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COVID-19 REAL TIME SOCIAL DISTANCE DETECTION AND ANALYSIS USING YOLO & NMS TECHNIQUE

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ABSTRACT

Lately, social distancing has become a trending term, more because of the COVID-19 pandemic that has affected the entire world causing more than 1 million deaths. The world we lived in a few months prior is completely different from what it is now.

2019 widespread corona virus (COVID-19) has brought a global catastrophe with its deadly spread beyond that 180 countries, with approximately 3,519,901 certified cases as well. There are 247,630 deaths worldwide from May 4, 2020. Absence of any function treatment agents and lack of vaccines against COVID- 19 increases the risk of census. Since they are vaccines are available, social isolation is the only possible option fighting this epidemic. Encouraged by this idea, this article suggests an in-depth automated reading framework social media monitoring function using surveillance video.

Social distancing is a technique that may be used to reduce the rate of new cases during a pandemic outbreak. This publication is focusing on surveillance of public places and detecting whether the people are maintaining social distancing or not.

The proposed framework utilizes the YOLO v3 object detection model to segregate humans from the background and Euclidean distance is then computed between all pairs of the returned centroids. Simply, a centroid is the center of a bounding box.

The results of the YOLO v3 model are further compared with other popular state-of-the-art models, e.g. faster region-based CNN (convolution neural network) and single shot detector (SSD) in terms of mean average precision (mAP), frames per second (FPS) and loss values defined by object classification and localization.

NMS (Non-maxima suppression) is also used to reduce overlapping bounding boxes to only a single bounding box, thus representing the true detection of the object. Having overlapping boxes is not exactly practical and ideal, especially if we need to count the number of objects in an image.

Keywords*: Coronavirus, Covid-19, Machine Learning, Convolutional Neural Network, Tensor Flow, Deep Learning, Social Distancing, Computer Vision, YOLO Object detection, Python, OpenCV Social health, Social surveillance.*

1. INTRODUCTION

Social distancing is not a new concept. Social distancing is a method used to control the spread of contagious diseases. As the name suggests, social distancing implies that people should physically distance themselves from one another, reducing close contact, and thereby reducing the spread of a contagious disease (such as corona virus).

COVID-19 belongs to the family of corona virus caused diseases, initially reported at Wuhan, China, during late December 2019. Several health care organizations, medical experts and scientists are trying to develop proper medicines and vaccines for this deadly virus, but till date, no success is reported.

The rampant Corona virus disease has brought a global crisis with its deadly spread to more than 180 countries. It is found that the lack of immunity against Covid-19 increases the vulnerability to the population. This is the reason that social distancing is being encouraged even after the development of vaccines, because it is the only feasible approach to stay completely safe. This situation forces the global community to look for alternate ways to stop the spread of this infectious virus. Social distancing is claimed as the best spread stopper in the present scenario, and all affected countries are locked-down to implement social distancing.

This research is aimed to support and mitigate the corona virus pandemic along with minimum loss of economic endeavors, and propose a solution to detect the social distancing among people gathered at any public place.

Social distancing aims at reducing the physical contact between possibly infected individuals and healthy persons. As per the WHO norms it is prescribed that people should maintain at least 6 feet of distance among each other in order to follow social distancing. Proper social distancing is the best way to reduce infectious physical contact, hence reduces the infection rate. This reduced peak may surely match with the available health care infrastructure and help to offer better facilities to the patients battling against the corona virus pandemic.

To study epidemiological phenomena, mathematical models are always the most preferred choice. Emerging technologies like Convolutional Neural Networks, Deep learning, and AI can enable us to enforce social distancing. YOLOv3 and Euclidean distance is then computed between all pairs of the returned centroids. Simply, a centroid is the center of a bounding box.

Furthermore, if the violation index crosses a set parameter, the system is to show a notification on the screen to the authorized personnel, following which they can use protocols to alert the people in such public places. No audio alarms are to be used, keeping in mind the panic situations that could be caused by such warning alarms. The paper deals with the problem statement, objectives and implementation of such a system in detail.

2. REVIEW OFLITERATURE

1) **Narinder Singh Punn, Sanjay Kumar Sonbhadra, Sonali Agarwal and Gaurav Rai,** Monitoring COVID-19 social distancing with person detection and tracking via fine-tuned YOLO v3 and Deepsort techniques, IEEE 2020., The article proposes an efficient real-time deep learning based framework to automate the process of monitoring the Social distancing via object detection and tracking approaches, where each individual is identified in the real-time with the help of bounding boxes.

