Estimation of Social Distance for COVID19 Prevention using K-Nearest Neighbor Algorithm through deep learning

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Abstract—**Coronavirus disease has a crisis with high spread throughout the world during the COVID19 pandemic period. This disease can be easily spread to a group of people and increase the spread. Since it is a worldly disease and not plenty of vaccines available, social distancing is the only best approach to defend against the pandemic situation. All the affected countries' governments declared locked-down to implement social distancing. This social separation and persons not being in a mass group can slow down the spread of COVID19. It reduces the physical contact between infected persons and normal healthy persons. Almost every health organization tells that to follow social distancing people should maintain at least 6 feet of distance from each other. This research proposes a deep learning approach for social distancing which is developed for tracking and detecting people who are in indoor as well as outdoor scenarios using YOLO V3 video analytic technique. This approach focuses to inspect whether the people are maintaining social distancing in many areas, using surveillance video with measuring the distance in real-time performance. Most of the early studies of detecting social distance monitoring were based on GPS for tracking the movements of people where the signals could be lost. On the other hand, some countries use drones to detect large gatherings of people who cannot have a clear view at night times [10]. In the future, the proposed system can be used fully for detecting threats in the public crowded or it can detect any person affected by critical situations (ie fainting, Cordia arrest) or planting the crops in the forms evenly with a uniform measurement. This proposal could be used in many fields like crowd analysis, autonomous vehicles, and human action recognition and could help the government authorities to redesign the public place layout and take precautionary action in the risk zones. This system analyses the social distancing of people by calculating the distance between people to slow downing the spread of the COVID 19 virus.**

Keywords—Social distancing, supervised learning algorithm, Object detection, Crowd analysis, covid-19.

I. INTRODUCTION

In the city of Wuhan, there were a lot of pneumonia cases of COVID-19 found in Dec 2019. It spread to almost all the country and the numbers of new COVID-19[1] cases and deaths appears in day-to-day life with many new variants. The entire world is under the grip of the fear caused by the latest digital age demon popularly known as Covid-19. Though the initial formation and spread of this menace is still a subject of suspicion, the devastating effects that have been caused by this invisible enemy to mankind are uncountable. The global COVID 19 [1-4] pandemic has perhaps created first of a kind of universal teachable moment for humanity, exposing the fault lines of our societal and economic structures and institutions and how they serve us in

a moment of acute crisis. It is mandated to self-isolate, limit external interactions, and work from home has meant that only with access to uninterrupted internet and digital technologies, primarily white-collar workers with steady pay and benefits, have been able to navigate this crisis relatively unscathed, both financially and health-wise. Social distancing is the best practice that aims to minimize or interrupt more spread of COVID-19. It also reduces the physical contact between possibly infected individuals and normal persons. The Deep Learning algorithm can be implemented in automated systems which can be used in health centers. Deep learning is a subset of Artificial intelligence. As neural network mimics the human brain likewise, deep learning is also a type of mimic of the human brain. In this, we need not explicitly program everything.

II. RELATED WORK

The identification of individuals via the use of computer vision is a subfield that falls under the umbrella of object detection. Using a model that has already been established, the found items are categorized according to the form that they have. It has been shown that the computational methods of convolutional neural networks (CNN)[2] and deep learning may attain higher levels of accuracy and performance when applied to visual recognition benchmarks. It is a perceptron neural network with several layers that includes huge fully connected layers, convolutional layers, and sub-sampling layers.

Object identification and recognition have seen a lot of success recently thanks to the use of neural network architecture. They are able to independently generate things by applying descriptors and learn certain attributes that are not extensively supplied in the dataset. However, this strategy comes with its own set of benefits and drawbacks, both in terms of performance and speed, as well as accuracy. You Only Look Once (YOLO) and Region-Based Convolutional Neural Networks (R-CNN) are developed for the detection of multiple classes of an object in various regions. The system uses R-CNN rather than CNN to use multiple classes in various regions. [3] Both of these methods were developed for the detection of multiple classes of an object in various regions. YOLO, which stands for "You Only Look Once," is an exact algorithm approach that is widely utilized in the CNN industry to speed up and improve the accuracy of object recognition. The YOLO model is used to demonstrate, in Figure 1, how an item may be recognized. The goal of the study has been transformed into the purpose of the proposed system, which is to provide a way for identifying people using an approach based on computer vision. The input is not

