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Monitoring System for Standard Operating Procedures during COVID-19

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Abstract: The novel coronavirus which was first seen in Wuhan, China has created havoc across the world. Its rapid spreading and the virulent outbreak have created a state of emergency in the world. From a public fitness standpoint, COVID-19 is a sickness of top significance, and it has become vital to barricade the virus from spreading with preventive measures like maintaining social distance and wearing a mask. This paper mainly aims to develop a system that helps monitor if people are maintaining social distancing and also detects face masks on humans. This paper makes use of the Tiny-YOLO algorithm on Raspberry Pi for real-time object detection. Although the YOLO object detector is widely regarded as one of the quickest deep learning-based object detectors, with a high Fames Per Second, it is still too slow to run on embedded devices like the Raspberry Pi. Hence, this paper uses tiny YOLO which has a small model size (< 50MB) and rapid inference speed, making it applicable for embedded deep learning devices. We could additionally be displaying the count of human beings found in a room on an LCD. Overall, this paper facilitates lessening the range of COVID-19 sufferers and makes public locations safer.

Index Terms **– COVID-19, Mask detection, Social Distancing, YOLO, Raspberry Pi.**

I. INTRODUCTION

The COVID-19 pandemic has claimed many lives around the world, and it poses an unknown threat to public health, food systems, and the workplace. The pandemic has had an influence on all aspects of life, including businesses, education, transportation, tourism, employment, food security, entertainment, sports, and religion. The pandemic has wreaked havoc on the economy and society, threatening tens of millions of people. According to WHO some simple precautions to stay safe from the virus are to avoid crowded places, maintain physical distance, wear a mask, and keep rooms well ventilated. The practice of social distancing, which involves reducing interactions between people to limit the transmission of the virus has become the new norm [1]. Lockdown was very useful in preventing the spread of the virus, but it cannot be continued over a long period as it would result in huge losses and a fall in the country's economy. Moreover, there are certain tasks where it is required that one must attend in-person such as passport offices and banks. Therefore, following the Standard Operating Procedures (SOP) is one of the greatest methods to keep us safe in these areas. Artificial Intelligence has been assisting in several components of human life. It has touched several enterprises like scientific applications, healthcare, and retail. AI can be utilized in crowded locations to check if people are following the SOP. It can be used to restrict the number of people coming into the building, to check if they are wearing masks inside the building, and to reveal social distance in public locations. If the number of individuals entering a building exceeds the limit or if they are not wearing a mask, an SMS can be issued to the appropriate authorities, instructing them to take the necessary steps.

This work aims to develop a prototype that helps monitor public places and ensure everyone is following SOP to prevent the virus from spreading. This project employs a face mask detection system to determine whether someone is wearing a mask. The other objective of this approach is ensuring that individuals maintain social distancing in public places. Video tracking and object tracking are used to accomplish this. The first stage is to utilize project tracking to determine the number of individuals present in a location; by limiting the number of people there, it is easier to maintain social distance. The second stage is to ensure that everyone in a closed space maintains social distancing. To do this, the Tiny-YOLO algorithm (You Only Look Once) is used on Raspberry Pi to identify objects in real-time. The algorithm finds the Euclidean distance between people by finding the detected bounding box centroids and determining the pairwise distances between the centroids of people. To estimate social distance violations between people, we used an approximation of physical distance to pixel and set a threshold. A violation threshold is established to evaluate whether the distance value breaches the minimum social distance threshold. Our project seeks to keep track of the number of individuals present and to alert them to the safety of a location based on the number of people there. This prototype can be used in public locations including retail malls, theatres, banks, and government buildingsby keeping track of the number of individuals ente ring a room, as well as proctoring if they are wearing masks and following pandemic SOPs.