2) **SnehaMadane , DnyanobaChitre Department of Computer Engineering Terna College of Engineering** , Nerul, Navi Mumbai, Social Distancing Detection and Analysis through Computer Vision 2021 6th International Conference for Convergence in Technology (I2CT) Pune, India. Apr 02-04, 2021. This work proposed an efficient and robust computer vision based social distancing detection and analysis framework for which heavy experiments were performed using different SOTA object detection models namely EfficientDet-D0, EfficientDet-D5, DETR with resnet 50 backbone for pedestrian detection in public places.

3) **Akanksha Shukla1|Ishani Garkoti2|Amisha Mittal3|Binit Choudhary4|Dr. Preety Verma Dhaka5, Social Distancing Detection Using Open CV and Yolo** Object Detector, International Journal for Modern Trends in Science and Technology, 7(01): 93-95, 2021, This publication is focusing on surveillance of public places and detecting whether the people are maintaining social distancing or not. It explains the development of technology through the use of AI-based procedures to detect whether the social distancing norm is followed or not, in any public video stream.

4) **Avadhut Joshi1, Chetan Narkhede2, Omkar Jadhav3, Jayashree Mohadikar4,** Social Distancing Detector Using OpenCV, International Journal of Advanced Research in Computer and Communication Engineering., IN THIS PAPER A tool for detecting social deviations using an in-depth learning model is proposed. Using computer vision, the distance between people can be measured and any people who do not obey the law will be shown in red Frame and red line.

5) **Shivang Srivastava1, Isha Gupta2, Gaurav Upadhyay3, Uma Goradiya4**, Social Distance Detector Using YOLO v3, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 08 Issue: 05 | May 2021, A tool for detecting social deviations using an in-depth learning model is proposed. Using computer vision, the distance between people can be measured and any people who do not obey the law will be shown in red Frame and red line.

3. SYSTEM ARCHITECTURE

The major requirement for implementing this project using python programming language along with Deep learning Machine learning, Computer vision and also with python libraries. We are using YOLO Algorithm in our proposed system.

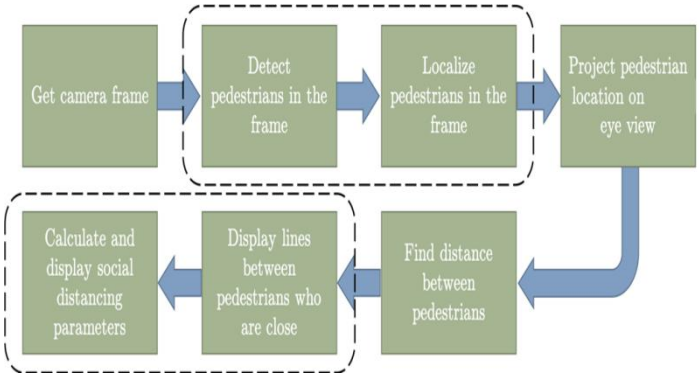

Figure 1: System Overview

In the below system overview you can see how the program begins with reading the frame followed by object detection model, YOLO v3 in this case. Once the object detection begins working using the pre-trained models, it is then followed by checking the social distancing of all the person present in the live video frame which will be detected by the webcam. The choices are made on the basis of the applied condition and accordingly the red or green box will surround the person detected by the pre-trained model in the live video frame which is being currently detected and will send alert on the basis of the count. The alert will be seen by the person that will be monitoring the video at that time and accordingly he or she can take the required actions and measures to make sure that social distancing is being followed. The total count of people not following social distancing that is the people in the red boxes will be seen in the bottom left side of the screen and as per the count when the certain limit is crossed there will be a notification pop up on the bottom right side of the screen in the laptop.

Object detection:

- We will be using YOLOv3, trained on COCO dataset for object detection. In general, single-stage detectors like YOLO tend to be less accurate than two-stage detectors (R-CNN) but are significantly faster.
- YOLO treats object detection as a regression problem, taking a given input image and simultaneously learning bounding box coordinates and corresponding class label probabilities.
- It is used to return the person prediction probability, bounding box coordinates for the detection, and the centroid of the person.

