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Social Distance Monitoring using AI & ML

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ABSTRACT

COVID-19 has shown its severe effects on people in the past two years. Social distancing is one of the critical measures to fend off the spread of the virus. International health organizations say that everyone should maintain a distance of at least six feet from each other. While a majority of the people are staying in lockdown to curb the spread of Covid, many frontline workers in the medical and production industries go to work to ensure that the basic necessities of the people are fulfilled. The tasks covered in this research are detecting the people automatically, tracking them, and calculating the distances amongst them. The CCTV footage is analyzed using a Neural Model. This research may find its application in avoiding crowds and help in preventing the spread of thevirus.

KEYWORDS: COVID-19, OpenCV, Social distancing, Deep learning, Computer vision, CCTV.

INTRODUCTION

The origin of the Covidillness (COVID-19) dates back to December 2019 in Wuhan, China. After a few months, the infection was hit by the worldwide flare-up in 2020. The World Health Organization (WHO) declared this particular circumstance as a global pandemic in May 2020. As per the WHO reports,the numbers rose to 23.78 million affected individuals across 198 nations on August 26, 2020. The death pace of the irresistible infection likewise portrays a terrifying number of 8,15,000 people. With the developing or rather a repeating pattern in patients, there is still no accessible treatment available for this infection. While researchers, medical associations,and analysts are consistently trying to create proper medications or antibodies for the dangerous disease, no distinctive accomplishment has been accounted for at the hour of critical analysis. There are no sure therapies or proposals to anticipate or fight this new illness. Therefore, safeguards have been adopted by the people all across the world to restrict thespread of this contamination. These alarming conditions have constrained the worldwide networks to search for elective approaches to decrease the spread of theinfection.

WHO has strictly advised everyone to maintain a distance of at least 6 feet or 1.8 meters from each other to curb the spread of thevirusgradually.

Ongoing researches have affirmed that individuals with negligible or no indications may likewise hold the tendency of becoming the transporters of the Coronavirus infection. Henceforth, it is significant that all people follow controlled practices and obey the social distancingnorms.

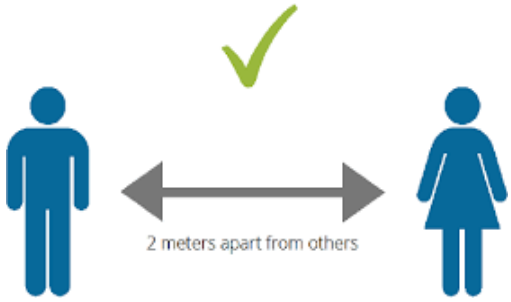

Figure 1: Minimum Social Distance

Many research works and studies done in the past have demonstrated social distancing as a feasible non-pharmacological methodology and a notable inhibitor for restricting the spread of infectious illnesses, for example, SARS and COVID-19.

Figure 2 shows the impact of adhering to the suggested social separating rules to reduce the rate of disease transmission among people. A more dynamic and vast Gaussian bend with a more limited spike inside the scope of the well-being framework administration limit makes it easier for the patients to fight the infection by getting continuous and convenient aid from the medical service associations. Any unexpected sharp spike in the disease spread rate (for example, the bend in Figure2) will lead towards disappointment in the administration. As the number of active cases saw a surge, a hike in the number of fatalities occurred.

Accordingly, social distancing now preaches to be much more crucial than thought before and probably an ideal approach to stop the outspreadof the infection, notwithstanding wearing facial veils. Practically, all nations have understood its necessity and adopted it as a need of the hour or a requiredpractice.

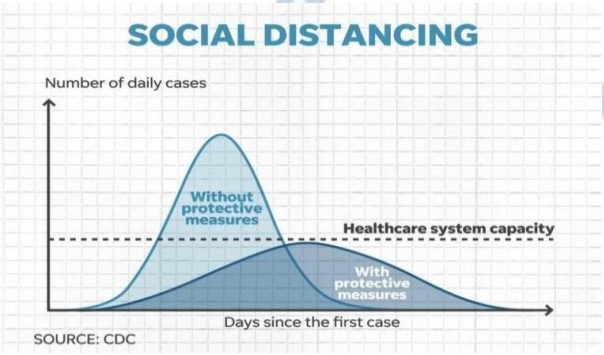

Figure 2: Distribution of virus transmission rate, with and without socialdistancing.

