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Social Distance Violation Alarming System: A Deep Learning Approach

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Abstract— **Nowadays, the fear and danger of COVID-19 virus is still great. Manually monitoring social distancing regulations is impractical due to large populations on the move and insufficient task force and resources to manage them. You need a lightweight and robust 24/7 video surveillance system to automate this process. This provides a complete and effective solution for detecting people and social distancing violations. For this purpose, YOLOv3 density-based Application Spatial Clustering was used in the surveillance video datasets. System performance is evaluated in terms of accuracy, F1 score and prediction time, which must be low to be practical.**

Keywords— **COVID-19, Social Distancing, YOLO, Real-time, Pandemic, AI/Deep Learning**

I. Introduction

The Final Year Project of this Course is Deep Learning Based Covid-19 Social Distance Violation alarming system. By avoiding physical contact, virus spread can be minimized. In order to track social distances, we provide an overhead perspective deep learning platform. To identify humans in video sequences, the framework uses the YOLOv3 object recognition paradigm. Monitoring compliance with social distancing is particularly well-suited to computer vision-based solutions. Advances in computer vision algorithms, especially convolutional neural networks (CNNs), have led to the development of several object detection algorithms that can recognize people in video feeds. Similarly, multiple camera calibration techniques have been proposed by researchers to infer distances in real-world coordinates from a 2D image which subsequently help in tracking the number of violations over time

II. Literature Survey

Krisha Bhambani, Tanmay Jain,etl. have implemented the Real time mask and social distance violation detection [1] using YOLO and demonstrated fairly accurate results for a wide field of view with time efficient computation. In 2022, Sergio Saponara1, Abdussalam Elhanashi, Qinghe Zheng, [2] used Yolov4- tiny model successfully for bird–eye view and depicted better performance in it. Developing a real-time social distancing detection system based on YOLOv4-tiny and bird-eye view for COVID-19, Published in: 2022. G V Shalini, M Kavitha Margret, M J Sufiya Niraimathi, S. Subashree worked on Social Distancing Analyzer [3] Using Computer Vision and Deep Learning, which proposed a system based on social distancing analyzer tool that was developed using computer vision, deep learning, and python to detect the interval between people to maintain safety. which was Published in: 2022. In the year 2022 The researchers B. Sahaja, R. Krupa Rani, G. Arun Kumar, A.Jagan proposed an experiment on SOCIAL DISTANCING VIOLATION DETECTION SYSTEM, which stands on Well-integrated social distancing violation detection system is created, where object detection takes place
[4] using YOLO v4. In this paper Using the coordinates given by the detection of the class person, the relative distance between two individuals is estimated using the principles of optics. Published in: International Research Journal of Modernization in Engineering Technology and Science. The study done by Afiq Harith Ahamad, Norliza Zaini, Mohd Fuad Abdul Latip on Person Detection for Social Distancing and Safety Violation Alert based on Segmented ROI, [5] Published in: 2020 10th IEEE International Conference on Control System, Computing and Engineering (ICCSCE2020) suggested the

detection of persons in segmented regions especially for energy saving purposes, where lights in areas with no people can be automatically turned off. Sreetama Das, Anirban Nag, Dhruba Adhikary, Ramswaroop Jeevan Ram1, Aravind BR, Sujit Kumar Ojha, Guruprasad M Hegde Implemented the Computer Vision-based Social Distancing Surveillance Solution with Optional Automated Camera Calibration for Large Scale Deployment and successfully achieved [6] real-time performance with satisfactory results under different lighting, crowding, and occlusion, later it got Published in: 2022. In 2021 Sergio Saponara, Abdussalam Elhanashi, Alessio Gagliardi worked on Implementing a real-time, AI-based, people detection and social distancing measuring system for Covid-19, It presented an intelligent surveillance system for people tracking and social distancing classification [7] based on thermal images. Sahana Srinivasan, Rujula Singh R, Ruchita R Biradar, Revathi SA studied COVID-19 Monitoring System [8] using Social Distancing and Face Mask Detection on Surveillance video datasets and provided an efficient solution to monitor social distancing practices in public areas. It was later Published in: 2021 International Conference on Emerging Smart Computing and Informatzics (ESCI). Joseph Redmon, Santosh Divvala, Ross Girshick, Ali Farhadi Implemented You Only Look Once: Unified, Real-Time Object Detection, in which [9] A single neural network predicts bounding boxes and class probabilities directly from full images in one evaluation. It was Published in: 2016.

