

COVID-19: Automatic Social Distancing Rule Violation Detection using PP-Yolo & Tensorflow in OpenCV

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Abstract— In this critical situations where people are fighting with dangerous pandemic disease; it is required to maintain the situation by indulging with social distancing or it can also be pronounced as physical distancing. Social or physical distancing may reflects to reduce the virus from spreading. There are several places where it should be followed properly to stop spreading COVID-19 like railway stations, malls, marts, airports and many more. It is advised to maintain at least 6 feet of social distancing as per the WHO guidelines. Various researches have been done to automatically detect the physical distancing violations but an ideal system should be available to detect it effectively with high level of accuracy. Here the system is based on PP-Yolo (PaddlePaddle – You only look once) and Tensorflow library. Tensorflow is an object detection or pattern recognition tool through which pedestrian can be detected automatically and then PP-Yolo classifies the distance between the pedestrians or classifying whether persons are following the physical distancing rule or not. Violation detection is bit challenging for any system because a crowd may have uncertain structures that can hardly classified distance among them. This challenge can be accepted through various researchers but not met the desired precision. Proposed system is intended to detect the physical distancing rule violations effectively and acquiring high level of accuracy with minimal false alarm rate.

Keywords— Physical Distancing Rule Violation Detection, Social Distancing, PP-Yolo, Machine Learning, Tensorflow, Computer Vision Library, CORONA Virus, Artificial Neural Network.

I. INTRODUCTION

Corona virus is from the family of SARS which causes illness and that leads you towards death. It was first identified in China and later spread over the world. It spread in 114 countries initially and infected so many people in the worlds that deceased so many people too [1], [2]. As of November 2021; 254,189,143 infected cases have been detected in which 5,118,348 people died and 229,844,600 people are now recovered. Social distancing is a general

wellbeing practice that plans to keep debilitated individuals from coming in close contact with sound individuals to diminish openings for infection transmission. Social distancing is intentionally expanding the actual space between individuals to abstain from spreading sickness by decreasing gatherings of individuals and swarmed spaces. Remaining no less than six feet from others lessens your shot at getting COVID-19. It can incorporate largescale measures like dropping gathering occasions or shutting public spaces, just as individual choices like keeping away from swarms. With COVID-19, the objective of social distancing is to dial back the flare-up to decrease contamination among high-hazard populaces and to facilitate the weight on medical care frameworks and workers. It considered fundamental should carry out approaches and practices that underline the significance of social distancing and accommodate something like six feet distance [3].



Fig. 1. Social Distancing Detection

As per the order, a social distancing official is assigned by a business as not-for-profit to set up, execute, and authorize social distancing arrangements predictable with rules. There is a shift from the expression "social distancing" to "physical distancing" in light of the fact that, while staying away from individuals is urgent for easing back the spread of COVID-19, social association with family, friends and family, and collaborators is fundamental. "Discover approaches to stay associated," says the WHO's Maria Van Kerkhove, "in light of the fact that your psychological well-being going through this is similarly pretty much as significant as your physical distancing [3].

II. RELATED WORKS

A. Related Works

Narinder Singh Punj et al. [4] proposes a viable consistent significant learning based framework to robotize the way toward noticing the social distancing through certain distinguishing methods or classifications and following philosophies, where each individual is perceived in the ceaseless with the help of bouncing boxes. Hopping; the encases for perceiving the bundles or get-togethers of people satisfying the closeness property enlisted with the help of pairwise vectorized approach. The amount of encroachment are insisted by enlisting the amount of social affairs molded and encroachment record term handled as the extent of the amount of people to the amount of get-togethers. The expansive fundamentals were driven with standard top tier object distinguishing proof models: Faster RCNN, SSD, and YOLO v3, where YOLO v3 portrayed the useful execution with changed FPS and Guide score. Since this philosophy is significantly fragile to the spatial space of the camera, a comparative approach can be changed to all the almost certain change with the looking at field of view. Sreetama Das et al. [5] proposed a system where the execution of social distancing visible to every places which is a critical approach for ensuring individual prosperity and workplace security, until antibodies or vaccination and prescriptions become open in volumes for mass uses. This work discusses a computer vision based strategy for social distancing perception, including an automated camera calibration method for basic modulation. Authors propose the use of time based edges to perceive transient and productive encroachment of social distancing methodology and use estimations like encroachment packs to assess risk. Authors have sent the output and achieved continuous execution with satisfactory results under different lighting, amassing, and hindrance. Future preliminaries to additionally foster our philosophy consolidate the usage of a solitary shot trackers or thickness based trackers, re-setting up the model with remarked on video that deals with from the sending locale similarly as testing the templates with more trendy estimations methods like EfficientDet and YOLO, which opened up all through the application improvement. Hendra Adinanta et al. [6] proposed the standard of work that will be recognize individuals, then to assess the physical distancing encroachment from their distance. By far most of the researchers have endeavored to utilize object ID systems, for instance, speedier RCNN, Yolo, and SSD to perceive individuals from the edge. Those procedures rely upon, the assistance of GPU to execute their robust