II. LITERATURE SURVEY

Object tracking in video surveillance is a popular application and research area in image processing that is gaining a lot of attention in the academic community [1]. “Image Processing Techniques for Object Tracking” was proposed by Shipra Ojha and Sachin Sakhare. They suggested that Video tracking is the technique of utilizing a camera to monitor a moving item or numerous objects over time. Video surveillance has a wide range of applications, including human-computer interactions, security, and surveillance, video communication, traffic management, and public spaces such as airports, subway stations, and mass gatherings. Tracking a target in a cluttered premise is still one of the challenging problems of video surveillance. A sequential flow of moving object detection, its classification, tracking, and identifying the behavior completes the processing framework of video surveillance. This paper takes insight into tracking methods and their categorization into different types focusing on important and useful tracking methods [2]. Tuan Linh Dang, Gia Tuyen Nguyen, Thang Cao proposed “Object tracking using improved deepSORT YOLO v3 architecture”. The original deepSORT tracking cannot track the object if YOLO does not draw bounding boxes. So, this object gets a new identity when it is detected in subsequent frames. To overcome this problem this paper provides an improved version of deepSORT in YOLO v3, which has better operating speed and lower identity switches. Detecting and categorizing the identified items are the two tasks that YOLO must do. Because both tasks are done in a single neural network, they are finished quickly. The input for this method is picture pixels, and the output is bounding boxes and box class probability.

Chethan Kumar B, Punitha R, and Mohana presented “YOLOv3 and YOLOv4: Multiple Object Detection for Surveillance Applications” [3]. In this paper, an object detection method called YOLO is used in traffic and surveillance applications to detect multiple object datasets containing picture classes such as car, truck, human, and two-wheeler. YOLO model variations such as YOLOv3 and YOLOv4 are implemented for image and video datasets, respectively. In their paper on "A Many Objects Monitoring Method Using Kalman Filter," Xin Li, Kejun Wang, Wei Wang, and Yang Li said that "it is crucial to retain the identity of multiple targets while tracking them in various applications such as behavior comprehension"[4]. However, owing to varying real-time conditions, unsatisfactory tracking data may be obtained. These situations include inter-object occlusion, backdrop obstacle occlusion, splits, and merges, all of which may be seen when objects are monitored in real-time. A feature-based Kalman filter motion method is developed in this work to handle multiple object tracking. The system is completely automated, and no user input is required for tracking to begin. The calculation of the cost function can be used to solve the problems of correspondence after split by establishing a Kalman filter motion model with the features centroid and area of moving objects in a single fixed camera monitoring scene, using information obtained by detection to judge whether merge or split occurred. The suggested approach is tested using human and vehicle picture sequences. This algorithm achieves effective tracking of numerous moving objects in perplexing conditions. Simple Online and Realtime Monitoring (SORT) is a pragmatic approach to multiple object tracking with an emphasis on simple, effective algorithms, according to Nicolai Wojke, Alex Bewley, and Dietrich Paulus, who suggested: "simple online and real-time tracking with a deep association measure" [5]. They used appearance information to increase SORT's performance in this research. They were able to follow objects over longer durations of occlusion as a result of this modification, thereby lowering the frequency of identification changes.

III. SYSTEM OVERVIEW

The block diagram of the prototype can be seen in Figure 1. This block diagram shows how the input video sequence is broken down into frames, which are then fed to the pre-trained YOLO del, which performs most of the image processing and detection, before being fed to the multi-object tracking block, which employs a Kalman filter and deep sort to track the required object. They operate in the background and aid in the tracking and prediction of objects. The monitored output is then fed to the LCD Display, and Website and an SMS is sent to the appropriate authorities.

Figure 1: Block diagram

Figure 2: Raspberry Pi model 4

Figure 3: Pi Camera

Raspberry Pi in general has gone through numerous iterations, each with different memory capacities and peripheral device compatibility. Raspberry Pi model 4 which is shown in Figure 2 is used in this work. The Pi Camera module has a camera that can capture photos and record high-definition video which is shown in Figure 3. The CSI (Camera Serial Port) present on the Raspberry Pi Board allows us to directly connect to the Pi Camera module. This Pi Camera module may be connected to the Raspberry Pi's CSI port using a 15-pin ribbon cable. A 7” touchscreen or any normal monitor for Raspberry Pi helps display the count of the number of people in a room.