III. METHODOLOGY

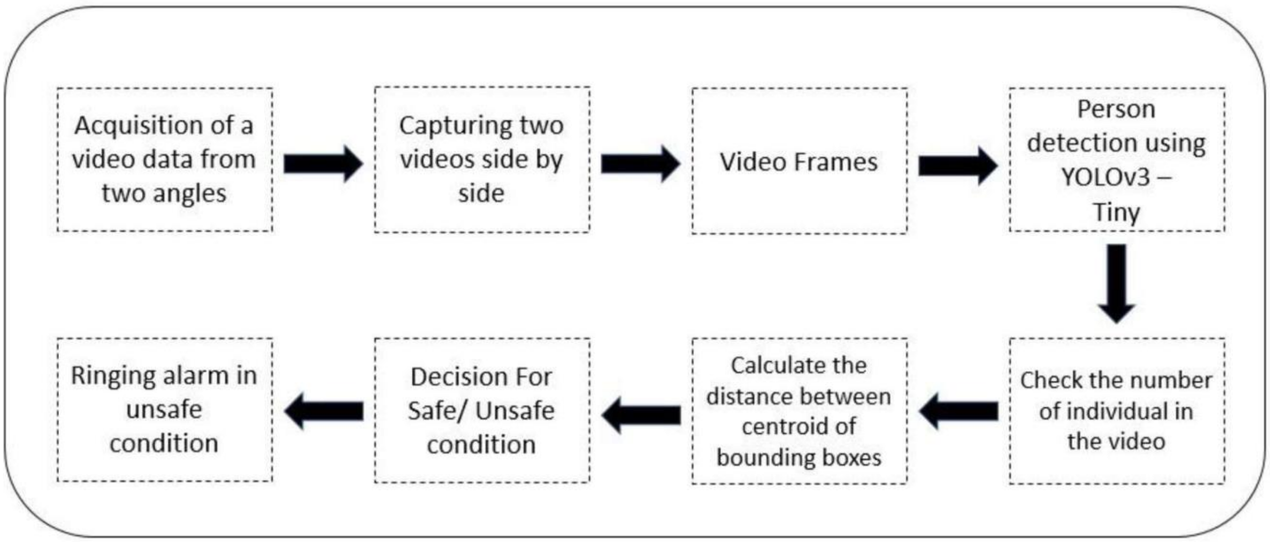


Fig 1. Sequence design for social distancing architecture

First of all, We needed two inputs i.e. a video recording from two different perspectives in which individuals are present, so for the purpose of getting and achieving the output we took a recorded video from two different angles, then we used that video in our program as an input and as we have mentioned earlier we're using YOLOv3 to detect persons in the video. After that, the centroid will get assign to each individual, and the system will raise an alarm if the distance between two individuals is less than 2.

A. Block Diagram Description-

1. Streaming the two videos from different angles, which contains the individuals.
2. Run these two videos side by side.
3. Extracting the videos into frames.
4. Applying YOLOv3 architecture to detect only the individuals in videos.
5. Verify the number of the individuals that are in the videos.
6. Calculate the distance between the center point of the bounding boxes that contains the individuals in the videos.
7. The algorithm will make the decision for violation or safe conditions for the individuals based on the number of individuals in the videos, and the measured distance between the centroid of bounding boxes. The violation level is defined as Risk, which is marked with a red colour for the bounding box. We marked the safe condition with a green color for the bounding box.
8. As soon as the box turns red in an unsafe situation, an alarm will sound to alert those who are violating social distancing.

B. Object detection

Use YOLOv3 model for person recognition. It consists of 53 layers of Darknet-53 trained on Imagenet that acts as a powerful feature extractor and an additional 53 layers for detection giving a total of 106 layered fully convolutional neural network. Fig . depicts the YOLOv3 architecture. Anchor box with 3 scales: 13x13, 26x26 and 52x52 are used. These three anchor boxes are used to predict the presence of people as shown in the figure. The output of this model after prediction is a list of bounding boxes along with the confidence of the person class detected. Non-maximum suppression (NMS) is used to solve the issue of overlapping bounding boxes leading to multiple detections for the same object. The final bounding boxes were selected based on confidence value and NMS threshold whose values were 0.5 and 0.3 respectively. This means that only classes with more than 50% confidence are included, and bounding boxes that overlap another bounding box by more than 30% are discarded.