estimation. In this works, authors propose social distancing checking by applying establishment derivation systems subject to Gaussian Mix Models (GMM) for instance Geometric Multigrid (GMG), k-Nearest Neighbor (KNN), Mix of Gaussian (MOG), and Mix of Gaussian 2 (MOG2). Zhenfeng Shao et al. [7] proposed a system where individuals are getting recognized using a UAV technique which can unequivocally distinguish humans by their heads, and a not really set in stone the social distancing of each normal on UAV pictures. System contains three areas, PeleeNet, multi-scale spatial thought module and acknowledgment layer. To research the features of small sized object like human head, authors join three sizes of feature maps (19×19 , 38×38 , 76×76) by de-convolution and connection. The spatial thought module is particularly used to further develop the component information and negligence the immaterial information. Then the space of human head is expected in disclosure layer. Authors differentiated the methodology and the top tier object distinguishing proof procedures (SSD model and YOLOv3 model) on a consolidated human head dataset. The test outcomes show that our procedure achieves 92.22% AP and 76 FPS, which turns out accurate and progressing revelation in genuine applications. Afq Harith Ahamad et al. [8] proposed a work for identifying people for social distance as a cautious advance in decreasing genuine contact between people. This assessment based on perceiving people in region of interest using the MobileNet Single Shot Detector (SSD) models and OpenCV library for image enhancement. The distance will be enlisted between individuals recognized in a frame and subsequently diverged from a proper pixels' characteristics. The distance is assessed between the principle issues and as far as possible between individuals in the separated after locale. With the acknowledgment of unsafe distances between people, alerts or cautions can be given to secure the premises. Regardless social distance measure, one more basic part of the system is recognizing the presence of people in restricted areas, which can moreover be used to trigger counsels. Some assessment has been performed to test the reasonability of the program for the two purposes.



Fig. 2. System GPU [10]

Savyasachi Gupta et al. [9] proposed a framework to utilize the Cover R-CNN significant neural network to perceive people in a video diagram. To dependably perceive whether social distancing is chipped away at during the connection between people, a centroid following estimation is utilized to follow the subjects all through the recording. With the aide of legitimate estimations for approximating the distance of people from the camera and between themselves, authors choose if the social distancing rules are being clung to. The design accomplished a high precision regard identified with a low fake alarm rate when taken a stab at Custom Video Film Dataset (CVFD) and Custom Individual Pictures Dataset (CPID), where it showed its sufficiency in choosing if social distancing rules were cleaned. Yew Cheong Hou et al. [10] proposed a technique of social distancing identifier gadget using a significant learning model. By using computer vision, the distance between people can be surveyed and any safe pair of people will be shown with a red bounding box and a red line. The proposed technique was supposed to showing individuals by walking around a street. The portrayal results showed that the proposed technique is capable to choose the social distancing measures between people which can be moreover established for use in other environment like office, diner, and school. Besides, the work can be also improved by redesigning the bystander disclosure estimation, organizing other distinguishing proof computations, for instance, cover area and human inner warmth level acknowledgment, further fostering the enrolling power of the hardware, and adjusting the camera perspective. Mohd. Aquib Ansari et al. [11] proposed an article suggests significant learning based human acknowledgment systems to screen social distancing in the continuous environment. These techniques have been made with the help of significant tangled network that has used sliding window. Further, they used the social distancing estimation to measure the distancing among people. This evaluated distancing measures pick two classes for adhering to social distancing. The examinations were performed with CNN based locaters. In experiments, it is found that CNN-based thing disclosure models are endorsed in accuracy. Sometimes, it conveys some counterfeit positive models while overseeing steady video progressions. Zhiming Chen et al. [12] proposed a framework with respect to the Coronavirus pandemic, creators cultivate a self-administering perception robot structure to progress social distancing. The robot system is predominantly made out of social distance ID, metropolitan and savvy voice cooperation. The legged robot shows extraordinary variety to different region with the objective that they can work commendably in human life circumstances. This current reality attempt furthermore displays that our robot viably keeps human's social distance. In this end, authors successfully pass on the structure in a certifiable environment to hinder the spread of Coronavirus. Meirui Qian et al. [13] proposed a social distancing included keeping a distance of 1.5 m between people, which can hinder the spread of most respiratory overwhelming ailments. Social distancing is maybe the best measures to decrease the spread of the infection, which is imparted through air drops. The drops caused by wheezing or compelled talking that have a particular transmission distance. By keeping this distance, we can diminish the

