillance cameras, and have implemented regulatory procedures to disperse the crowd[4,5].

Transforming the objective and interpretation from the work, this system presents a method for detecting people using computer vision. Instead of using drone technology, the input stream can be from a camera. The YOLO algorithm, which is based on deep CNN, is used to detect humans in video feeds. The distance between persons is measured to see if the pedestrians in the video maintain a sufficient social distance[6,7].

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III. METHODOLOGY

The proposed system provides a solution for detecting people gathering in public places such as banks, shopping malls, clinics etc. To ensure public safety, Computer vision, deep learning, and Python are used to determine the distance between people. The development of this work is done with the help of the YOLOv3 model based on convolutional neural networks. In the beginning, YOLOv3, a real-time object detection method, was used to recognise objects in live video streams. Humans are screened from the results, with other objects being ignored. The identified humans are mapped with the bounding boxes. Using the result generated from this method, the distance between the centroid of bounding boxes is measured.

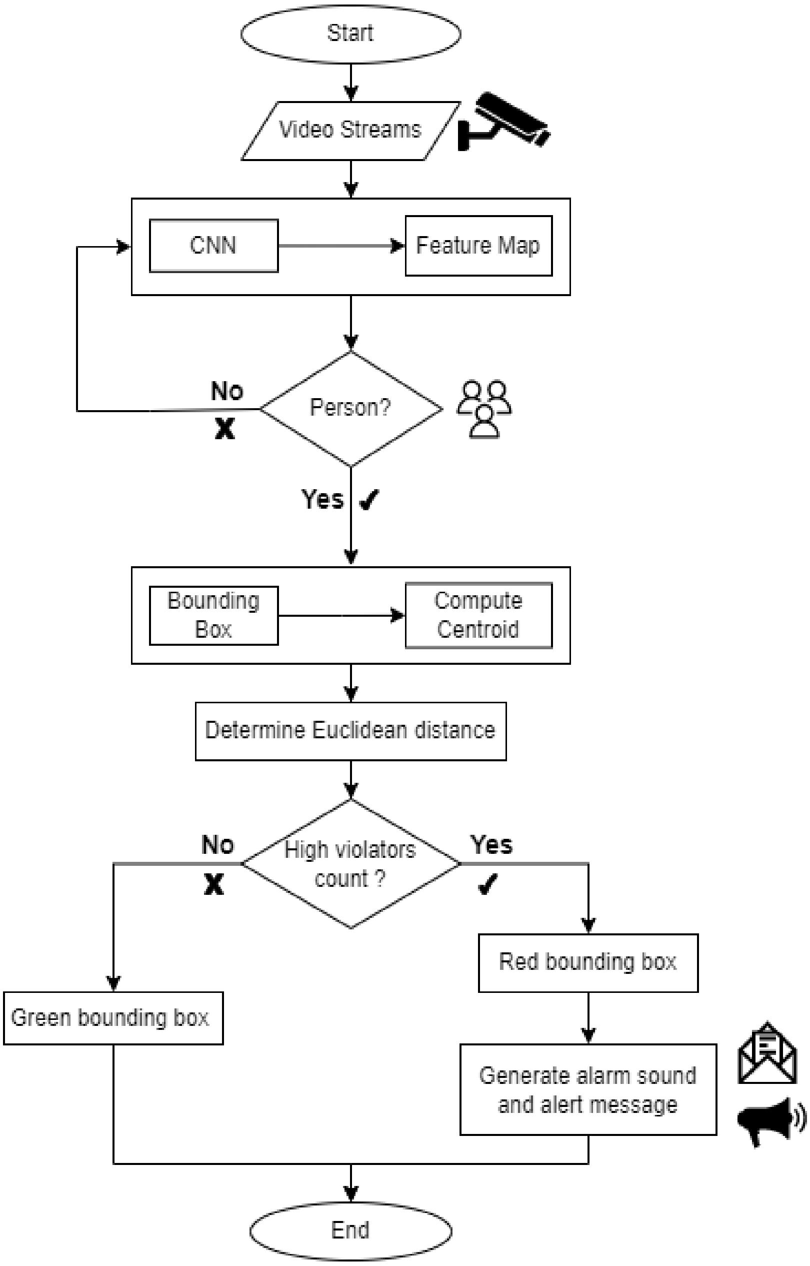

Fig. 1. System Architecture

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A. *Data Collection:*

This system uses live video directly from a camera (webcam / CCTV) which is fed as input as shown in the figure below. Since the video has an average frame rate of roughly 80 frames per second, some frames could be skipped because the movement of people would not be too drastic within a fraction of a second. As a result, this gives a means for increasing computation speed without having to compromise model performance.

