Realtime Social Distance Detection and Human Count using Deep Learning

Parth Desai
Dept of Computer Engineering
V.C.E.T.
Vasai, India
parthjd2000@gmail.com

Hitesh Gosavi
Dept of Computer Engineering
V.C.E.T.
Vasai, India
hiteshgosavi40@gmail.com

Salman Ansari
Dept of Computer Engineering
V.C.E.T.
Vasai, India
salman250220@gmail.com

Asst. Prof. Sunil Katkar
Dept of Computer Engineering
V.C.E.T.
Vasai, India
sunil.katkar@vcet.edu.in

***Abstract*— To minimize the effects of the coronavirus pandemic, this research paper provides a social distance detection system that uses deep learning techniques to measure distance between individuals. By analyzing video feed, detection techniques are intended to alert people to keep a safe distance from one another. A pre-trained open-source object detection model is applied for human detection, with the video frame as input. A pair of violators is displayed with a red frame, and the distance between them can be determined. A video of people on the street is being used to validate the proposed strategy. The proposed method can be used to calculate the social distance between multiple individuals in a video.**

Keywords—social distance detection, human count, deep learning, CNN, YOLOv3, Euclidean distance

I. INTRODUCTION

When the coronavirus pandemic broke out, the world was concerned about the virus's spread as there was no viable cure. As the number of cases started increasing worldwide, the World Health Organization announced COVID-19 as a pandemic [1]. To contain the pandemic, many governments had imposed a lockdown, in which citizens were told to stay indoors throughout that critical period. Health organizations like as the CDC had to make it apparent that to stop the spreading of COVID-19 preventing close contact with others is the best method [2]. To flatten the curve of the COVID-19 pandemic, citizens around the world have started practicing physical distancing.

Group activities and gatherings such as travel, seminars, and prayers have been forbidden to practice social distancing. To reduce person-to-person contact, people are encouraged to coordinate and run events by phone and email whenever possible. They are also being advised on hygiene techniques such as frequent hand washing, wearing a mask, and avoiding direct contact with patients to prevent the virus from spreading. But knowing what to do to stop the infection from spreading isn't the same as really doing it.

Where the number of cases has gone down, the government have allowed economic activities to resume so as to reduce the economic burden of the country. Concerns about worker safety have surfaced in the new post-Covid-19 climate as many countries cautiously recommence their economic activities. To limit the risk of spreading of the virus, people are advised to avoid direct contact and keep a minimum distance of 2 meters.

Several disease prevention strategies are proposed by the Health Ministry of Malaysia at workplaces, schools, and worship places to prevent spread of the virus [3]. Implementing social distance measures, increasing physical distance between workers in the workplace, adjusting working hours, restricting social contact in offices, and major gatherings are all examples of these methods. It includes non-essential travel limitations and regular employee and guest health checkups for companies with high-risk staff that host business events and activities online.

Many medical organizations, scientists, and healthcare experts are researching for viable vaccinations and medications to combat this deadly illness. The international community is searching for innovative ways to stop the virus from spreading. The virus is primarily spread by people who are in proximity (within 6 feet) for an extended period. When an infected individual sneezes, coughs, or talks, droplets from their nose or mouth travel through the air and infect those in their immediate vicinity. The droplets reach to the lungs, where it starts killing lung cells. The introduction is summarized as follows:

a) Deep learning has received a lot of importance in the study of object detection, especially when it comes to human recognition.
b) To create a monitoring technology, which can measure social distance to ensure safety between individuals.
c) Evaluating video feed from a viewing device to estimate the results.

II. Related Work

We shall look at some of the deep learning-based detection models in this section. From March 23rd 2020, no new cases were recorded for five days in a row. This is owing to the approach of social distance, which was first used to control COVID-19 in China and has now been applied all over the world. According to the research, moderate intervals of exercise could be tolerated to avoid a significant flare. Several technology-based solutions have come up by countries to overcome pandemic loss. It presents an overview of many developing technologies, including GPS, Wi-Fi, Bluetooth, etc. that could be useful in a variety of real social distancing scenarios. To detect crowds, some researchers have employed drones and other surveillance cameras.

Multi-class object detection in deep learning research has shown phenomenal output on complex datasets. Nguyen et al. [4] provided a complete study on current developments and human detection trials. Human descriptors and machine learning techniques are all covered in the survey. Krizhevsky et al. [5] proposed on a variety of image recognition benchmarks, approaches based on deep convolutional neural networks (CNN) have proven to outperform others.

Present object detectors have their benefits as well as drawbacks when measured with parameters like speed and accuracy. Within the image, the subject can be at any spatial location. Hence, object detection algorithms like R-CNN by Girshick et al [6] and YOLO by Redmon et al. [7] have been developed to detect multiple classes in a single frame. The most popular object identification algorithm, YOLO (You Only Look Once) is fast in both speed and accuracy. The pipeline architecture is shown in Figure 1.