spread of the infection. Wearing cover, washing hands regularly and cleaning with alcohol in like manner help to hold the infection back from spreading beginning with one individual then onto the following.

III. PROBLEM IDENTIFICATION

This paper reviewed various implemented systems that detect social distancing rule violations using CNN, DNN, SSD Filtration and many more. Most of the system uses CNN and a training model for creating templates that later match for nearest classification. But there is no appropriate model for actual feature extraction, instead of that it can be achieved through Tensorflow or any object classifier along with various pre-processing models. Commonly most researchers try to pick machine learning approach for acquiring better accuracy. But due to heavy or deep learning; network weight could higher that directly affects the computation power or time. Even it takes many weeks for getting trained and iteration delayed the system computational time. So we need a deeper network with less weight and smaller filters with sufficient number of convolutional layers. So by the help of better approach or neural network we can create better system that can detect social distancing rule violations. Hendra Adinanta et al. [8] proposed a system that uses KNN, MOG, MOG2, and GMG for classifying pedestrian and their social distancing. System uses background subtraction methodology for detecting pedestrian and social distancing with various samples of social distancing frames. But background subtraction model is very conventional and based on binary model. Binarization of an image may erode the information from the image that degraded the accuracy of the system. It is not enough capable to dealing with irregular crowd or backgrounds. Background subtraction model is poor for crowd based image and hard to predict correct decision on the basis of that. System achieved 9.00%, 8.67%, 7.49%, and 5.74% respectively accuracy which could be bit higher. The system can be enhanced in by implementing it with Yolo and tensorflow, which acquire good accuracy and minimal false alarm rate. Because as per the ideal system, accuracy is an important parameter, that is why accuracy of system can be enhanced with Yolo and Tensorflow.

IV. PROPOSED IMPLEMENTATION

Here the system uses PP-Yolo along with Tensorflow for detecting physical distancing rule violation from various number of frames.

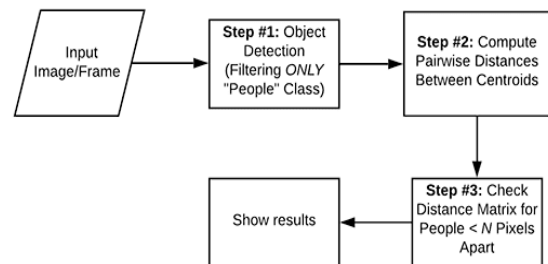


Fig. 3. Block Diagram

PP-YOLO took the YOLOv3 organization and made iterative enhancements in preparing and design by adding a

Resnet spine, DropBlock, IoU loss, Framework Affectability, Grid NMS, CoordConv, SPP layers, and a superior ImageNet pretraining designated spot. The PP-YOLO creators first add the aggregation network then, at that point they add the mish activation capacity. PP-Yolo has great potential to classify the object on the basis of patterns. Similarly when people around themselves then system firstly predict the pedestrian then classify the physical distance by observing the vector positions between the pedestrian points. Social distancing is seemingly the best nonpharmaceutical approach to forestall the spread of an infection — by definition, in case individuals are not near one another, they can't spread microorganisms. For the most dependable outcomes, you ought to align your camera through characteristic/extraneous boundaries so you can plan pixels to quantifiable units.



Fig. 4. Proposed System

A simpler other option (yet less exact) strategy is apply triangle likeness alignment. Both of these strategies can be utilized to plan pixels to quantifiable units. Finally, on the off chance that you don't need/can't apply camera adjustment, you can in any case use a social distancing indicator, however you'll need to depend stringently on the pixel distances, which will not really be as exact.



