



# “AI Social Distancing Detector Using Image Processing”

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**Abstract:** Social distancing is a recommended solution by the World Health Organization (WHO) to minimize the spread of COVID-19 in public places. The majority of governments and national health authorities have set the 2-meter physical distancing as a mandatory safety measure in shopping centers, schools and other covered areas. In this research, we develop a generic Deep Neural Network-Based model for automated people detection, tracking, and inter-people distances estimation in the crowd, using common CCTV security cameras. The proposed model includes a YOLOv4-based framework and inverse perspective mapping for accurate people detection and social distancing monitoring in challenging conditions, including people occlusion, partial visibility, and lighting variations. We also provide an online risk assessment scheme by statistical analysis of the Spatio-temporal data from the moving trajectories and the rate of social distancing violations. We identify high-risk zones with the highest possibility of virus spread and infections. This may help authorities to redesign the layout of a public place or to take precaution actions to mitigate high-risk zones. The efficiency of the proposed methodology is evaluated on the Oxford Town Centre dataset, with superior performance in terms of accuracy and speed compared to three state-of-the-art methods.

## I. INTRODUCTION

The novel generation of the coronavirus disease (COVID-19) was reported in late December 2019 in Wuhan, China. After only a few months, the virus was hit by the global outbreak in 2020. On May 2020 The World Health Organisation (WHO) announced the situation as the pandemic<sup>1, 2</sup>. The statistics by WHO on 26 August 2020 confirms 23.8 million infected people in 200 countries. The mortality rate of the infectious virus also shows a scary number of 815,000 people. With the growing trend of patients, there is still no effective cure or available treatment for the virus. While scientists, healthcare organisations, and researchers are continuously working to produce appropriate medications or vaccines for the deadly virus, no definite success has been reported at the time of this research, and there are no certain treatments or recommendation to prevent or cure this new disease. Therefore, precautions are taken by the whole world to limit the spread of infection.

These harsh conditions have forced the global communities to look for alternative ways to reduce the spread of the virus. Social distancing, as shown in Figure 1(a), refers to precaution actions to prevent the proliferation of the disease, by minimising the proximity of human physical contacts in covered or crowded public places (e.g. schools, workplaces, gyms, lecture theatres, etc.) to stop the widespread accumulation of the infection risk (Figure 1(b)). According to the defined requirements by the WHO, the minimum distance between individuals must be at least 6 feet (1.8 meters) in order to observe an adequate social distancing among the people. Recent researches have confirmed that people with mild or no symptoms may also be carriers of the novel Coronavirus infections.

Therefore, it is important all individuals maintain controlled behaviors and observe social distancing. Many research works such as 5, 6, 7 have proved social distancing as an effective non-pharmacological approach and an important inhibitor for limiting the transmission of contagious diseases such as H1N1, SARS, and COVID-19.



(a) Social distancing monitoring



(b) Accumulated infection risk (red-spots) due to multiple breaches of the social-distancing

## II. AIM AND OBJECTIVES

The main contribution of this research can be highlighted as follows:

- This study aims to support the reduction of the corona virus spread and its economic costs by providing an AI-based solution to automatically monitor and detect violations of social distancing among individuals.
- We are develop one of the most (if not the most) accurate deep neural network (DNN) models for people detection, tracking, and distance estimation called Deep SOCIAL.
- To perform a live and dynamic risk assessment, by statistical analysis of spatio-temporal data from the people movements at the scene.
- Today developed model is a generic human detection and tracker, not limited to social-distancing monitoring, and can be applied for various real-world applications such as pedestrian detection in autonomous vehicles, human action recognition, anomaly detection, and security systems.

### Social and Physical Distancing, Why?

When someone coughs or sneezes they spray small droplets from their nose or mouth which may contain the virus. If you are too close, you can breathe in the droplets, including the COVID-19 virus if the person coughing has the disease, even if they do not feel sick. The best way to fight the spread of the virus is to stay at home, be away from your friends and socialize online. If you must go outside or meet someone in person make sure you keep a distance of at least 1.5 meter (about 5 feet) between yourself and anyone around.

