Retraction

Retraction: Social Distancing Analyzer Using Computer Vision and Deep Learning (J. Phys.: Conf. Ser. 1916 012039)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Social Distancing Analyzer Using Computer Vision and Deep Learning

G V Shalini¹, M Kavitha Margret², M J Sufiya Niraimathi¹, S Subashree¹
¹Student, Department of Computer Science, Sri Krishna College of Technology, Coimbatore, Tamilnadu, India
²Assistant Professor, Department of Computer Science, Sri Krishna College of Technology, Coimbatore, Tamilnadu, India
Email - shalinigv07@gmail.com

Abstract. In the fight against the coronavirus, social distancing has proven to be an effective measure to hamper the spread of the virus. The system presented is for analyzing social distancing by calculating the distance between people in order to slow down the spread of the virus. This system utilizes input from video frames to figure out the distance between individuals to alleviate the effect of this pandemic. This is done by evaluating a video feed obtained by a surveillance camera. The video is calibrated into bird’s view and fed as an input to the YOLOv3 model which is an already trained object detection model. The YOLOv3 model is trained using the Common Object in Context (COCO). The proposed system was corroborated on a pre-filmed video. The results and outcomes obtained by the system show that evaluation of the distance between multiple individuals and determining if rules are violated or not. If the distance is less than the minimum threshold value, the individuals are represented by a red bounding box, if not then it is represented by a green bounding box. This system can be further developed to detect social distancing in real-time applications.

1. Introduction
The World Health Organization has claimed the spread of coronavirus as a global pandemic because of the increment in the expansion of coronavirus patients detailed over the world. To hamper the pandemic, numerous nations have imposed strict curfews and lockdowns where the public authority authorized that the residents stay safe in their home during this pandemic. Various healthcare organizations needed to clarify that the best method to hinder the spread of the virus is by distancing themselves from others and by reducing close contact. To flatten the curve and to help the healthcare system on this pandemic.

A new report shows that practicing social distancing and wearing masks is a significant regulation measure to slow down the spread of SARS-CoV-2 since individuals with mild or no indications at all may accidentally convey crowd contamination and can spread the virus to others. To contemplate data-driven models and numerical models which are consistently the most favored decision. In the fight against the coronavirus, social distancing has proven to be an effective measure to hamper the spread of the disease. As the name suggests, it implies that people are suggested that they should maintain physical distance from one another, reduce close contact, and thereby reduce the spread of coronavirus.

By referring to the already existing works, enhancements are to be done to the proposed system. The system to be developed aims to promote social distancing by providing an analyzer tool to monitor public areas, workplaces, schools, and colleges to analyze and detect any social distance violation and
to generate warnings. This is done using a computer vision and deep learning model. Computer vision alongside image processing, machine learning, and deep learning provide effective solutions to measure social distancing among humans across the moving frames. Computer vision extracts information from the input images and videos to possess a correct understanding of them to predict the visual input just like the human brain. To achieve the above objective, objects are detected in real-time using YOLO (You only look once), an algorithm supported convolutional neural networks which are employed for the detection & determine the distancing between the human using clusters of pedestrians during a neighborhood by grabbing the feed from a video.

2. Related Works
This section features and highlights some works related to object detection and person detection using deep learning. A heft of work recently focused on the classification of objects and detecting them involving deep learning are also discussed. Detection of humans done using computer vision is considered as a part of object detection. The detected objects are localized and classified based on their shape with the help of a predefined model [1]. The techniques that use convolutional neural networks (CNN) and deep learning have shown to achieve better performance on visual recognition benchmarks. It is a multilayered perceptron neural network that contains many fully connected layers, sub-sampling layers, and convolutional layers. It is powerful in detecting different objects from different inputs and it is a supervised feature learning method. Because of the outstanding performance in large datasets such as ImageNet, this model has achieved tremendous success in large-scale image classification tasks [2].

The object detection and recognition have achieved great success due to its neural network structure which is capable of constructing objects on its own with the help of descriptors and can learn distinguished features that are not primarily given in the dataset. But this has its own set of advantages and disadvantages as of speed and accuracy. The real-time object detection algorithms which use the CNN model such as Region-Based Convolutional Neural Networks (R-CNN) [3-5] and You Only Look Once (YOLO) are developed for the detection of multiple classes in various regions. YOLO (You Only Look Once) is a prominent technique as to speed and accuracy in deep CNN based object detection. Figure 1 shows how object detection is done based on the YOLO model.