Fig. 5. Yolo Pedestrian Classification

$$\lambda_{coord} \sum_{i=0}^{s^2} \sum_{j=0}^B \prod_{ij}^{obj} [(x_i - \hat{x}_i)^2 + (y_i - \hat{y}_i)^2]$$

This equation predicted the loss function of the bounding box where object has to be detected in the reference of (x, y) co-ordinates. λ is considered as constant function. (j = 0..B) is considered as grid cell. If object is available in bounding box then it will be considered as 1 otherwise 0.

$$\lambda_{coord} \sum_{i=0}^{s^2} \sum_{j=0}^B \prod_{ij}^{obj} [(\frac{w_i - \hat{w}_i}{\hat{w}_i})^2 + (\frac{h_i - \hat{h}_i}{\hat{h}_i})^2]$$

This equation is defined as yolo loss function in the reference of width and height. Loss function defines the error handling tool or prediction based definition that helps to detect the object in the prediction boundaries. As per the flowchart as in Fig. 4, first of all a frame has to be acquired for processing. Then system will call the PP-yolo weight along with tensorflow. Then feature maps will be extracted and all feature vectors will be stacked as the size of the object and their appearance. Then system classifies the objects and focuses on pedestrian only. Then system predicts the distance between the various pedestrians and if that computed distance is greater than the threshold value, it means that pedestrian follows the social distancing rule otherwise they are violating the rules and system indicates both the situations accordingly. Utilizing PP-YOLO with OpenCV requires a bit more yield preparing than other item location techniques (like Single Shot Indicators or Quicker R-CNN), so to keep our code clean, we should execute a recognize individuals work that embodies any PP-YOLO object recognition rationale. PP-YOLO calculation is utilized for Item Recognition just as Article Following, this exploration utilizes PP-YOLO for ascertaining the social distancing and recognizing face veil all over with the assistance of Article Identification, though following the face and individuals in the edge for counting the articles and tracking that article in the following edge is finished by Item Following. The base distance to keep while holding fast to social distancing is 6 Feet, saving this as the base for computing distance, the model was prepared and utilized for object identification just as article following. The TensorFlow item identification programming interface is the structure for making a deep learning network that tackles object discovery issues. It contains some pre-prepared models prepared on various datasets which can be utilized for derivation. The instinct behind move learning for classification is that if a model is prepared on an enormous and general enough dataset, this model will successfully fill in as a conventional model of the visual world. It would then be able to exploit these learned component maps without beginning without any preparation via preparing a huge model on a huge dataset. For this situation, we didn't have to apply move learning since we need to distinguish pedestrian.

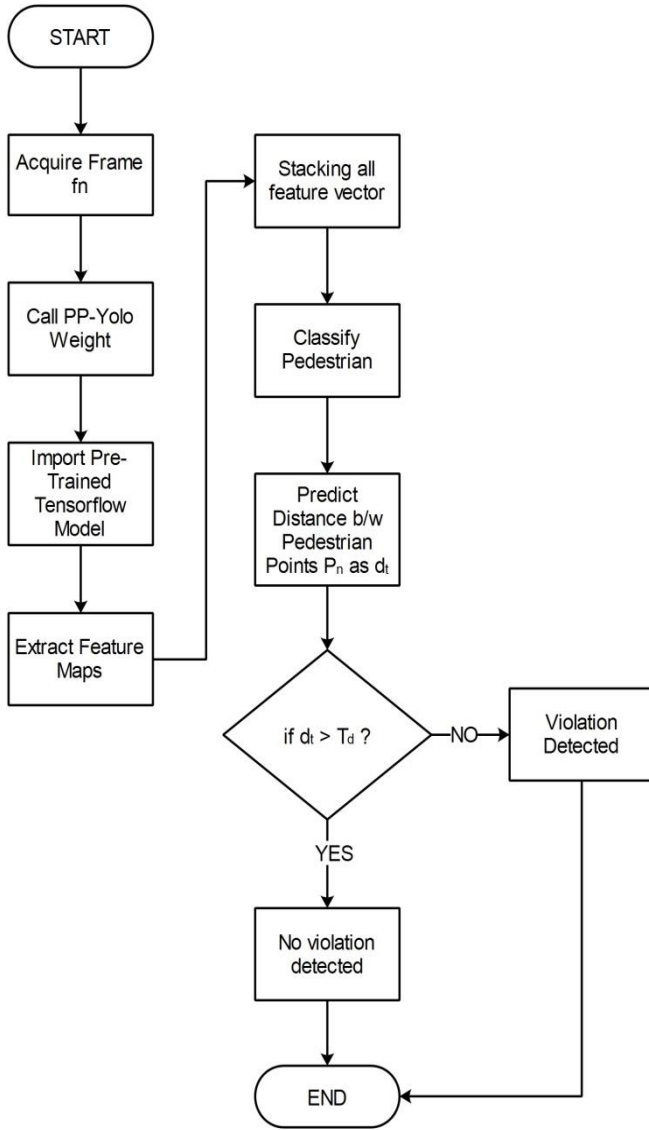


Fig. 6. Flow Chart of Proposed System

A. PP-Yolo & Tensorflow Weight Model

Input: Datasets Frames

Output: Violation Prediction Distance

Step 1. Import data

Data = $\{x_n, y_n\}$ frames in a dataset

Step 2. Transform and normalize data by mean, standard deviation and float to integer

