SOCIAL DISTANCING DETECTOR USING YOLO NETWORK

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Abstract: The Coronavirus Disease, commonly known as COVID-19, has swept the world by storm. The most serious concern is that it spreads from person to person if they are in proximity. As a result, precautions such as following Social Distancing rules and wearing masks are necessary. However, many people are finding it difficult to adhere to social distancing standards due to personal obligations. As a result, Flattening the coronavirus case curve is not an easy task, and it is critical to recognize people in real-time and determine whether they are adhering to social distancing rules. Our study focuses on detecting people using YOLO object tracking model which is well-known for its speed and accuracy. Taking the center points of the bounding boxes produced by the model, we apply Euclidean distance to find the distance between two people's bounding boxes. If the distance between two points is small, the bounding box containing those points turns red, and it can be used to warn individuals not to break the rules and to take appropriate action.

IndexTerms **- Covid-19, Social Distancing, YOLO model, Euclidean distance.**

I. INTRODUCTION

The coronavirus pandemic is a worldwide outbreak that has affected several countries and is changing the way we live. With 29.3 million reported cases of COVID-19 infection as of June 2020, India has the world's second-highest number of confirmed cases (after the United States) and the third-highest number of COVID-19 deaths (after the United States and Brazil) at 367,081 deaths [1]. To combat the disease, the country has implemented a variety of measures, including transportation shutdowns, strict quarantine, and daily testing. In addition, all shops, restaurants, and other businesses are taking the necessary precautions to ensure compliance with government regulations. The social measures adopted in public places are depicted in the Figure 1-2.

Fig. 1 Social Distancing outside a market.

Fig. 2 Cashless Payment

The research is being proposed to help with the mitigation of Covid-19 spread. It helps by detecting people gathering in public places such as malls and clinics, and then measures the distance between any two detected people. It is possible to warn people who are not adhering to the rules imposed by the government in this manner.

Aircraft corridors, personal property and construction areas are examples of hazardous areas that frequently necessitate visual surveillance. As a result, these areas must be monitored to reduce the possibility of people entering and causing unwanted incidents. Many people are refusing to return to work until the workplace is safe. Having social distancing detection in the workplace is a great way to reassure employees that the workplace has been made safe for their benefit. The proposed tool can be integrated into cameras to monitor in areas where queueing cannot be avoided.

II. RESEARCH BACKGROUND

2.1 A Comprehensive survey

A study [2] presented a comprehensive survey of technologies that can be used for the Social Distancing Detector tool. The research provided a thorough understanding of various practical social distancing scenarios and their models. They talked about various technologies like machine learning and computer vision, as well as open issues and challenges in putting social distancing into practice. The study separated social distancing tactics into two groups in the first portion of the survey: public and individual measures. Based on that, they've devised several strategies to aid in the reduction of coronavirus disease and various models to detect social distance. The authors have discussed the applications and limitations of various technologies in the second part of the survey.

- WIFI: Because Wi-Fi technology is widely deployed in indoor environments, it can be regarded as a promising solution for practicing social distancing inside multi-story buildings, airports and so on.
- Cellular: Different social distancing scenarios can be supported by cellular technology. Cellular can assist in determining people's locations in real-time monitoring and infected movement data scenarios. People and traffic density can also be predicted based on these locations.
- Bluetooth: Based on Bluetooth technology, a contact tracing application. When two persons are near each other, the programme will capture the occurrence. The programme can then alert the other person if one of them tests positive for an infectious disease.

2.2 A VISION-BASED SD DETECTION SYSTEM

[3] proposed a tool which uses a monocular camera and deep learning-based real-time object detectors to measure social distancing. A signal is emitted whenever a violation is detected, but it does not target the person who violated the social distancing. The technology also sends a control signal to modulate intake into the ROI if the social density exceeds a certain value.

2.3 An autonomous approach

A study [4] presents a scalable sensing system for detecting physical activity in public open spaces and monitoring compliance with the US Centers for Disease Control and Prevention's social distance requirements (CDC). Using video feeds from a pre-installed security camera network, a deep learning-based computer vision sensing framework is being developed to examine the cautious and appropriate use of parks and park facilities with hard surfaces. The sensing framework is tested by comparing autonomous sensing findings to ground-truth results that have been manually labelled. By developing simple data visualizations for federal and state organizations, the proposed approach considerably enhances the efficiency of reporting spatial and temporal statistics of users in public open spaces.

2.4 Deep learning-based detection

By implementing the model on a Raspberry Pi 4 to watch activities and detect violations through camera, [5] proposed an effective computer vision based technique centered on real-time automated surveillance of individuals to detect both safe social separation and face masks in public spaces. After detecting a breach, the Raspberry Pi 4 sends an alert signal to the state police headquarters' control center.