The software used for this work is briefly described here. Raspbian Operating System is a Linux-based operating system, which has been specially designed for interaction with Raspberry Pi. Python is an object-oriented, imperative, and functional programming language and is supported by Raspbian Operating System. It is also a programming language that allows to work quickly and integrate systems more efficiently. TensorFlow developed by the Google team helps implement machine learning and deep learning models most efficiently. It is a software library for python. It combines the computational algebra of optimization of many

mathematical expressions. YOLO v4 is an efficient object detection system in real-time that recognizes various objects in a single enclosure. It can estimate approximately up to 9000 or even more seen and unseen classes of objects.

IV. METHODOLOGY & RESULTS

The project's prototype was successfully developed, and the software implementation was completed. The model receives the camera's input and counts the items in the frame while also tracking the object in the frame. The camera's data is then passed on to the mask detection model, which draws a bounding box on a person's face and determines whether that person is wearing a mask. This primarily helps check the two important COVID-19 procedures, social distancing, and mask detection. The steps involved in Mask Detection are given as follows:

1. The mask detection model is trained and tested with over 10,000 images of people with and without a mask.
2. The model is created using Convolutional Neural Network and then the output is shown in a local host webserver.
3. Initially, the project takes live input from the webcam/ pi Camera and this input is processed frame by frame to detect faces in each frame
4. These detected faces are then passed on to the trained CNN Model to detect if that person is wearing a mask or not.
5. The CNN network returns the predicted accuracy and based on this accuracy the algorithm decides if a person is wearing a mask or not.
6. This predicted result is then displayed in the localhost web server using Flask.