a stream from a drone; rather, it is a feed from a CCTV camera that has been deployed in areas that are densely populated. The range of the CCTV camera allows it to cover the areas inside the marketplaces, schools, and colleges that are within the range of the camera that was placed. The RCNN models use a bounding box in the shape of a rectangle to represent the person visible in the frame. The RCNN-based YOLO algorithm is used in order to recognize the individuals caught on video by the CCTV system. The calculations are carried out by determining the distance between each person's centroid; the result will indicate whether or not the individuals caught on camera maintain an appropriate level of social distance.
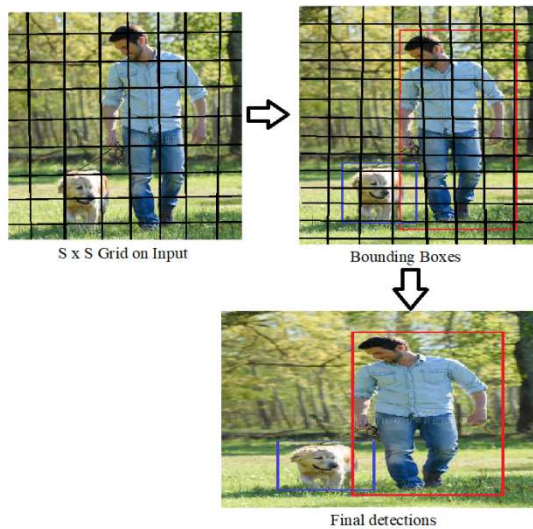

Fig. 1. Object Detection using the YOLO model

III. PROPOSED SYSTEM

Because there has been such a significant increase in the number of people who have been diagnosed with coronavirus all over the globe, the World Health Organization has classified the spread of the virus as a worldwide pandemic. Many countries have instituted stringent curfews and lockdowns in an effort to slow the spread of the epidemic. The authorities in these countries have instructed their citizens to remain in the safety of their own homes for the duration of the outbreak. It was necessary for a number of healthcare organizations to stress that the most effective strategy to limit the spread of the coronavirus is for people to socially remove themselves from others and reduce the amount of close contact they have with one another. to reduce the slope of the curve and to provide assistance to healthcare organizations dealing with the epidemic. A non-pharmaceutical intervention for infection prevention and control, social distancing involves reducing the amount of contact between people who are infected with a disease-causing pathogen and those who are not infected with the pathogen in order to slow the rate of disease transmission in a human community. This is done to avoid the terrible decrease in contact between infected people and uninfected people. In most cases, Fig. 2 demonstrates that there are no special preventive measures, hygiene, or physical distance between individuals in the market. As a result of this circumstance, there has been a reduction in the rate of the disease's spread as well as its mortality and morbidity.

Fig. 2. Violation of Social distance in Market

According to recommendations made by the World Health Organization (WHO), businesses are required to maintain a barrier of one metre between themselves and their clients. measures to lessen the congestion in the marketplaces during rush hours The social distance between people is clearly maintained in the market locations, as Fig. 3 demonstrates.

Fig. 3. Social distance maintained in the market

A. Motivation for Deep Learning

First, on a large variety of important problems, the simple machine learning algorithms work very well. However, the deep learning approach has not succeeded in solving the central problems in Artificial intelligence, like recognizing Objects or speech. This is designed to overcome this problem and another obstacle.

B. Algorithm for K-Nearest Neighbour-based Object Detection

Capture video from CCTV

Detect people using YOLO V3

Begin

    Area = Estimate the size of the event area

    Human = Detection of No. of humans in the frame

    Density = Area x Human

If (Density> Threshold value)

    then

    "Need to follow social distancing"

    else

    "Social distance maintained"

    Compute K-Nearest Neighbour Authorism

    Measure Dp (Distance between Person)

Begin

Selecting the best search algorithm

for each frame

{

  Extract region proposal

  Implementing K-Nearest Neighbour Features

  Classify Regions with bounding Box

Calculate Centroid Distance between bounding box

Begin

        Define Threshold value = 1 meter

  If distance of People = Threshold value

  Then

        Maintain Social Distance

        Display "Green Bounding Box"

        Else

        No Social Distance

        Display "Red Bounding Box"