A computer vision-based approach to identifying individuals using a viewing device mounted on a pavement [8]. The camera's peripheral vision includes individuals walking in a specific area. Deep CNN methods have been used to detect bounding boxed objects and the number of individuals in the video feed. In the application, by measuring the Euclidean distance between people, we can check if social distancing is being followed or not.

III. Methodology

The basic steps are: To get the video feed from the viewing device. The captured frame is then converted.

The distance between the centroid of each bounding box is calculated after the detection. Following the Euclidean distance calculation, a fixed threshold value is employed to determine whether the distance between two centroids is less than or equal to the threshold value. The bounding box information is recorded in a breach set and the bounding box color turns to red if two persons are close and their distance value exceeds the minimal threshold for social distance. For tracking, an algorithm is adopted to help find those individuals who violate / cross the threshold of social distancing. The model's output shows the overall number of social distance violations as well as the people who were spotted in the bounding boxes and centroids.

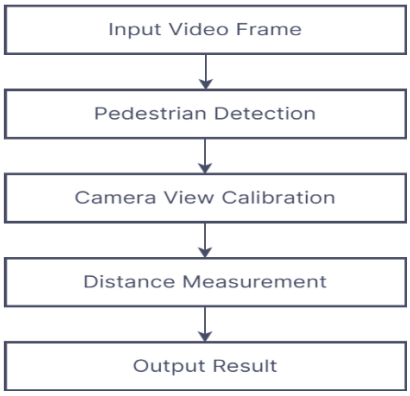

Figure 1 Pipeline for social distancing detection.

We check if the number of bounding boxes (>) or (<) than the maximum limit of people. If it is greater than the limit value, an alarm is issued, indicating that the maximum number of people has crossed the threshold value and changes the color of the text and the bounding box to red. If it's not bigger, it just changes color to green.

The application displays the total number of individuals detected in output. Flow chart for detection is shown in figure 2.

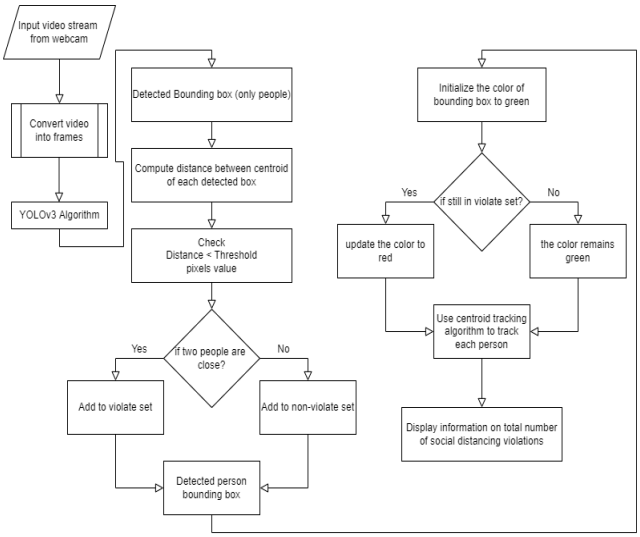

Figure 2 Flowchart for Social Distance Detection.

A. Human Detection

In terms of speed, YOLOv3 is one of the best object detectors for real time use. The model has been used to detect people in this study. Following the detection of individuals in video frames, the distance is calculated using the centroid of the bounding boxes of every individual, which are represented in green color. The bounding box centroid is calculated using the detected bounding box coordinates (x, y). After the centroid for each bounding box

is calculated, every box is given a separate identification number to keep a track. Flow chart for human count is shown in Figure 3.

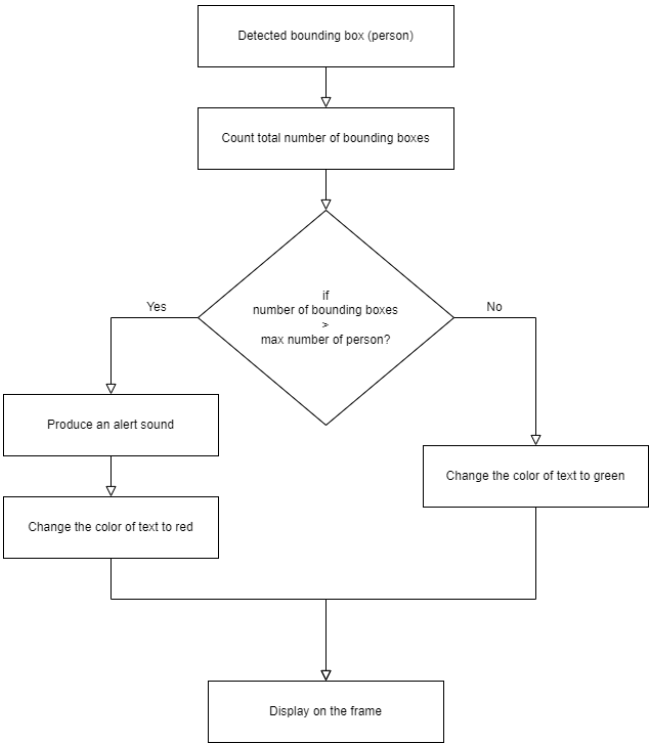

Figure 3 Flowchart for Human Count.