B. *Human Detection:*

Object detection is a key problem in computer vision and the images domain. Its goal is to identify objects in videos that belong to specified classes, such as humans, vehicles, and other things. Because a video is made up of a series of fast-moving frames, Object Tracking is used to identify the objects and their locations in each frame. For object detection, we will use the YOLOv3 (You Only Look Once model) trained on the COCO dataset. The YOLO-v3 algorithm uses a Darknet-53 as a backbone for feature detection. There are totally 106 layers in the YOLO-v3, including convolutional, residual, and up-sampling layers. To detect objects on a single input image, the YOLO algorithm utilises only one forward propagation pass through. Because of the up-sampled layers, YOLO-v3 is better at detecting small things, preserving the fine-grained details of the small objects. The Common Objects in Context dataset (COCO dataset) was used to train the YOLOv3 model. This dataset has 80 labels, including a pedestrian class for humans.

We use YOLOv3 to take advantage of its excellent precision and real-time processing capabilities. YOLO considers object recognition as a regression problem, using an image or video as input and learning bounding box coordinates, matching class label probabilities, and object confidence all at the same time. It is used to return the person prediction probability, bounding box coordinates, and the person's centroid. In computer vision, Non-Maximum Suppression (NMS) is a vital post-processing technique. It is used to convert several imprecise and unnecessary object windows into a smooth single bounding box for each object detected. Overlapping boxes aren't exactly practical or ideal, especially when counting the number of objects in a frame. The NMS function is used in this system.

C. *Social Distance Evaluation:*

Once the bounding box for each person is mapped, the interval between the set of individuals in an input frame can be easily calculated. The midpoint equation is used to calculate the centre point, C (x, y), of the bounding box for the detected individual using eq. (1).

$$C(x, y) = \left(\frac{x_{min}+x_{max}}{2}, \frac{y_{min}+y_{max}}{2}\right) \quad \text{eq. (1)}$$

To compute the distance between two different locations of the bounding boxes, the centre point of the bounding boxes is used. The centre point of the bounding box can be calculated using the minimum and maximum values for the corresponding width, x_{min} and x_{max}, and height, y_{min} and y_{max}, of the bounding box.

$$d(C_1, C_2) = \sqrt{(x_{max} - x_{min})^2 + (y_{max} - y_{min})^2} \quad \text{eq.(2)}$$

The Euclidean distance equation is applied to compute the distance between each detected individual in the frame, $C_1(x_{min}, y_{min})$ and $C_2(x_{max}, y_{max})$ using eq. (2).

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D. *Social distance tracking*

After obtaining the value of the centre points, the algorithm determines if the distance is less than or greater than the threshold value. Using pixel to distance assumptions, a predefined minimum social distance violation threshold is defined. The set of individuals whose interval is less than the minimum threshold value is considered as violation. A red bounding box is used to identify those who violate the criteria, while a green bounding box is used to identify those who do not. The violators bounded by the red box are counted using a people counter.

E. *Real time Alert system:*

Our system's main goal is to identify persons who violate social distance and alert them via sound alarms or by informing the authorities via SMS or email. This system determines the overall violators count and if the number exceeds the threshold value, an alarm sound, as well as SMS and email notifications, are sent to the appropriate authorities in that location. Twilio is used to send SMS, SMTP is used to send email, and pygame is used to generate a sound alarm. People would always follow social distance if proper actions are taken, which will subsequently help to restrict the spread of covid-19.