C. Euclidean distance and violation thresholds

In this phase of this work, after detecting people in thermal video, we use the Euclidean formula to measure the distance between each detected pair of centroids using the enclosed bounding box and their centroid information. The computation distance is calculated using the scale factor to obtain real-world measurements. The distance for the Euclidian measurement is defined as 6 feet (about 180cm).Two different predefined minimum social distancing rules are determined by the distance assumption. With this in mind, we set two different thresholds, yellow and red, for the detected bounding boxes for these violations. The violation of the first threshold is defined as 'alert' marked in yellow and the second assumption of violation is defined as 'risk' marked in red. If the distance between detected bounding boxes is greater than 6 feet, the bounding box colour is previously initialized to green. If the distance is less than or equal to 6 feet but more than 5 feet (first threshold "Alert"), the bounding box colour updates to yellow, and if the distance is less than or equal to 5 feet (second threshold "Risk")

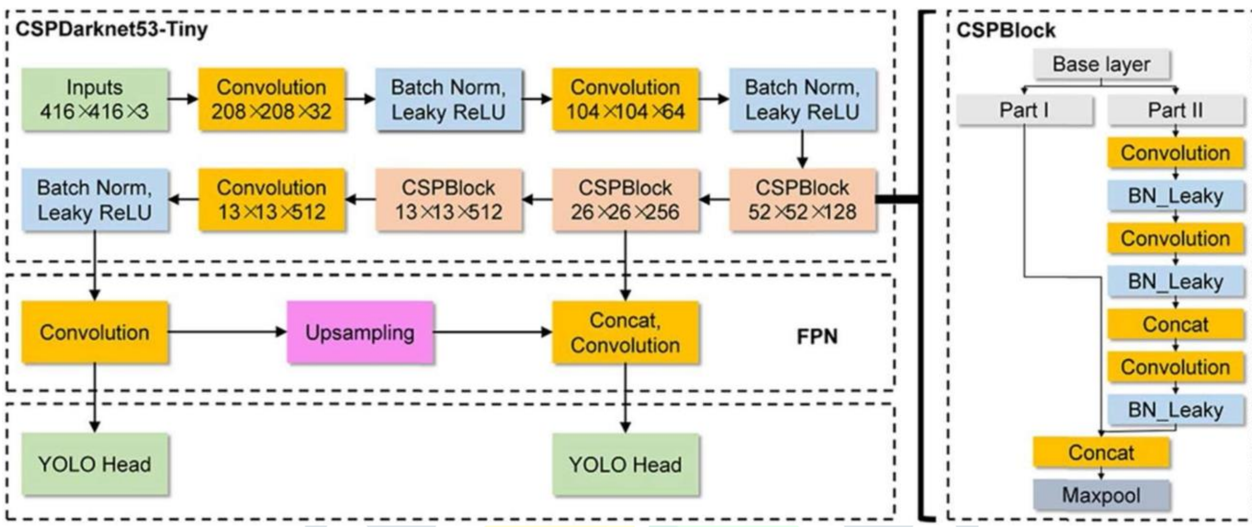


Fig.2. The architecture of YOLOv3 Network

between the detected individuals, the bounding boxes colour are changed to red, which means the social distancing is not maintained.

$$d(c_1, c_2) = \sqrt{(x_{max} - x_{min})^2 + (y_{max} - y_{min})^2} \qquad \text{.........(1)}$$

where d is the distance between the centroid of bounding box

IV. RESULTS AND DESCUSSION

The application will be implemented in various public places and the results that are obtained will be analyzed. The results obtained are displayed, and the results show that an accuracy of almost 98% has been recorded. The image is surrounded by two colours, green and red as shown in Fig.3 and 4.Images circled in green are maintaining social distancing and images circled in red are not maintaining social distancing.

For metric calculation, the confusion matrix criterion was used to evaluate the proposed algorithm. The metrics that have been chosen to analyze the goodness for the algorithm are recall, accuracy, and precision;

$$Precision = \frac{TP}{TP + FP'} \qquad Accuracy = \frac{TP + TN}{TP + FN + TN + FP'} \qquad Recdll = \frac{TP}{TP + FN'} \qquad \text{.........(2)}$$

where TP represents the number of true positive; TN represents the number of true negative; FP represents the number of false positive; FN represents the number of false negative.