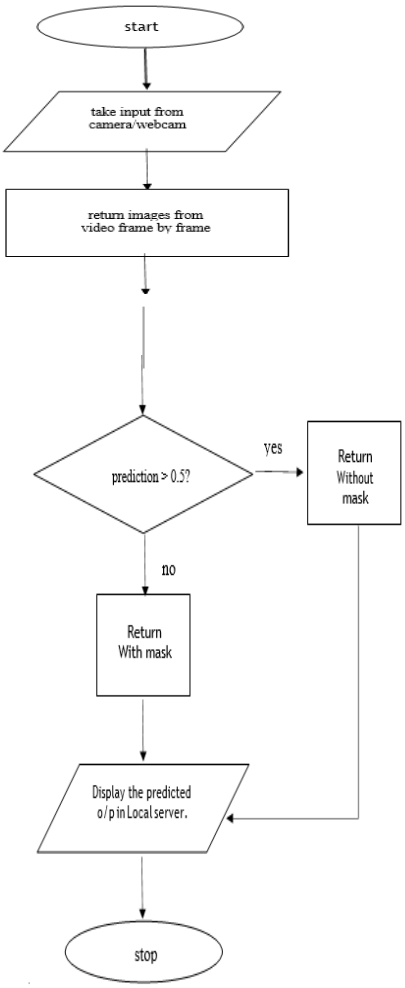

Figure 4 : Flow Chart for mask detection

Figure 5: With Mask

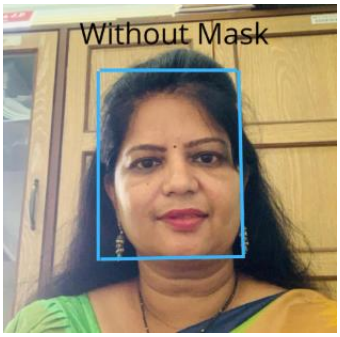

Figure 6: Without mask

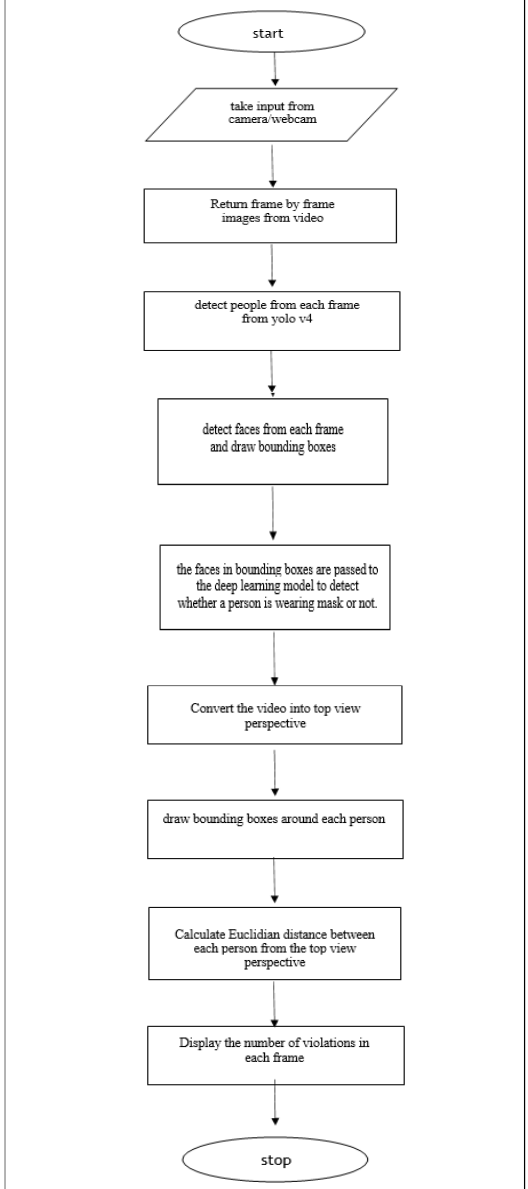

Figure 7: Flow chart of Social Distance Detection

Figure 8: Social Distancing monitoring

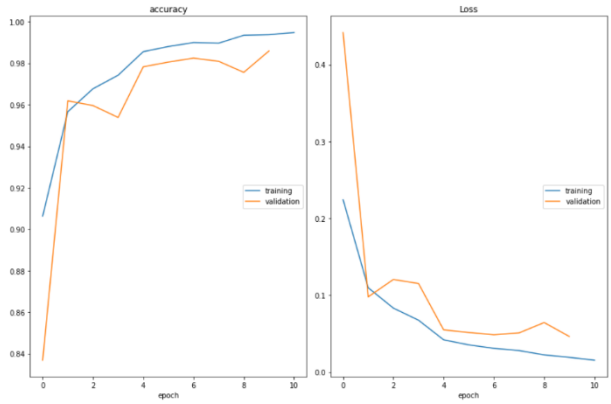

Figure 9: Accuracy and losses of model

Figure 10: Social Distancing monitoring implemented on Raspberry Pi

The flow chart of Social distancing is shown in figure 7 and the steps involved in it are as follows:

1. The object detection and Social distance monitoring is performed using the pre-trained YOLOv4 model using the COCO dataset.
2. The Social distancing model takes live input from the webcam/ pi camera and returns frame-by-frame images from the video.
3. The algorithm finds the Euclidean distance between people by determining the detected bounding box centroids and finding the pairwise distances between the centroids of people. A violation threshold is estimated to evaluate whether the distance value breaches the minimum social distance threshold.
4. Finally, the output is displayed on the monitor as shown in Figure 10.

Figure 9 depicts the accuracy and losses of the created deep learning model. Figure 10 shows the result of social distancing. Figures 5 and 6 depict the output of Face Mask Detection with and without masks respectively.

V. CONCLUSION

In this work, the mask detection model is trained and tested with over 10,000 images of people with and without masks using CNN, and results are displayed in the localhost web server using Flask. The object detection and social distance monitoring is performed using the pre-trained YOLOv4 model using the COCO dataset and the violation threshold is displayed. Thus, this model can be used to monitor public places and ensure everyone is following SOP to prevent the virus from spreading. Such a system can also be used to limit the number of people entering the building, count the number of vehicles entering the parking lot and hence the remaining slots can be displayed for the convenience of the visitors, to check the number of people wearing masks inside a building, ball tracking in a cricket stadium and to monitor kids.

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