Finding an optimal distance of social distancing for COVID 19

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Abstract

Social distancing is a non-pharmaceutical infection prevention and control approach that is now being utilized in the COVID-19 scenario to avoid or restrict the transmission of illness in a community. As a consequence, the disease transmission, as well as the morbidity and mortality associated with it are reduced. The deadly coronavirus will circulate if the distance between the two persons in each site is used. However, coronavirus exposure must be avoided at all costs. The distance varies due to different nations' political rules and the conditions of their medical embassy. The WHO established a social distance of 1 to 2 metres as the standard. This research work has developed a computational method for estimating the impact of coronavirus based on various social distancing metrics. Generally, in COVID – 19 situations, social distance ranging from long to extremely long can be a good strategy. The adoption of extremely small social distance is a harmful approach to the pandemic. This calculation can be done by using deep learning based on crowd image identification. The proposed work has been utilized to find the optimal social distancing for COVID – 19 and it is identified as 1.89 meter. The purpose of the proposed experiment is to compare the different types of deep learning based image recognition algorithms in a crowded environment. The performance can be measured with various metrics such as accuracy, precision, recall, and true detection rate.

Keywords: deep learning, social distancing, COVID 19

1. Introduction

Since the COVID-19 was launched in Wuhan, China, in December 2019, several governments across the world have taken note of it. On March 11, 2020, the World Health Organization proclaimed it a worldwide pandemic after the virus spread to 114 nations, killed 4,000 people, and affected 118,000 individuals with active cases. On October 7, 2020, many confirmed COVID-19 instances were reported, as well as a huge number of unconfirmed cases [1]. Researchers, scientists, and healthcare organizations around the world are trying to find a solution to stop the further spread of the deadly virus, but so far no significant progress has been testified [2]. Figure 1 shows some randomly captured image in a crowded park.

Figure 1. Randomly Captured Image in Crowded Area

The global community is searching for the alternatives to prevent the virus from further spreading. Most people catch the virus by being in close contact with the other people for a long period. When a person infected with the virus sneezes, coughs, or speaks, the virus spreads by the droplets produced from the individual's nose or mouth into the surrounding area [3, 4]. Dissolved

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in the bloodstream, the droplets go into the lungs, where they start killing lung cells. Recent studies indicate that, those with no symptoms but who are infected is still responsible for the spread of virus [5]. This is important because some people can have no symptoms and still need to be at least 6 feet away from others [6, 7].

As a consequence of travel and commerce, the pandemic begins with the animals and spreads throughout the world. Coronavirus infection has the ability to communicate with others and coordinate patient interaction [8, 9]. However, it is incapable of actually making contact with the infected individuals. The infection strikes the lung cells in the respiratory system of the patients, resulting in the infection recreating itself and giving rise to an unbelievably alluring issue with a greatly restricted ability to care [10]. Figure 2 shows some standard benchmark social distance measures.

Figure 2. Social Distance Measurement

When two or more people are standing in the same frame and maintaining a social distance from each other, the software will flag it as evidence of Social Distancing. It will identify a person who adheres to WHO's social distancing recommendations as people who maintain or are following those rules using the Euclidean Distance algorithm [11-13].

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Motivation of this research

The main motive of this research work is to implement social distancing for determining whether or not an object has already been detected. To do so, it is highly ensured that two people maintaining social distance from each other have not found each other yet. While the machine learning technique cannot compute the optimal distance for social distancing monitoring in these situations, it can identify one. The area of Artificial Intelligence known as Computer Vision has shown that it may be a useful tool for identifying people in crowded settings and could even be used to do social distance observation. With deep neural networks, the most complicated characteristics can be extracted from data in order to allow us to develop a better understanding on web cameras.

2.   Organization of the Research

This research article is organized as follows: section 3 provides various past researches on social distance analysis. Section 4 discusses various methodologies to find an optimal social distance between people. Section 5 discusses about the performance metrics of the proposed algorithm. Section 6 concludes the proposed research work with few extension tasks.

3.   Preliminaries

Ainslie et al. examined the connection between a region's financial standing and social distancing. They are highly concentrated to minimize the possibility of the outbreak that permitted social distancing range. The technology-based approaches have been used to combat the epidemic thus far. In industrialized nations, many governments and medical facilities are using GPS to track the travels of infected people, as well as those who are suspected of being affected [14].

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The researcher Nguyen et al. discusses an overview of a variety of new technologies, such as wireless, Bluetooth, cell phones, and GPS location, computer vision localization, and deep learning, which may play a critical role in many real-world social distance situations. Drones and other surveillance cameras are often used to find masses of people [15].