Transforming the objective and interpretation from the work [6-8], this system which is proposed presents a method for detecting people using computer vision. Instead of using drone technology, the input is a stream of a video sequence from a CCTV camera installed. The camera’s range of view covers the pedestrians passing by in the range of the installed camera. The people in the frame are represented using a bounding box using the deep CNN models. The deep CNN based YOLO algorithm is used to detect the people in the sequence of video streams taken by the CCTV camera. The calculations are done by measuring the centroid distance between the pedestrians, this will represent whether the pedestrians in the video follow sufficient social distance Figure1.

Figure 1. Object Detection using YOLO model.

3. Proposed System
The proposed system, the social distancing analyzer tool was developed using computer vision, deep learning, and python to detect the interval between people to maintain safety. The YOLOv3 model based on convolution neural networks, computer vision, and deep learning algorithms is employed in the
development of this work. Initially, for detection of the people in the image or frame YOLOv3 is used an object detection network based on the YOLOv3 algorithm was used [9-11]. From the result obtained, only the “People” class is filtered by ignoring objects of classes. The bounding boxes are mapped in the frame. The distance is measured using the result obtained by this process.

3.1. Approach
The working of the Social Distancing Analyzer is depicted using a flowchart shown in Figure 2.

![Flowchart](image.png)

**Figure 2.** The flow chart for the social distancing analyzer model.

3.2. Process Flow Diagram
The process flow pipeline for the Social Distance Analyzer is shown in Figure 3.
4. Design Methodology

This section discusses the design methodology and working of the Social Distancing Analyzer model.

4.1. Input Collection

The image captured and video recorded by the CCTV camera is given as the input as shown in Figure 4. The camera is set up in a way it captures at a fixed angle and the video frame’s view was changed into a 2D bird’s view to accurately estimate the distance between each person. It is taken that the people within the frame are leveled on the horizontal plane. Then, four points from the horizontal plane are chosen, then it is changed into the bird’s view. Now the position of each person can be calculated based on the bird’s view Figure 4.

![Sample Image captured by CCTV camera.](image)

Figure 4. Sample Image captured by CCTV camera.

The interval between people is easily estimated, scaled, and measured by calculating the euclidean distance between the centroids. A threshold value or a preset minimum value for the distance is set. Depending upon this value, any distance lower than the preset minimum threshold value is found, then a warning is shown using red-colored bounding boxes.

4.2. Calibrating the camera
The region of interest (ROI) of an image or a video frame focused on the person who is walking was captured using a CCTV camera was then changed into a two-dimensional bird’s view. The changed view’s dimension is 480 pixels on all sides. The calibration is done by transforming the view frame captured into a two-dimensional bird’s view. The camera calibration is done straightforwardly using OpenCV. The transformation of view is done using a calibration function that selects 4 points in the input image/video frame and then mapping each point to the edges of the rectangular two-dimensional image frame. On performing this transformation, every person in the image/frame is considered to be standing on a leveled horizontal plane. Now the interval of each person in the frame can be calculated easily as it corresponds to the total pixels present in between each person in the changed bird’s view.

4.3. Detection of pedestrians
Deep Convolutional Neural Networks model is a simple and efficient model for object detection. This model considers the region which contains only “Person” class and discards the regions that are not likely to contain any object. This process of extracting the regions that contain the objects only is called as Region Proposals. The regions predicted by region proposal can vary in size and can be overlapping with other regions. So to ignore the bounding boxes surrounding the overlapping region, depending upon the Intersection Over Union (IOU) score maximum non suppression is used.

The object detection approach used in the Social distancing analyzer model reduces the computational complexity issues. It is done by formulating the detection of objects with the help of a single regression problem [5]. In object detection models based on deep learning, the You Only Look Once model. This model is suitable for real-time applications and it is faster and provides accurate results. Figure 5 shows the pedestrian detection using the YOLOv3 model. The YOLOv3 is an object detection model that takes an image or a video as an input and can simultaneously learn and draw bounding box coordinates (tx, ty, tw, th), corresponding class label probabilities (P1 to Pc), and object confidence. The YOLOv3 is an already trained model on the Common Objects in Context dataset (COCO dataset) [4]. This dataset consists of 80 labels including a human class known as pedestrian class. The Figure 5 represents the YOLOv3 model used in Social Distancing Analyzer. The parameters used in the detection of pedestrians are as follows:

- Box Coordinates - tx, ty, tw, th
- Object Confidence - C
- Pedestrians - P1, P2, … Pc

![Figure 5. Detection of pedestrians using YOLOv3 model.](image-url)
There are different objects present in a single frame, the goal is to identify “Only Person” class map bounding boxes related to only the people. The code for drawing the bounding boxes is given below and the output of this code is shown in Figure 6.

```python
#To identity “Person Only” class
x = np.where(classes==0)[0]
p=box[x]
count= len(p)
x1,y1,x2,y2 = p[0]
print(x1,y1,x2,y2)
```

**Figure 6.** Output obtained from Bounding Box method.

### 4.4. Measurement Of Distance

The interval between the set of individuals in an input frame can be easily calculated once the bounding box for each person is mapped. To do so the bottom center of the box mapped to every person within the range is considered. Figure 7 represents the steps followed by the social distancing analyzer model in order to calculate the distance and generate warnings.