2.5 You Only Look Once model

[6] presents a deep learning-based system for automating the task of social distancing surveillance video monitoring. The suggested framework employs the YOLO v3 object detection model to distinguish persons from the background, as well as the Deep sort technique to track recognized people using bounding boxes and assigned IDs. The pairwise vectorized L2 norm is then computed using the three-dimensional feature space generated by employing the bounding box's centroid coordinates and dimensions. The non-adoption of the social distancing protocol is quantified using the violation index term.

III. METHODOLOGY

In this study, the proposed idea is built using Python 3, OpenCV and the darknet framework. The suggested project is divided into two parts: the first involves detecting a person from a video captured frame by frame, and the second involves using a mathematical function to calculate the distance between two persons**.**

The process begins by taking video as input and sequentially reading the frames of a video. To detect persons in a frame, we employed the You Look Only Once (YOLO) model, which is based on the darknet framework. It predicts the bounding boxes and their class probabilities using a single forward pass neural network applied to the entire image. We have chosen YOLO algorithm for our research mainly because of its speed and accuracy. The YOLO model was trained using 2000 human-generated custom datasets. These datasets can be obtained from [7].

3.1 Working of YOLO

To begin, the input image is divided into grids. Each grid has a N x N dimension. If an object appears within a grid cell, that cell will be in charge of detecting it.

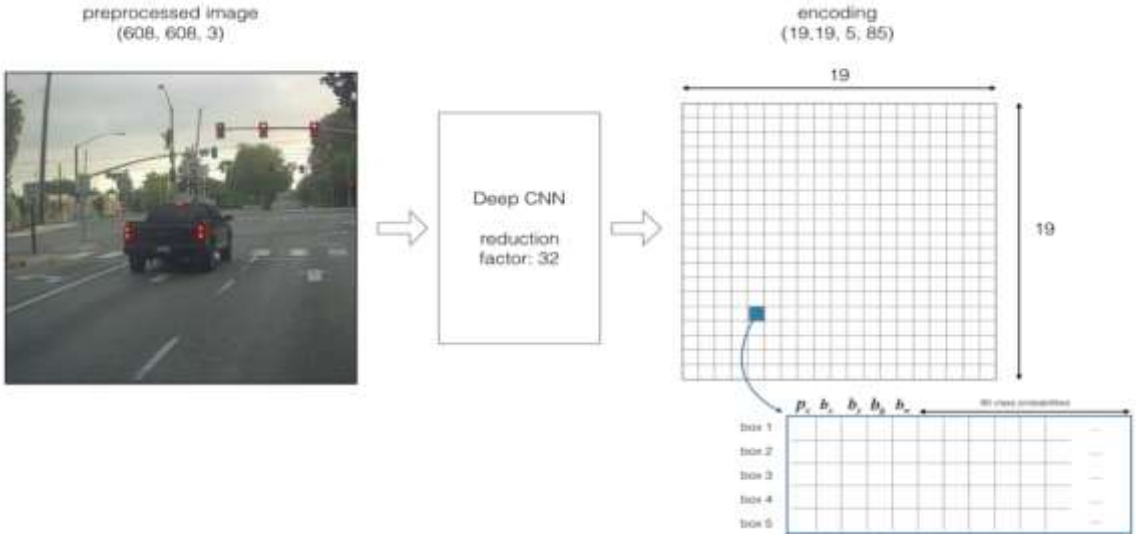

Fig. 3 Working of YOLO algorithm [8]

A bounding box is an outline that draws attention to an object in an image. Each bounding box in the image has the following attributes:

- width(b_w)
- height(b_h)
- probability(p_c)
- bounding box centers (b_x, b_y).

YOLO uses Intersection Over Union, known as IOU, to provide an output box that perfectly surrounds the objects. If the predicted and actual bounding boxes are the same, the IOU is equal to one. This mechanism removes bounding boxes that aren't close to the actual box. This is also known as Non-Max Suppression.

Fig. 4 Non-Max Suppression

3.2 Calculate the center point of a bounding box

After it returns predicted bounding boxes of humans, we take the center points of bounding boxes. To measure the center point, the equation used is

$$C\ (x1, y1) = (x + w/2, y + h/2) \quad (1)$$

where x, y are the top lest coordinates of a bounding box and w, h are width and height of a bounding box.

3.3 Calculate distance between bounding box

The distance between the centers of two predicted bounding boxes is calculated using Euclidean distance.

$$\text{Euclidean distance}(d) = \text{sqrt}((x_2 - x_1)^2 + (y_2 - y_1)^2) \quad (2)$$