For the year 2018, Joel Joseph Joy and co-authors proposed a traffic density identification technique that was based on image analysis. The pictures taken by the camera are used to determine the length of the line and the density of traffic. It was decided to use fuzzy logic to the visual input to combat the concept of partial reality. The outcome of the partial reality notion may range from being entirely correct to be utterly untrue [16].

When it came to infectious exhalations, the majority of the researchers thought that a social distance of around 1.6 to 3 metres (about 5.3 to 8.4 feet) should be considered, while other areas such as coughing and sneezing may require a somewhat shorter distance. If a low-altitude air conditioning system was installed, it was anticipated that at least $8.2 million in resources would be available [17]. When the model was run to completion, the results revealed that up to 40% of the hosts with the virus were required to maintain a certain distance to have a faith based on past experiences.

Research Gap

The globally verified instance distance should not be used to calculate the optimum actual distance. Instead of categorizing confirmed instances based on social distance maintained by individuals, the deep learning algorithm classifies the cases based on the social distance maintained by people. As far as we know, this study has not been done anywhere else. Additionally, the findings provided in this study will help in locating the optimum distance for social distancing.

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4.   Methodologies

4.1   Proposing Method

The basic computer vision issue is establishing object detection in the image domain. To do this, the project aims to locate the different instances of semantic items, such as people, vehicles, and buildings in the public places of any city. In the past, deep Convolutional Neural Network (CNN) models [18] have reigned supreme when it comes to object identification standard.

4.1.1 Object Detection in Image Domain

The objects are detected in the image sector with CNN model, which is trained with a benchmark dataset. It is written in mathematical format as follows;

$$\{P_T\}_k = f_{CNN}(I)$$

Step 1:

$P_T = (l_i, b_i, s_i), \forall i \in \{1,2\ldots.n\} \ and \ n \ is \ the \ number \ of \ detected \ objects.$

Where,

$P_T \ is \ Python \ tuple$

n is the number of detected objects from the crowd area. $l_i \in L$ is the object class label.

Step 2:

$f_{CNN}.b_i = b_{i,1} \ldots b_{i,j}$

Where $b_{i,j} = (x_{i,j}, y_{i,j})$ provides pixel index in the picture domain.

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Step 3:

The interested case of detected persons with pixel pose vector of the object by using centre point of the below border of the bounding box as follows,

$$P'_T = \frac{(b_{i,1} + b_{i,2})}{2}$$

4.1.2 Measurement formulae for social distancing

P_T are python tuples, which is used to store the number in sequentially in the data structure. In the co-ordinates are obtaining the list of peoples distances through measurement index as follows;

$$E_{d(i,j)} = \left\| P_i - P_j \right\|$$

Step 4:

The social distancing defilement in the camera frame is calculated by following; when i ≠ j;

$$v = \sum_{i=1}^{n} \sum_{j=1}^{n} E_{d(i,j)}$$

4.2 Measuring Index

To get the measuring index, societal density must be reached and then the measures must be taken to the extension of COVID-19 [19]. Some procedures are required for post-processing.

1. Social Distancing Calculation

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For individuals in regions where the social crowd density is higher than the critical social density value, non-alarming audio and visual signals are delivered. Violation of the social distancing technique results in creating an increased awareness of the individuals, who engage in the behaviour [20]. Additionally, the device is capable of sending out influx modulation signals. To control crowd density, site administrators may utilize these signals. It remains as the significant solution to avoid overpopulation.

2. Comprehensive Critical Analysis

When analysing offline data, basic measurements such as the average number of people in various areas, such as parks are obtained with the strategically positioned webcams. This is important for establishing policymaking and event planning on a broad scale [21].

5. Results & Discussion

To support our approach, the proposed algorithm is validated by examining the Oxford Town Center dataset, since it represents the reality. All of the 4501 annotated frames together count as' 4501'. The 2500-frame training set was divided into two sections, one portion for training and the other for validation [22]. The CNN-based object detectors are developed by using the results of our experiments, which are shown in the figure 4 a & b.

The purpose of this division is to make an end-to-end CNN model to detect social distance violation, which was built by using the training dataset, which compete with the suggested approach [23]. The validation frames were utilized for all of the evaluation and findings. Table 1 shows some results obtained by the proposed work. The violation detection between the people from the total object has been captured. It measures the distance between them and classifies it into two regions named as red and green alert zone.