B. Distance Measurement

The centroid distance between every bounding box is calculated using Euclidean distance after detection. The distance between centroid of bounding box detected is calculated using the below formula.

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

Following the measurement, a fixed threshold value is used to check if the distance between two boxes is less than (<) or equal to the threshold value. The information we get from the above calculation is stored in a violate set and the color turns to red if two people are close and the distance between them is less than the minimal threshold for social distance. The model's output demonstrates the overall number of social distancing violations, as well as the individuals that were detected in the bounding boxes.
People whose distance is below the threshold value is put in the violate set and the color is changes to red or else it remains green.

$$c = \begin{cases} red & d < t \\ green & d \geq t \end{cases}$$

IV. RESULT AND DISCUSSION

The results of framework test were visualized with a previously trained model. The test results are assessed with different videos. The size of the person also varies when they are away or close from the viewing device.

As only human class is considered, a human like object will be detected. The pre-trained model performs well and recognizes the bounding boxes of people of different sizes with green rectangles. In the output images, if people are within social distancing limit, then they are marked with green color. In example images, we observe that after the person has been recognized, recognized limit frame is calculated to check if social distancing is followed or not. In the below output images, a person is effectively recognized in various places in the scene.
However, the appearance of the person is always not same; thus, we get false identifications. Reason for the misidentification may be that the previously trained model is not trained considering the person's top view, which can be misleading to the model. Figures 4, 5, 6, 7, 8 and 9 shows the output.

Figure 4

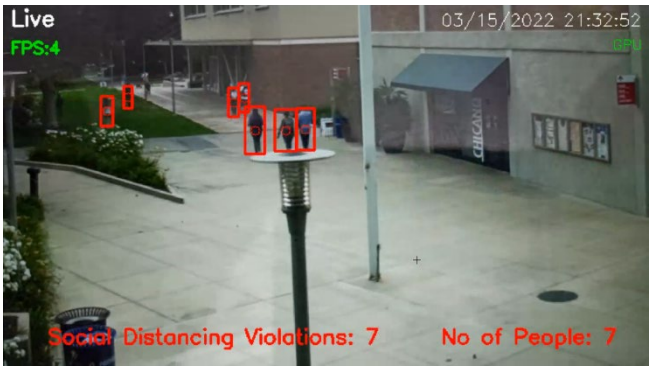

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

V. Conclusion and Future Work

To detect social distancing, a deep learning model is proposed. With the help of algorithm, we check the distance between people and the pair violating it are displayed with the red frame. We validate the proposed method with the help of a video in which we see people walking on a street. From the results w observe that this method can be further developed to use in workplaces, universities, and schools. In addition, improvement can be made by optimizing the algorithm for human detection, implementing mask and body temperature detection. Also, improvement can be made in the computing power of the hardware and proper positioning of the viewing device.

References

[1] Centers for Disease Control (CDC). Implementation of Mitigation Strategies for Communities with Local COVID-19 [Online]. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019 (Accessed 8 May 2020).
[2] Centers for Disease Control (CDC). Implementation of Mitigation Strategies for Communities with Local COVID-19 Transmission [Online]. Available at https://www.cdc.gov/coronavirus/2019-ncov/downloads/community-mitigation-strategy.pdf (Accessed 8 May 2020).
[3] Ministry of Health Malaysia (MOHM) Official Portal. COVID-19 (Guidelines) [Online]. Available at
(Accessed 8 May 2020).
[4] D.T. Nguyen, W. Li, P.O. Ogunbona, “Human detection from images and videos: A survey”, Pattern Recognition, 51:148-75, 2016.
[5] A. Krizhevsky, I. Sutskever, G.E. Hinton, “Imagenet classification with deep convolutional neural networks”, In Advances in neural information processing systems, pp. 1097-1105, 2012.
[6] R. Girshick, J. Donahue, T. Darrell, J. Malik. "Rich feature hierarchies
for accurate object detection and semantic segmentation." In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 580-587. 2014.
[7] J. Redmon, S. Divvala, R. Girshick, A. Farhadi, “You only look once: Unified, real-time object detection”, In Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 779-788. 2016.
[8] Landing AI Creates an AI Tool to Help Customers Monitor Social Distancing in the Workplace [Onlive]. Available at https://landing.ai/landing-ai-creates-an-ai-tool-to-help-customersmonitor-social-distancing-in-the-workplace/ (Access on 4 May 2020).