Distance calculation:

- NMS (Non-maxima suppression) is also used to reduce overlapping bounding boxes to only a single bounding box, thus representing the true detection of the object. Having overlapping boxes is not exactly practical and ideal, especially if we need to count the number of objects in an image.
- Euclidean distance is then computed between all pairs of the returned centroids. Simply, a centroid is the center of a bounding box.
- Based on these pairwise distances, we check to see if any two people are less than/close to 'N' pixels apart.

System Workflow:

- Counting the number of people in the stores/buildings/shopping malls etc., in real-time.
- Sending an alert to the staff if the people are way over the social distancing limits
- Optimizing the real-time stream for better performance (with threading)
- Acts as a measure to tackle COVID-19

Fundamental Steps for Social Distance Detection:

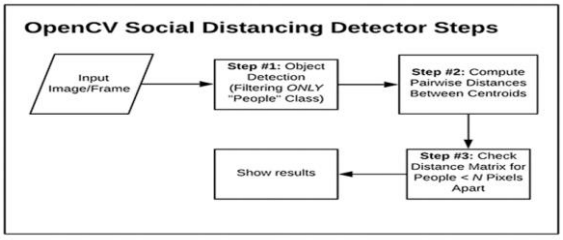

Figure 3: Social distance detection steps

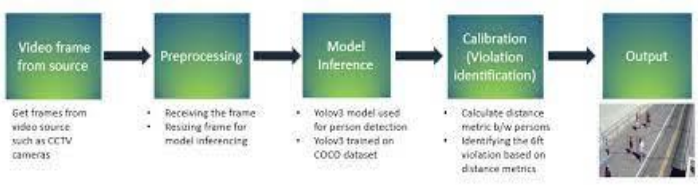

Figure 2: Fundamental Steps for Social Distance Detection

Yolo architecture:

The Yolo algorithm stands for You Only Look Once, this algorithm is a state of art, which works on a real-time system, build on deep learning for solving various Object Detection as well as Object Tracking problems. The architecture of Yolo can be observed from the below Fig

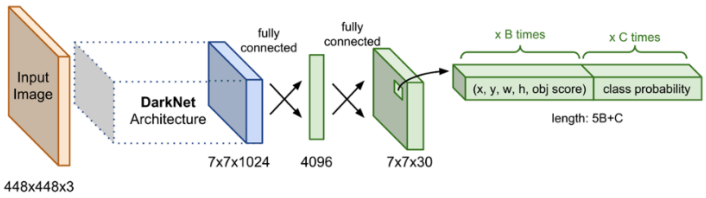

Figure 4: Yolo Architecture

It can be observed from the above figure that the architecture contains the Input image layers which are responsible for taking the inputs that would be passed to further layers, input can be any image depending upon the use cases. Along the input layer comes the Dark Net Architecture, this is an open-source neural network for which framework is created with the help of C & CUDA, this framework features YOLO for object detection & object tracking.

Further, the architecture consists of the flattened layer which is densely connected with the convolutional layer which is also densely connected to pass the data from each node to other nodes in the architecture, similarly, this is passed to the output layer which gives 4-part values, those 4 parts describe the predicted value for the bounding box, denoted by x, y, w, h, along with the object detection score plus the probability of the predicted class. This YOLO is part of the One-Shot object detector family which is accurate & fast, there is also a Two-Shot object detector.

Two-Shot object detectors which are popular are R-CNN, Fast R-CNN, and Faster R-CNN, these algorithms are accurate in obtaining the results based on certain use cases but are slow as compared to that of Yolo, You Only Look Once is an algorithm that looks at the image at a single glance and based on that look predicts the bounding boxes related to certain classes, classes can be anything ranging from Dog to Car, or Gun to Tanks, this special feature makes Yolo stand out from others. Different types of object detectors based on a shot can be observed in Fig below.

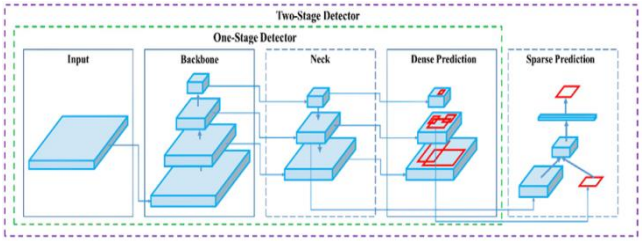

Figure 5: Components of CNN

From the above figure, we can find out different components, there are 4 different types of components

Input The input to the detector can be an image or video based on the use cases specified in the research.

Backbone The backbone of the object detector contains models, these models can be ResNet, DenseNet, and VGG.