IV. EXPERIMENT RESULTS

Fig. 2. System detecting people at public place – outdoor

Fig. 3. Email alert when violators count is high

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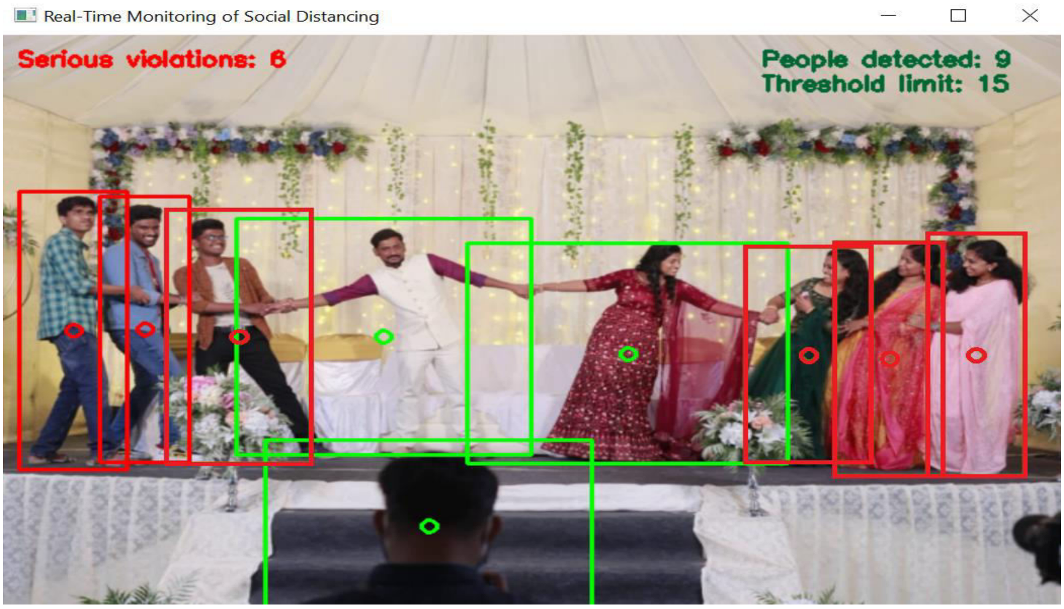

Fig. 4. System detecting people at wedding hall – indoor

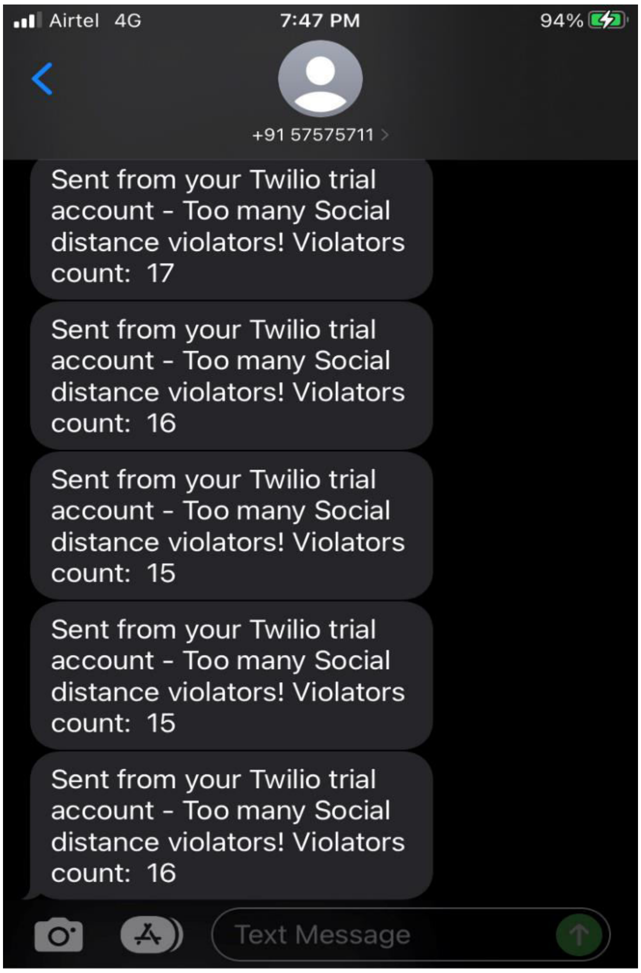

Fig. 5.Message alert when violators count is high

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V. CONCLUSION AND FUTURE WORK

In today's world, deep learning has a wide range of applications. In this paper, we propose an approach that uses computer vision, object detection, and tracking with deep learning to help maintain a secure environment by automatically monitoring public places to prevent the spread of the COVID-19 virus, as well as assisting police by reducing their physical surveillance work in containment zones. Furthermore, the solution is simple to integrate into any current existing system while maintaining the security and privacy of users' data. In the current circumstances, when the lockout is being lifted, this proposed technology will be effective in tracking public venues in an automatic manner. In the future, we plan to use GPS to add location so that multiple public places can be monitored at the same time. Facemask detection based on deep learning can also be used in addition to social distance monitoring. As a result, we can avoid the spread of the corona virus and live in peace thanks to these technologies.

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