**Figure 7.** The steps involved in the social distancing analyzer model.

For each person in the input frame, the orientation in the bird’s view transformation is calculated based on the central axis point of every person in the input frame. The distance interval of every set of people can be estimated from the bird’s view by calculating the euclidean distance between centroids. As the camera is calibrated, more accurate results can be obtained.

The set of individuals whose interval is lower than the preset minimum threshold value is considered as violation. The people who violate the condition are marked using a red box, and the remaining people are marked using a green box. The code for computing the centers of the boxes of are given below:

```python
#To compute center
x_c = int((x1+x2)/2)
y_c = int(y2)
c = (x_c, y_c)
_ = cv2.circle(image, c, 5, (255, 0, 0), -1)
```
plt.figure(figsize=(20,10))
plt.imshow(image)
def mid(image,p,id):
    x1,y1,x2,y2 = p[id]
    _ = cv2.rectangle(image, (x1, y1), (x2, y2), (0,0,255), 2)

The code to compute the pairwise distances between all detected people in a frame is given below:

```python
%%time
from scipy.spatial import distance
def dist(midpt,n):
d = np.zeros((n,n))
for i in range(n):
    for j in range(i+1,n):
        if i!=j:
            dst = distance.euclidean(midpt[i], midpt[j])
d[i][j]=dst
return d
```

If the result obtained in the previous method is less than the minimum acceptable threshold value, then the box around the set of people is represented using red color. The code that defines a function to change the color of the closest people to red is given below:

```python
def red(image,p,p1,p2):
    unsafe = np.unique(p1+p2)
    for i in unsafe:
        x1,y1,x2,y2 = p[i]
        _ = cv2.rectangle(image, (x1, y1), (x2, y2), (255,0,0), 2)
    return image
```

5. **Results And Discussion**
The pre-filmed video of people in a crowded area is taken as the input. As the input video is at an angle, the perspective of the recorded video is changed into a two-dimensional bird’s view frame by frame for the precise calculation of the pairwise distances between all detected people in a frame. The view of the video is changed and every person within the given range of the camera’s view is detected. Every person who is detected in the frame is represented using points and circles. The individual whose distance is lower than the acceptable minimum threshold value is represented by red points as shown in Figure 8 and the individuals who keep a safe distance from others are represented by green points as shown in Figure 9.

![Figure 8](image)

*Figure 8. Social distancing analyzer detecting pedestrians in video frame - Unsafe Distance.*
Figure 9. Social distancing analyzer detecting pedestrians in video frame - Safe Distance.

Even though the detection people within the range are detected, some detection error occurs possibly because of the overlapping of frames or the people walking too close to each other. This detection error is shown in Figure 10, where there are six people within the range of detection but only five people are detected, this is due to the overlapping of frames and two people are standing too close to each other.

Figure 10. Error in detection people within the range.

The accuracy of the calculated distance between every individual depends upon the algorithm. The YOLOv3 algorithm can also detect pedestrians as an object even if only their half of the body is visible, the bounding box will be mapped even to the half-visible body. The position of the person corresponding to the midpoint of the lowermost side of the bounding box is comparatively less precise. To eliminate the error occurring due to the overlapping of frames, a quadrilateral box is added to represent the range. Figure 11 shows the range of detection, only the people within this range will be considered for distance calculation.

Figure 11. Pedestrians who are out of the specified range are not considered.
6. Conclusion And Future Work
A tool for analyzing social distance is proposed. The system uses computer vision and a deep learning model. With the help of computer vision, the distance between each person can be easily calculated. If any set of individuals is found violating the minimum accepted threshold value will be indicated with a red bounding box. The developed system uses a pre-filmed video of people on a crowded street. The proposed system is capable of estimating the distance between people. The social distancing patterns are distinguished and classified as “Safe” and “Unsafe” distance. Additionally, it also displays labels as per the object detection and classification. The classifier can be implemented for live video streams and can be used for developing real-time applications. This system can be integrated with CCTV for surveillance of people during pandemics [9]. Mass screening is feasible and hence is often utilized in crowded places like railway stations, bus stops, markets, streets, mall entrances, schools, colleges, work environments, and restaurants. By monitoring the space between two individuals, we can confirm that a safe distance is maintained, this can help us to curb the virus.

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