Since the onset of the Covid, governments have tried to keep up social distancing at public places. The actions taken by the governments include restricting unnecessary travel, shutting down restaurants and bars, spreading awareness amongst the masses about taking mandatory precautions, and maintaining social distancing. But ensuringthe required distance from everyone is not as easy as it seems. People tend to go out to buy essential items such as food, medicines, soaps and detergents, oral care products, etc. In such a situation, Machine Learning andArtificial Intelligence may play an essential role in assisting the authorities.

This paper provides an enhanced approach to monitor social distancing with minimal support from human beings. The paper proposes to use CCTV and drones for tracking human activities in public places. The positions of every human in the frame can be marked, and the corresponding distances amongst people can be calculated. Anyone violating the social distancing norms can be tagged and fined. This will, in turn, help in preventing social gatherings and crowds in public places.

Religious people gathering in huge numbers at worship places have the potential of causinga spike in the number of Covid cases. The majorityof the countries have imposed lockdown measures in the past two years, and the citizens have had to stay at home for their well-being. But with time, people will tend to visit public places frequently. They would also plan vacations to popular destinations frequently and it increase the chances of spreading the virus. In such a situation, automated monitoring would be much more effective and beneficial than the policepatrol.

Computer Vision, amalgamated with Deep Learning, can analyze the Live CCTV footage of a particular place. The distance in pixels amongst the people can be calculated and projected in a 3d space using computer vision and distance algorithms. All thepeople violating the laws can be identified and can be summoned by the concernedauthorities.

METHODOLOGY

The model has 3 stages: Detection of Human Beings, tracking their locations and estimating inter-distances amongst them. The model can be continuously applied to any CCTV camera ranging from VGA to Full-HD. The frame byframe video from any CCTV can be analyzed to find out the metrics required to ensure that everyone is following social distancing norms.

A. ObjectDetection

The YOLO model is used to detect objects in a frame. In this research, It is used to identify humans in a video frame. Before the introduction of the YOLO model, multiple parts of a single image were processed many times with different scales and purposes. This proved to be quite time-consuming and hampered the efficiency of themodel.

YOLO(You Only Look Once) brought forth a new approach to detect objects. It only scans the image one time and returns the objects it detected. Due to its speed and efficiency, it is widely used in the current models. A YOLOv4 model trained on the COCO dataset has been used in thispaper.

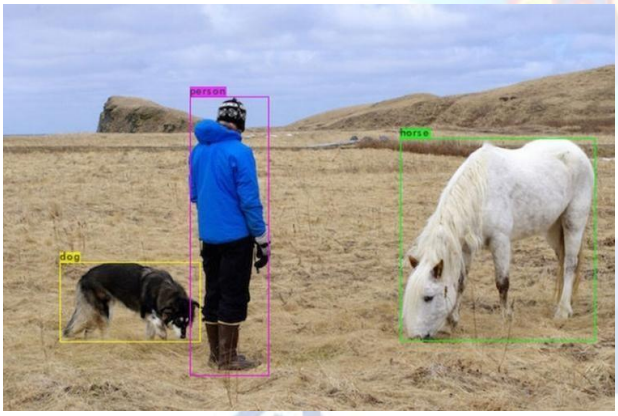

Figure 3: YOLOv4 trained on COCO dataset

B. ObjectTracking

The object tracking algorithm is used to find the Euclidean distance between an old object and two new objects in consecutive video frames. It tracks the centroids of the objects and measures the distances amongstthe centroids for the social distancing evaluation.

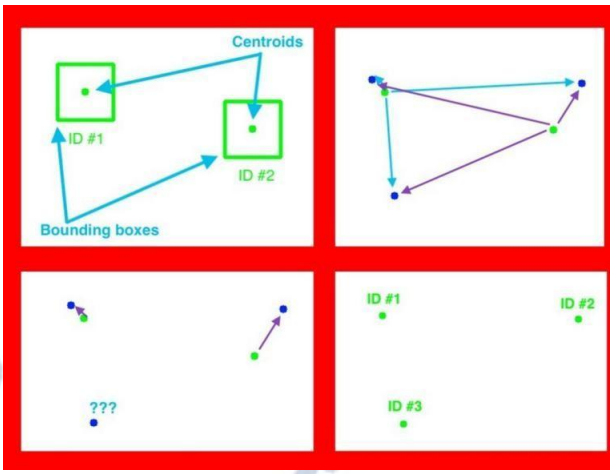

Figure 4: Object Tracking

The algorithm tracks the centroids withthe help of a set of thebounding box (x,y)coordinates for every object detected in the frame. There are many ways to produce the coordinates of these bounding boxes. Popular object detectors like HaarCascades, Faster R-CNNs, HOG + Linear SVM are used for finding the bounding box coordinates for every video frame. The centroid of the object can be easily calculated using the bounding box coordinates. Figure 1 shows detecting a bounding box and finding the centroid.