## III. SYSTEM FLOW DIAGRAM

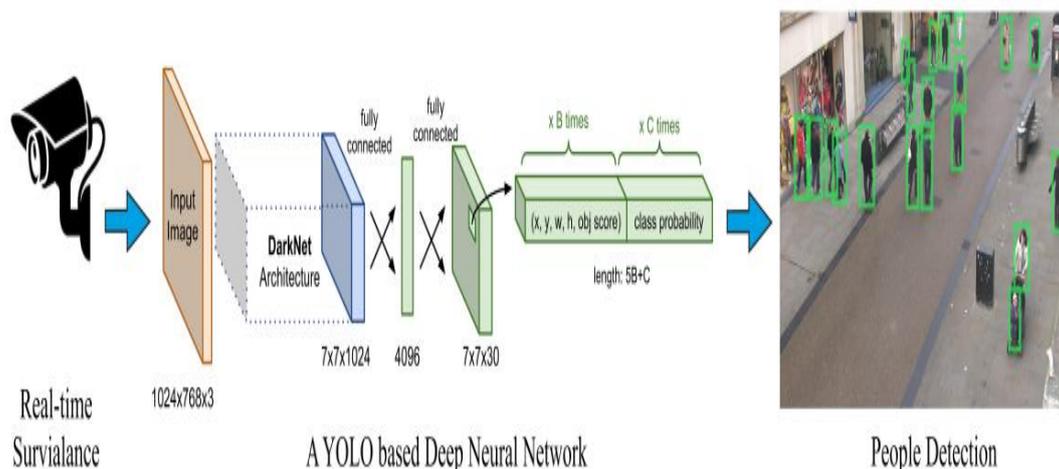
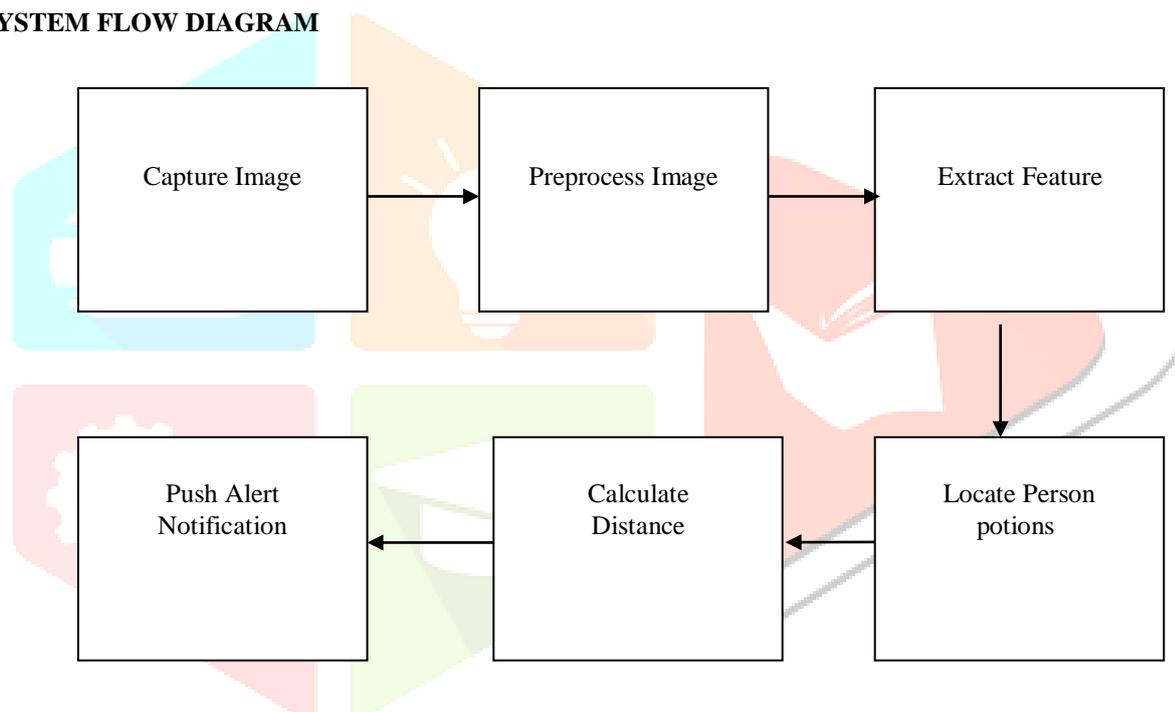


Figure 3. Stage 1- The overall structure of the people detection module.