End

IV. METHODOLOGY

In light of the works that are already in existence, the suggested system needs to have a few improvements carried out on it. This system was designed with the intention of fostering social distancing by installing CCTV cameras in public spaces, such as marketplaces, workplaces, colleges, and schools. These cameras will monitor the areas, identify and assess any violations of social distance, and send out warning signals. This method illustrates some significant work that has been done in the area of detecting people using deep learning. A significant amount of recent research that has focused on the identification of objects using a deep learning technique is also included in this article. It is regarded to be an application of computer vision's object detection capabilities when surveillance cameras are used to look for people. The found artifacts have been pinpointed in their exact locations and categorized according to the characteristics of their shapes. It has been shown that the methods that make use of the YOLO V3 Algorithm and deep learning are able to generate improved results in the object identification process. It is a supervised feature learning technique of deep learning strategy because it is more strong in identifying and finding distinct objects from diverse inputs. This is because it is a deep learning strategy. The information included in the dataset was collected from real-world sources such as public markets, educational institutions, and community centers. ensuring that the Specifications do not lose their Integrity. Figure 4 depicts the model's organizational structure in its entirety. The k-th lowest (or biggest) number in a set may be found by an approach called the Selection Algorithm. That value is termed the kth order statistic. The numerous uses for determining the least, most, and middle values in a collection are covered.
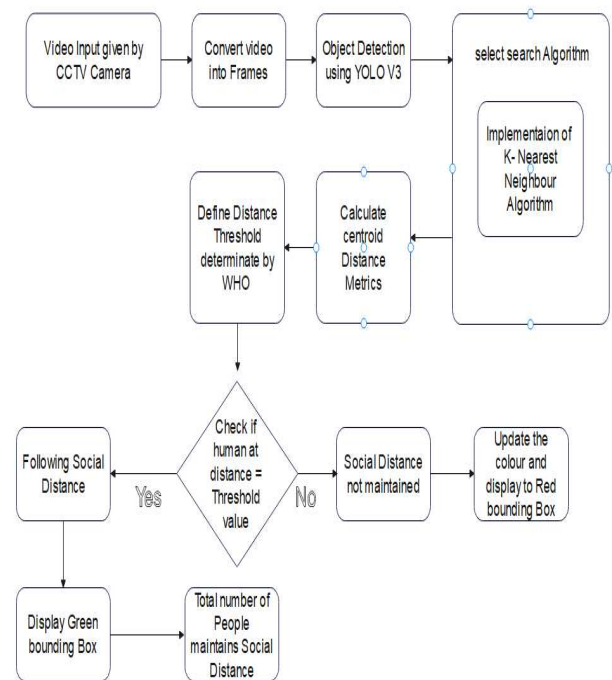

Fig. 4. The architecture of detecting social distancing measurement using the K-Nearest Neighbor Algorithm

C. YOLO V3 Algorithm

The YOLO algorithm [5] makes multiple predictions about the bounding boxes associated with each grid cell. During the stage of training, it is necessary to have a single predictor of the bounding box that is accountable for each class. The predictor will choose an object to make its prediction based on the one that has the greatest intersection value with the ground truth's union value. After completing this step, you will be able to specialize in the bounding box prediction. In order to calculate loss, this approach makes use of a sum-squared error between the ground truth and the bounding boxes. The localization, classification, and confidence losses associated with this model are all accounted for by the final sum squared error. YOLO [6] is based on the concept of dividing the initial picture into a grid of S by S cells, with each cell having the potential to contain just one object and a certain number of boundary boxes. After this, it predicts B boundary boxes for each grid cell in the original image. Next, it finds one object and makes a conditional prediction for each of the C class' probabilities, one for each class. With a distance threshold of 1 meter, the projected class reflects the highest score.

D. Selecting Search Algorithm

The K – Nearest Neighbor algorithm is the simplest supervised learning algorithm it is mostly used for classification. It is the method where KNN [7] algorithm saves all the data and classifies new cases on similarity according to the data. The K value in the K-Nearest Neighbor algorithm is a high influence on the performance of the KNN algorithm. Some of the data mining approaches were knowledge extraction, pattern analysis, knowledge mining from the database, and classification of data. Classification is the data mining technique that is to predict the unknown data class with the training data set with the known class data sets. KNN is easy to implement, it is used to classify future data and it has higher data accuracy.