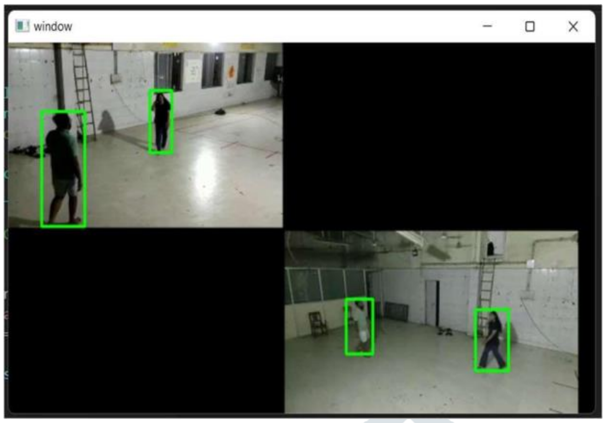


Fig.3 Image showing individuals maintained social distance hence, bounding box is shown by GREEN Colour.

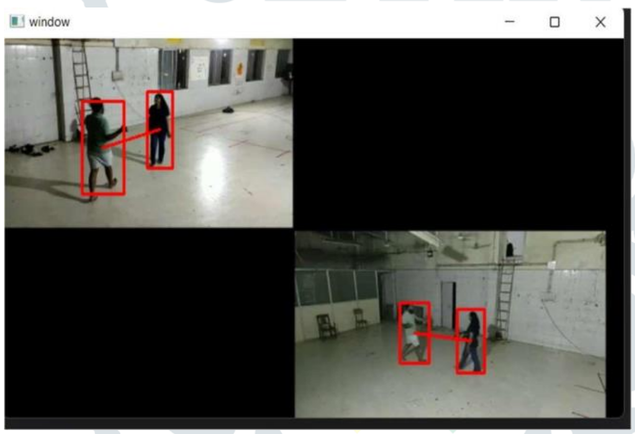
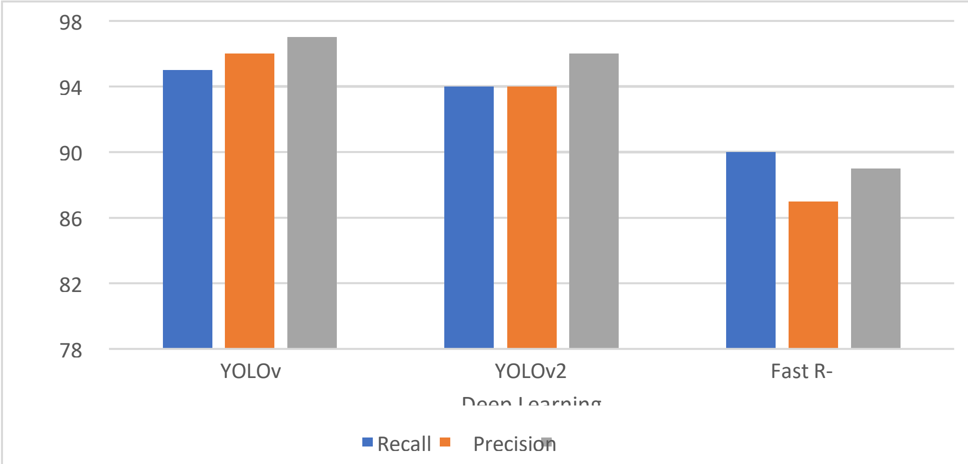


Fig.4 Image showing the individuals didn't maintain the social distance (at least 2 m) hence, shown by RED Colour.

We can see that YOLOv3 has better recognition performance than the other two architectures. The YOLOv3 model uses a modified path aggregate network, and a partial spatial pooling of pyramids, all of which are used to improve accuracy. In addition to that, YOLOv3 uses CSPDarknet53 as backbone neural network in the model. CSPDarknet53 added Cross Stage Partial Network (CSPNet) on every large residual block of Darknet53 and integrated into mapping the features from images. This feature map is split into one convolution operation and another operation that is a combination of the final convolution results. Therefore, CSPDarknet53 can effectively enhance the learning ability of his CNN layer, minimize the computational cost, and give the network more accurate detection ability.

V. CONCLUSION

This proposed a deep learning-based social distancing technique using bird's-eye view for people detection on videos. The results obtained confirmed that the developed intelligent surveillance system identified individuals who violated the social distancing and at the same time screening their body temperatures. YOLOv3 showed good performance in terms of accuracy and precision in comparison to the other deep learning models.



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