## IV. WORKING

We propose a 3-stage model including people detection, tracking, inter-distance estimation as a total solution for social distancing monitoring and zone-based infection risk analysis. The system can be integrated and applied on all type of CCTV surveillance cameras with any resolution from VGA to Full-HD, with real-time performance.

### i. People Detection

Figure 3 shows the overall structure of the Stage 1. The objective is to develop a model to detect humans (people) with various types of challenges such as variations in clothes, postures, at far and close distances, with/without occlusion, and under different lighting conditions.

To gain this we inspire from the strength of cutting-edge research; however, we develop our own unique human classifier and train our model based on a set of comprehensive and multifaceted datasets. Before diving into further technical details, we overview the most advanced object detection techniques and then introduce our human detection model.

Modern DNN-based detectors consist of two sections: A backbone for extracting features and a head for predicting classes and location of objects. The feature extractor tends to encodName - Prof. C. H. Kidile

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Subject- Electrical Engg.

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No. of student present- 38/54to the query object(s). Examples of feature extraction architectures can be seen in VGG1646, ResNet-5047, CSPResNeXt-5048, CSPDarknet5348, and EfficientNet-B0/B749. The head of a DNN is responsible for the classifying the objects (e.g. people, bicycles, chairs, etc.) as well as calculating the size of the objects and the coordinates of the correspondent bounding boxes.

### ii. People Tracking

The next step after the detection phase is people tracking and ID assignment for each individual. We use the Simple Online and Real-time (SORT) tracking technique<sup>73</sup> as a framework for the Kalman filter<sup>74</sup> along with the Hungarian optimization technique to track the people. Kalman filter predicts the position of the human at time  $t+1$  based on the current measurement at time  $t$  and the mathematical modeling of the human movement. This is an effective way to keep localizing the human in case of occlusion.

The Hungarian algorithm is a combinatorial optimization algorithm that helps to assign a unique ID number to identify a given object in a set of image frames, by examining whether a person in the current frame is the same detected person in the previous frames or not.

### iii. Inter-distance Estimation:

Stereo-vision is a popular technique for distance estimation such as in<sup>75</sup>; however, this is not a feasible approach in our research when we aim at integration of an efficient solution, applicable in all public places using only a basic CCTV camera. Therefore we adhere to a monocular solution.

On the other hand, by using a single camera, the projection of a 3-D world scene into a 2-D perspective image plane leads to unrealistic pixel-distances between the objects. This is called perspective effect, in which we cannot perceive uniform distribution of distances in the entire image. For example, parallel lines intersect at the horizon and farther people to the camera seem much shorter than the people who are closer to the camera coordinate center.

In three-dimensional space, the center or the reference point of each bonding box is associated with three parameters  $(x,y,z)$ , while in the image received from the camera, the original 3D space is reduced to two-dimensions of  $(x,y)$ , and the depth parameter  $(z)$  is not available. In such a lowered dimensional space, the direct use of the Euclidean distance criterion to measure inter-people distance estimation would be erroneous.

Using these three steps we will come to know if people are maintaining social distancing or not.

## V. REQUIREMENT

### 1. SOFTWARE

- Python
- Windows OS or Linux
- Visual Studio code

### 2. HARDWARE

- Windows Machine
- Webcam

## VI. ADVANTAGES AND LIMITATIONS

- It slows and decreases transmission of influenza which limits the effects on individuals plus schools, workplaces and the health care system.
- To avoid Corona spread this system will be more effective. It has wide area applications.
- Limitation is only the camera angle position.

## VII. CONCLUSION

This project proposed a social distance detection algorithm which is free from sensors. The objective of this project is to create a system which would be able to detect social distance as early as possible from a live video feed. System is expected to detect social distance while it is still small and has not grown to mammoth proportions. Also, the hardware is minimal and has been already existent in places, thus saving capital. Based on the results produced, the system will be proven to be effective at detecting social distancing.

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