These are the elementary set of boundary box coordinates; therefore, each of them is assigned a new ID.

For every frame that comes next in the video stream, this algorithm is applied again. However, a new unique ID is not assigned to every object as it won't optimize the objecttracking. Foremost, it needs to be determined whether or not the new centroids of objects (blue) can be found out using the old object centroids (green). For this, the Euclidean distance (highlighted with blue and purple) betweenexisting object centroids and new centroids are calculated. Figure 4 shows that the centroids inthe upper half are the old ones while the centroidat the bottom is a newobject.

Centroid tracking works on the assumption that a particular object will move in consecutive frames, but the distance between its old location at a time(t) and new location at time(t+1) will be significantly less as compared to all other distances in the frame. The algorithm will try to

find a mapping for all the objects of the previous frame in the next frame. If it is able to find suchan object within the proximity of the old object, it will update the location of the old object without generating a new ID. Therefore, tracking the same object in consecutive frameshelps the model in objecttracking.

Figure 4 shows how the centroid tracker picks the centroids that are closest to the lastlocationof an object. Here, the tracker is able to deduce that two existing objects have just changed their position and a new object has entered the frame.If more objects in a frame are detected than the previous one, new objects must beregistered.

Registering a new object includes adding it to the list of objects currently in theframe and giving it a new unique ID. Its bounding box coordinates are stored and are used in calculating its centroid. Once the bounding box coordinates are stored, the top left coordinate of each bounding box is calculated so that it is easy to plot the bounding box in the frame. These steps can be followed again for each frame present in thevideo.

Figure 4 illustrates how theminimum Euclidean distances algorithm tracks existing objects and registers new ones. The old objects retain their ID while the new objects get a new ID. If an existing object goes out of the frame, its ID gets deleted from the model.

A functional object tracker should handle all the practical cases in the environment, like an objectdisappearing,gettinglost,orgoingoutof the frame of view. The process of handling these situations depends on the application, so here the old objects get deregistered if they cannot be matched to any old object for N consecutive frames.

C. Inter-DistanceEstimation

The pinhole camera has been used in this research to capture the video. Using theprinciple of rectilinear motion of light, a relationship can be established between the known variables: focal length of the camera (f), the height of theobject (R) and height of the image (R), and the unknown variable, distance of the object from the camera(d).

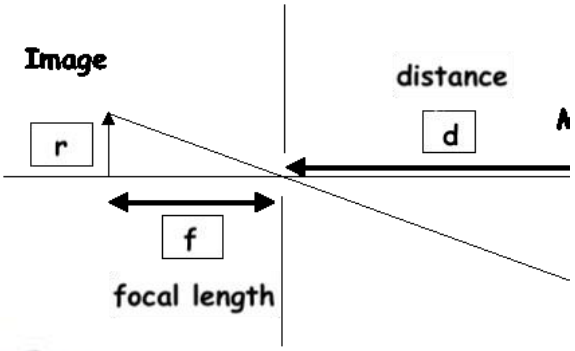

Figure 5: Inter-distance estimation

The following formula is deduced using the principle of Similarity ofTriangles

$D = F \times (R/R)$

CONCLUSION

Moving out of the Covid Era makes it all the more critical for the people to realize their responsibilities and follow social distancing norms for their good health. Everyone must accept and obey the rules and precautions listed by WHO. Direct human contact would be the primary cause of spreading the virus. Therefore, it is essential to follow the social distancing norms. As it is a very tough task for authorities to ensure social distancing everywhere, the solution provided in this paper may act as a game-changer forthem.

A lot of CCTV Cameras are already installed all over the world. Coupling them with drones, all human activities can be tracked,and gatherings of large numbers of people can be prevented. All the people who properly follow social distancing practices will be highlighted with green color while those who violate thelaws will be highlighted with red color. If a lot of people start accumulating at a place, that place will be marked with a darker red, and the authorities will be informed to keep thesituation under control. As managing a big crowd is a challenging task, this research canhelp the authorities handle the group before the condition worsens. The implementation of this research would drastically reduce the workforce required on the ground by the authorities. A lot of the time and energy of the

officers would be saved. The government would be able toutilize its human resources in otherfields.

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