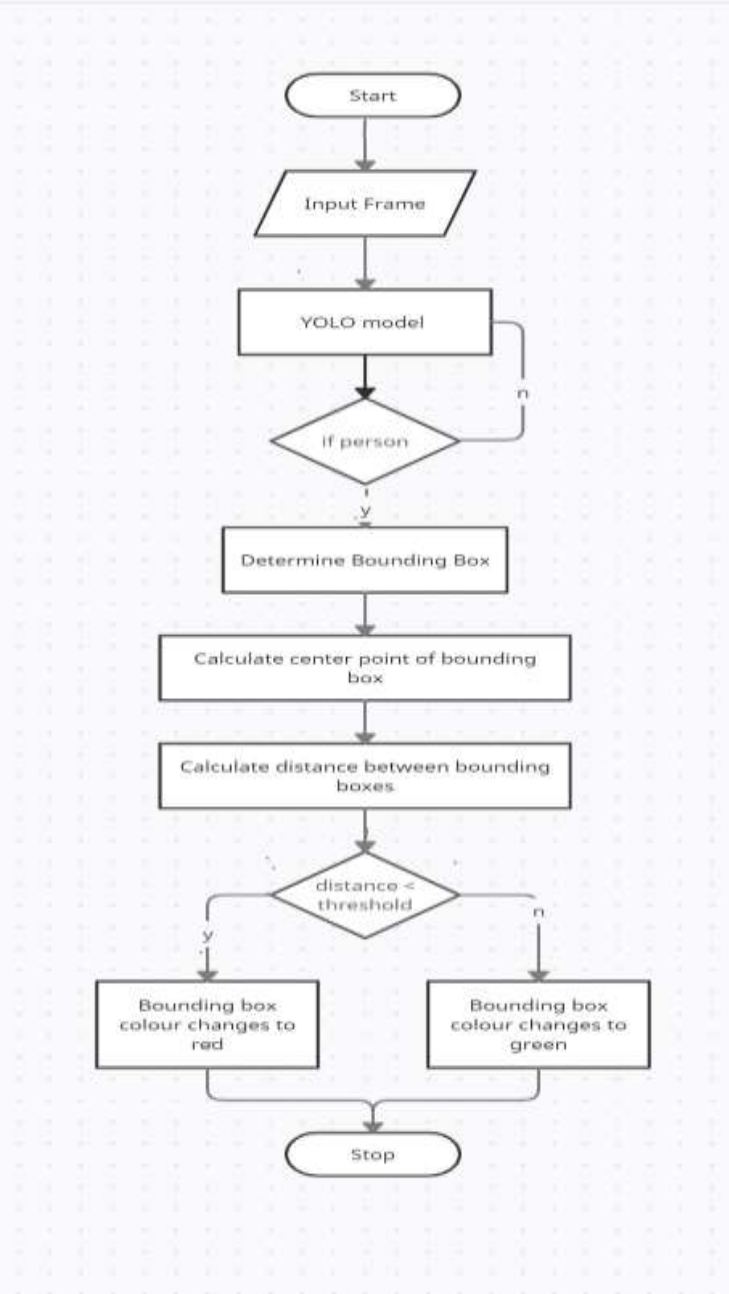

Fig. 5 Social distancing detector flowchart

IV. RESULTS AND DISCUSSIONS

The distance between two predicted bounding boxes is calculated and compared to a predefined threshold. If it is less than the threshold value, it indicates that the two people are very close. As a result, the color of the bounding box changes to red. If it is greater than the threshold value, it indicates that the two people are adhering to social distancing rules. As a result, the color of the bounding box changes to green.

Fig. 6 Image taken from the video available on the Internet

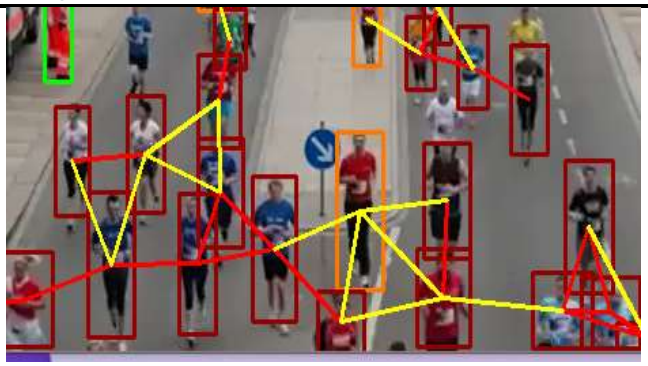

Fig. 7 Output returning green and red bounding boxes
Note: If the distance is equal to threshold , It returns Orange color.

For our research, we have used a video with many people from the internet. First, it goes through the video frame by frame, applying the algorithm to detect humans in each frame. The distance between two predicted bounding boxes belonging to a person is then calculated in the following step. Based on the calculated distance, the rectangle changes to other colors. The trained model has an accuracy of 85 percent, which is not the best accuracy available right now. This issue is caused by two factors. One reason is that the dataset is smaller. Second, in a difficult environment, it is unable to detect every single person in the frame.

V. CONCLUSIONS

Social distancing is one of the most important precautions in reducing physical contact that could lead to the spread of coronavirus. Failure to follow these guidelines will result in higher rates of virus transmission. As a result, a detector tool for detecting human violations of social distancing rules has been developed. A better detection model can be implemented in the future for further improvement.

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