Neck The neck in the detector acts as an extra layer, which goes in parallel to the backbone & the head.

Head The head is the network that is in charge of the detection of objects based on bounding boxes.

4. METHODOLOGY & ALGORITHM

This part of the topic highlights the algorithm used for object detection as well as object tracking.

- In this project, we are using a YOLO-COCO Detector for our task. We have created 2 different folders one for keeping the detection and configuration and other consisting of the pre-trained model. YOLO-COCO file consists of coco. Names, yolov3.cfg, yolov3. weights.

- We are using the pre-trained models for object detection. Other than the two folders we have kept in the main folder in the main folder we have the main python file which we are going to run in order to check if the program is running successfully or not.

- The main python file is interconnected internally with the other two files which has configuration and the one which use the trained model to detect the people and label them. When we call the main file it access the webcam of the laptop to take the input of the video file.

- Once the live video is detected the trained model and configuration file start doing its work and the main file then uses all the feature and detect the people in the frame not following and following social distancing.

- As per the program there is kept a certain 10 second gap between the pop up of warning notification if the number of people not following social distancing norm increases. The pop up can be seen in the side of the screen by the viewer who is watching the live feed.

A. Data Collection and Preparation

This research paper uses a two pedestrian videos, the first is obtained online from YouTube4 which is provided by BriefCam5 and the other video footage of the Oxford Town Centre. The first dataset contains a CCTV footage of pedestrians in an area walking on the pavement and the other dataset contains a video of people walking in a busy downtown center in Oxford, England. The Oxford Town Centre dataset has been utilized multiple times in multiple research projects. These are open datasets and can be used for various developments and research projects in the area of object detection, facial recognition, and many such other projects.

This dataset is a very unique dataset, in the sense that it uses video footage straight out of a public CCTV camera that on the contrary was assigned for public safety reasons. In this video, it shows that the pedestrians are walking or acting in a normal and unrehearsed manner. These pedestrians are just normal people walking on the road or pathway minding their own business.

Although these people do not know about the research projects, they were aware of being under supervision cameras and it is with their consent that this dataset has been created hence not violating any ethical issues.

B. Data Pre-processing

This research first downloads the video footages that are available online. The video footage contains a fixed camera that detects individuals in a region of interest (ROI) and measures their distances in real-time without recording any sort of data. Moreover, this research proposes a novel approach towards detecting people and whether or not they are violating any social distancing regulations.

While detecting the interpersonal distances between the individuals present in the video, with the help of facial detection, their faces are detected to verify whether the individuals are wearing a mask or not.

C. Object Detection and Tracking

Although there has been a confusion between the two terms Image Classification and Object Detection, often meaning them to be the same, they are completely different. Image Classification performs identification of objects in images while Object Detection performs identification of the objects including its location in the images. Both of these terms are widely popular in Computer Vision tasks (Merkulova, Shavetov, Borisov and Gromov, 2019). They can be used in every field possible such as healthcare, defence, sports, and various other industries.

The next question that arises is whether Object Detection and Tracking are the same terms or not. Yes, Object Detection and Tracking are two very similar terms in the way they are functioned. They are basically designed to perform the same functionality but with a little difference. Object Detection is used to detect objects present in an image or in multiple images where an object is stationary while Object Tracking performs detection on videos, that is, it keeps a track of the following object detected while it is moving (Porikli and Yilmaz, 2012). A video is a combination of fast-moving frames and thus identification of the objects and their location from every frame is performed by Object Tracking.

5. ALGORITHMIC STRARTEGY

To implement Covid-19 Real Time Social Distance Detection and Analysis Using YOLO & NMS technique we are using YOLO Algorithm.

Introduction to YOLO Algorithm for Object Detection

YOLO is an algorithm that uses neural networks to provide real-time object detection. This algorithm is popular because of its speed and accuracy. It has been used in various applications to detect traffic signals, people, parking meters, and animals.

This article introduces readers to the YOLO algorithm for object detection and explains how it works. It also highlights some of its real-life applications.

Introduction to object detection

Object detection is a phenomenon in computer vision that involves the detection of various objects in digital images or videos. Some of the objects detected include people, cars, chairs, stones, buildings, and animals.

This phenomenon seeks to answer two basic questions:

- What is the object? This question seeks to identify the object in a specific image.

- Where is it? This question seeks to establish the exact location of the object within the image.