The KNN algorithm is normally used in classification. when the model has several classified data and has a new data item, but is not sure which is the class of that new data item, in that case, we use the KNN learning algorithm. KNN is a supervised learning and pattern classification data learning algorithm. The KNN algorithm can be used in classification and also regression. This algorithm is the most accurate model because KNN makes a highly accurate prediction, so the system can use the KNN algorithm where we need high accuracy. But the drawback of this algorithm is that the outcomes of accuracy depend on the quality of the data which is available. If the data is of good quality, then the accuracy of the outcome is higher. This algorithm is easy to implement with two parameters. The first parameter is the value of the K, and the second is the distance function. KNN algorithm is one of the most useful data mining and also classification algorithms. It is used in detecting cancer, pattern recognition, text classification, email spam detection, and regression it is used to risk assessment, and score prediction. The KNN algorithm stores the available data cases and classifies new data for K in the same measure. It suggests that if the node is similar to the neighbor, then the node is one of them. For example, a car is more similar to a bike, cycle, or bus rather than hands, legs, or eyes than the most likely car belonging to the group of vehicles. KNN is mainly used for search applications thus this search is called KNN search.

The K is the number of neighbors that we have to assign and it is nearer to the new object. If k=3 then the three nearest neighbors were checked and the common neighbors' class will be assigned to the testing data item. This method of assigning data is the K in the KNN algorithm. The recommendation system is the biggest use of the KNN algorithm. The recommended system is like the system asking for commodities to sell to the customer. when the customer asks for a product and it is not showing only that product, the system also suggests the relevant sets of products related to the item which the customer too interested in buying it. The KNN algorithm is used in Amazon, Netflix, Flipkart, etc. which are the recommended products. Nearly 35% of amazon's e-selling business revenue is generated only by its recommendation system engine.

E. Working principle of K-Nearest Neighbours Algorithm

The KNN [8] algorithm is the k-Nearest Neighbors algorithm which finds the nearest neighbor of the new data item. If k=3, (when k is the nearest neighbor) then the three closest neighbors have been checked and the most common data item class will be assigned to the new data item. We can measure the distance between k and new data points through Centroid distance and similar to this were hamming distance, the Manhattan distance measurement formula which can be used in the KNN algorithm. The distance that exists between the original centroid points and the other data points has to be computed.To get the centroid from the cluster table, first obtain the positions of all the points that make up a single cluster, then add all of those positions together and divide the total by the total number of points.
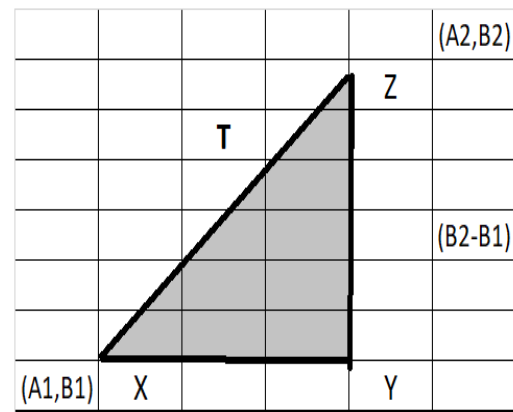

Fig. 5. Centroid distance calculation

For calculating the Centroid distance between two points (A1, A2) and (B1, B2) in two-dimensional space then the Centroid distance between two points is

$$T = \sqrt{(A2{-}A1)^2 + (B2{-}B1)^2}$$

(^2 is denoted by the square)

And in three-dimensional space, for points (A1, B1, Z1) and (A2, B2, Z2) then in this case the Centroid distance of this point is

$$T = \sqrt{(A2{-}A1)^2 + (B2{-}B1)^2 + (Z2{-}Z1)^2}.$$

In KNN we should have data set first, before applying the KNN algorithm. This algorithm uses facture similarities to predict values, so the first step is to store the data set during the first phase of the KNN [9] algorithm. Table 1 shows the people who violate the social distance.

TABLE I. VIOLATION OF SOCIAL DISTANCE AMONG 10 PEOPLE

People	X Axis	Y Axis	Keeping Distancing
Node1 (P)	5	3	NO
Node 2(A)	1	10	Yes
Node 3 (B)	9	2	Yes
Node 4 (Q)	6	5	No
Node 5(C)	6	3	No
Node 6(D)	7	9	Yes
Node 7(E)	9	6	Yes
Node 8(F)	12	1	Yes
Node 9 (G)	3	8	Yes
Node 10 (H)	1	6	Yes