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Figure 4. Object Captured and Social Distancing Measures by CNN

Table 1. Results Obtained from Test Images

Model	Images	Violation found	Object captured	Distance measure for Red alert (m)	Distance measure for green (m)
CNN (trained with overhead dataset)	Test img 1	1	8	0.5	2.1,2.2,3.1
	Test img 2	3	8	0.5,0.2,0.1	2.9
	Test img 3	3	9	0.1,0.1,1.89	2.5,4.1
	Test img 4	2	12	1.71,1.61,	3.1,2.2,4.3,2.2
CNN (Pre-trained)	Test img 1	1	8	0.5	2.3,2.8,3.0
	Test img 2	2	7	0.2,0.1	1.9, 2.9
	Test img 3	2	8	0.1,0.1	2.1,2.5,4.1
	Test img 4	1	10	1.71	3.1,2.2,4.3,2.2

The findings in figure 4 demonstrate the results of utilizing CNN to find pedestrians in a picture, as well as social distancing in the measuring index coordinates. There were many missed positives based on the qualitative findings. It may be for two reasons which we were faced in our proposed work.

1. A primary reason for missed detection is occlusions.

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2. Violation with critical social density

Table 2. performance measures with various metrics

Model	Accuracy	Precision	Recall	True detection Rate	False detection rate
YOLOV$_3$ (Pre trained)	92%	84%	78%	92%	0.4%
CNN(Pre-trained)	89%	81.51%	77.89%	90%	0.7%
CNN(Trained with overhead dataset)	93%	88%	81%	96%	0.21%

Table 2 shows some overall performance measures with various metrics. In terms of social distancing violations, only a small number of missed detections impact the detection rate. For the most part, the main objective of the system is to identify whether or not there is a social distancing violation. Even if the number of violations and critical social density is less than the required minimum, we will be satisfied as long as we can discover a suitable approximation. Figure 5 shows the overall performance measures with basic metrics.
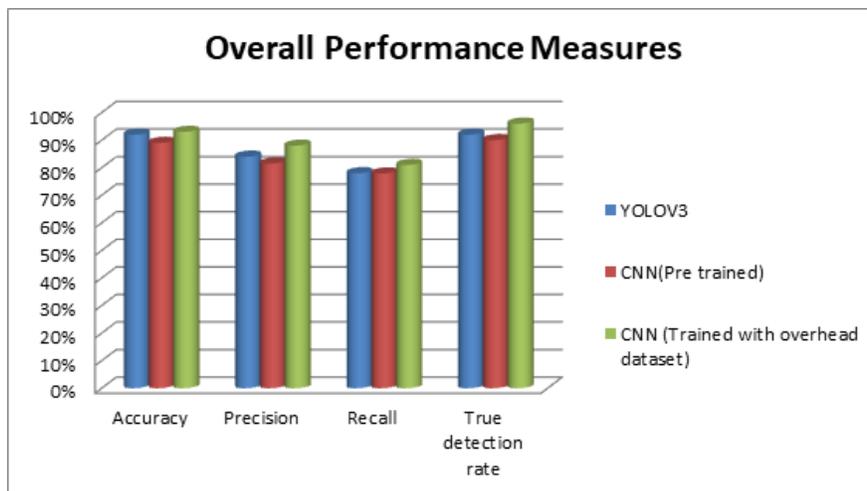

Figure 5. Overall Performance Measures

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We have set 1.89 meter as optimal distance for social distancing by using the proposed framework. Using the Euclidean distance, the pairwise centroid distances between identified bounding boxes are measured. To verify social distance violations between individuals, an estimate of physical distance to the pixel is utilized, and it will also set a threshold.

6.   Conclusion

This study suggested the use of the deep learning CNN algorithm for performing real time distance measurement with web cameras. This method is used to identify and track social desensitization in any location that has a crowd. Additionally, the proposed approach has used the optimum social distance value 1.89m, which reduces the risk of coronavirus by controlling the number of individuals at a gathering. The traditional methods have computed the distance measurement with around 2m. Using three distinct pedestrian crowd datasets, the suggested method was shown. To offer real-world validation, quantitative validation was performed on the Oxford Town Center Dataset, which is populated with ground-truth pedestrian detections. Our future efforts will include overcoming the algorithm's current restrictions. For this kind of job, family members are not considered. Realizing this problem and applying it in other locations, for example, in playgrounds, will be useful for future research. Practicing social distancing is important since some couples or close friends will have to move away from their loved ones to get on the packed trains. Besides, if all the features are detected then the image is recognizing by CNN method due to its flattened value. It is therefore inescapable that our planned task is rather limited [24, 25].

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