Object detection consists of various approaches such as fast R-CNN, Retina-Net, and Single-Shot Multi box Detector (SSD). Although these approaches have solved the challenges of data limitation and modeling in object detection, they are not able to detect objects in a single algorithm run. YOLO algorithm has gained popularity because of its superior performance over the aforementioned object detection techniques.

What is YOLO?

YOLO is an abbreviation for the term 'You Only Look Once'. This is an algorithm that detects and recognizes various objects in a picture (in real-time). Object detection in YOLO is done as a regression problem and provides the class probabilities of the detected images.

YOLO algorithm employs Convolutional neural networks (CNN) to detect objects in real-time. As the name suggests, the algorithm requires only a single forward propagation through a neural network to detect objects.

This means that prediction in the entire image is done in a single algorithm run. The CNN is used to predict various class probabilities and bounding boxes simultaneously.

The YOLO algorithm consists of various variants. Some of the common ones include tiny YOLO and YOLOv3.

Why the YOLO algorithm is important

YOLO algorithm is important because of the following reasons:

Speed: This algorithm improves the speed of detection because it can predict objects in real-time.

High accuracy: YOLO is a predictive technique that provides accurate results with minimal background errors.

Learning capabilities: The algorithm has excellent learning capabilities that enable it to learn the representations of objects and apply them in object detection.

6. RESULT AND ANALYSIS

The real time and 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 theindividuals who keep a safe distance from others are represented by green points as shown in Figure.

Figure 6: Social distancing analyzer detecting pedestrians in video frame - Unsafe Distance.

Figure 7: 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.

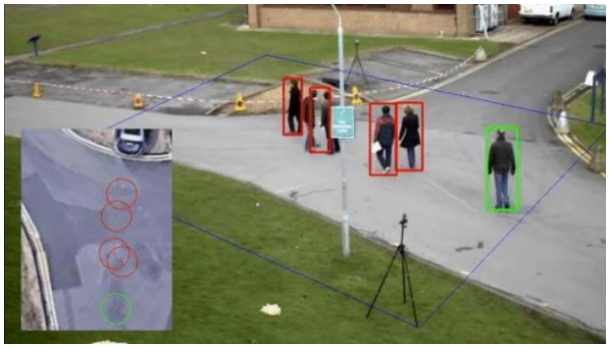

Figure 8. Error in detection people within the range

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.

TABLE I: Performance comparison of the object detectionmodels.

Model	**TT(insec.)**	**NoI**	**mAP**	**TL**	**FPS**
FasterRCNN	9651	12135	0.969	0.02	3
SSD	2124	1200	0.691	0.22	10
YOLOv3	**5659**	**7560**	**0.846**	**0.87**	**23**

Above table demonstrate various models of object detection and their performance comparison.

7. BENEFITS

Monitoring & Measuring:

The technology isn't just for the office, for example, at a factory where employees are very close to each other, the software can be integrated into their security camera systems. Allowing them to monitor the working environment and highlight people who's distancing is below the minimum acceptable distance.

Queue Monitoring:

For retail, healthcare and industries where queueing is avoidable, queue monitoring can be integrated into your cameras. The cameras will then have the ability to monitor and detect whether people are abiding by the social distancing guidelines. The solution can also be set up to work with automated barriers and digital signage for real-time notifications and health and safety information.

Reassuring Employees:

With 41% of employee's not wanting to return to the office until the workplace is made safe, having social distancing detection in the workplace is a great way of reassuring staff that the workplace has been made safe for their benefit. The solution is also safer than the thermal cameras – those without a fever can also be contagious.

8. CONCLUSION & FUTURE SCOPE

Based on the results obtained, we can see that social distancing detector is correctly marking people who violate social distancing rules. While all the people who are following the norm are enclosed in green rectangular boxes, people violating the social distancing norm are enclosed in a red rectangular box. Nowadays, social distancing along with other basic sanitary measures are very important to keep the spread of the pandemic (Covid-19) as slow as possible. Along with the color representation, the count, that is the number of the times the norm is violated is also displayed based on the video stream. The algorithm is used to analyze social distancing in a public area and carry out necessary actions to better deal with the pandemic. The project has been completed using the implementation of computer language technology onto a video stream to develop an application working as a social distancing detector, also capable of keeping count of norm violation. This also included the testing of the application, cross-checking of the data until a satisfactory, required, correct and good result was obtained.

With advanced technical updates, the system may be capable to trace and detect the violations from an aerial view.

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