The exact centre of any item is referred to as its centroid. The point in the triangle where the three medians meet is known as the centroid of the triangle. It is also known as the point where the medians of all three sides of the triangle meet, where a median is defined as a line that connects the midpoint of one side to the vertex on the opposite side of the triangle. Figure 5 depicts the computation of the centroid distance[10-11], and Figure 6 depicts a person standing in the centroid distance, which indicates that there is no social distancing present.
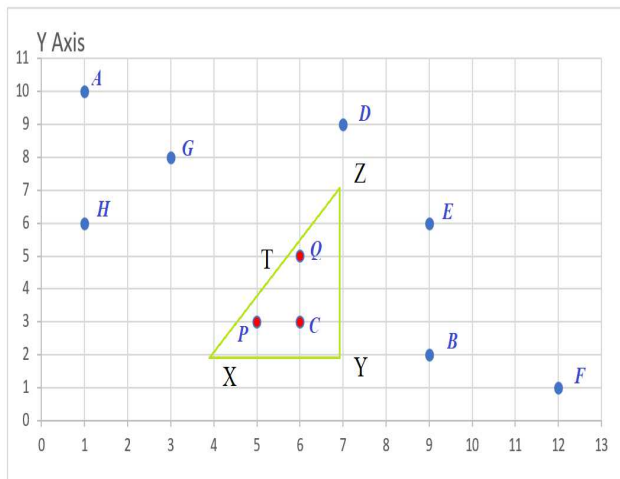
Fig. 6. Coordinates of Human standing in a Centroid distance area and violation of the social distance

The graph presented in Fig. 6 shows the location of the human standing and people standing in the centroid distance violating the social distancing.

V. EXPERIMENTAL RESULTS

As the input, we use the footage captured by the CCTV system showing a congested location filled with people. Through the use of the YOLO V3 algorithm, it has been converted into the total number of frames from the point of view of the video that was captured. Each individual person may be identified by using this object detection technique. Points and circles are used to symbolize each and every individual who is found to be present in the picture.

Fig. 7. Human with no social distancing

The person whose distance is less than the minimum threshold value that is considered acceptable is shown by red dots in Figure 7, and the people who maintain a safe distance from one another are represented by the green point box in Figure 8. Closed-circuit television, known as CCTV, is a kind of television system in which the signals are not broadcast publicly but are instead monitored, usually for the purposes of security and surveillance. The use of strategically placed cameras and the discreet monitoring of the feed from those cameras on monitors are essential components of CCTV. The camera is able to perform its functions by monitoring, recording, and transferring video pictures to a monitor and saved in different file formats shown in TABLE II
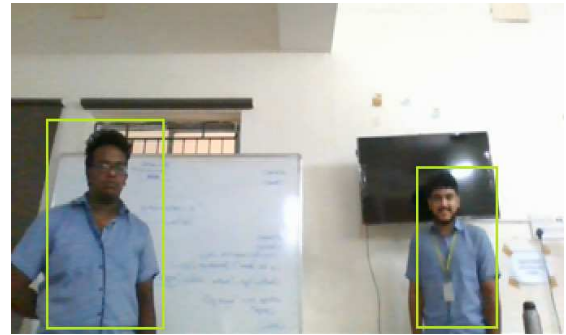

Fig. 8. The human with social distancing

TABLE II.   FINDINGS OF VIOLATION OF SOCIAL DISTANCE FROM VARIOUS CCTV FOOTAGE

CCTV Footage	Video File name	No of Persons Detected	No. of Persons With Social Distance	No. of Persons No Social Distance
1	area1.mp4	12	4	8
2	area22.vlc	14	8	6
3	area12.avi	6	3	3
4	area16.avi	10	6	4
5	area10.fly	6	2	4
6	area9.mp3	5	2	3
7	area8.mov	13	9	4
8	area13.mp4	7	4	3
9	area15.mpeg	6	3	3
10	area11.mp3	7	4	3

VI. CONCLUSION AND FUTURE WORK

A method for determining social distance is put forth in this proposal. Because the system makes use of a model that employs deep learning, it is simple to determine the distance that separates each individual. If any group or individual people are discovered to be in violation of the minimum threshold value, a red bounding box will be shown to reflect this fact. This newly created method makes use of video material that was taken by the CCTV camera in order to count the number of individuals present in a congested location. The model that has been presented is able to calculate the distance that separates individuals. During times of epidemic, this technology may be used with closed-circuit television for the purpose of monitoring human activity. It is possible to do mass screening, and it is now being done in crowded sites such as train stations, market areas, bus stops, busy streets, the entrances of shopping malls, schools, colleges, work settings, and restaurants. The device is able to certify that a safe distance is maintained between two or three individual people by monitoring the space between them. This may assist in the destruction of the coronavirus. In the not too distant future, we will be able to implement this technology on mobile camera systems that are installed on autonomous drone camera systems. Drones are simple to use and more successful than other methods for getting immediate actions with a variety of perspectives of an item that has been discovered.

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