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}$$

Where μ is mean, N is total no. of dataset, x_i is an individual value

$$(1 - 2s) \times (1 + f) \times 2^e$$

s is the sign bit (0 or 1), f is the mantissa

and e is the biased exponent

Step 3. Initialize parameters for creating bounding boxes

Step 4. Set Parameters W and b as tensorflow weight and bias

Step 5. Load the Trained model PP-yolo weights and compute loss functions

$$\begin{aligned} & \lambda_{coord} \sum_{i=0}^{s^2} \sum_{j=0}^B \prod_{ij}^{obj} [(x_i - \hat{x}_i)^2 + (y_i - \hat{y}_i)^2] \\ & + \lambda_{coord} \sum_{i=0}^{s^2} \sum_{j=0}^B \prod_{ij}^{obj} \left[\left(\frac{w_i - \hat{w}_i}{\hat{w}_i} \right)^2 + \left(\frac{h_i - \hat{h}_i}{\hat{h}_i} \right)^2 \right] \\ & + \sum_{i=0}^{s^2} \sum_{j=0}^B \prod_{ij}^{obj} [(c_i - \hat{c}_i)^2] + \lambda_{coord} \sum_{i=0}^{s^2} \sum_{j=0}^B \prod_{ij}^{obj} (c_i - \hat{c}_i)^2 \\ & + \sum_{i=0}^{s^2} \prod_{ij}^{obj} \sum [p_i(c) + \hat{p}_i(c)]^2 \end{aligned}$$

Step 6. Built Computation Graph

Step 7. Compute distance between the pedestrian points as

$$d_t$$

d_t = Compute Euclidean Distance (P [iterator1]) and (P[iterator2]) / Average Person Width

Step 8. **if** $d_t > T_d$ **then**

No Violation Detected;

else

Violation Detected;

end else

end if

Step 9. End

V. RESULT ANALYSIS

The result has been calculated as on the basis of various trails. So many frames have been tested and evaluated the outcomes as per the physical distancing rule. There are four parameters such as True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN). System has been trained with various samples and weight has been build for offline pedestrian classification and distance prediction.

Table No. I Result Analysis

Terms	Outcomes
True Positive	2246
True Negative	51
False Positive	1022
False Negative	26
Frames	886

$$\text{Accuracy} = \frac{TP+FP}{TP+TN+FP+FN} * 100 \%$$

$$\text{Accuracy} = 97.69 \%$$

If a frame includes pedestrians and followed the social distance and system recognized it positively then it has been encountered in the category of true positive but if system recognized the same as violating the rule then it comes in the category of true negative. If a frame includes pedestrian with violating the social distancing rule and system detected it positively then it encountered in the category of false positive but if system detect the same as following the rule then it comes in the category of false negative.

Table No. II Result Comparison

Method	Average Detection Rate
GMG [6]	4.79
MOG [6]	5.74
MOG2 [6]	8.67
KNN [6]	9.00
PP-Yolo & Tensorflow (Proposed)	9.76

VI. CONCLUSION & FUTURE SCOPE

To stop spreading the corona virus; it is import step to maintain the physical distancing as per the guidelines which should be followed. The proposed system is intended to detect the physical distancing for classifying whether it has been properly followed or not. The proposed system is based on PP-Yolo and Tensorflow models. These techniques are very efficient for detecting objects as per the pattern or template of the pedestrian along with classifying from the background or other objects like non-pedestrian. System is also able to calculate the distance between the pedestrian points and detect the violation as per the threshold. System has been pertained 97.69 % of precision as per the parameters. This system can be enhanced in future by implementing it in distinct technique like upcoming Yolo based networks or any other object detection technique. The limitation of the system is that it gets confused when a huge

crowd has been associated with this system. It can be enhanced by more predictive training that can work at that environments too with high level of accuracy.

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