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Social Distancing Detector Using OpenCV

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Abstract: - In the face of the global Covid-19 scenario, the process of softening the curve of the corona virus will be difficult if citizens do not take steps to prevent the spread of the virus. With no vaccine available, social distancing is the only possible way to combat the epidemic. The proposed framework uses the YOLO v3 object detection model to identify people in the background and in-depth tracking of identified people with the help of binding boxes and assigned IDs. The model results of YOLO v3 are compared to other popular modern models, e.g. CNN-based regional speed (convolution neural network) and single-shot detector (SSD) in terms of average accuracy (mAP), frames per second (FPS) and loss values are defined by object classification and location. Later, the L2 line shown in pairwise is calculated based on the three-dimensional feature space obtained using links and the size of the binding box. The name of the infringement index is proposed to reduce the inconsistency of the public deviation process. From the experimental analysis, it is evident that YOLO v3 with an in-depth tracking scheme shows good results with moderate mAP and FPS score to monitor community deviations in real time. We are using the YOLO v3 object acquisition model and the OpenCV image processing library to run this project. The project will play an important role in an area where large numbers of people can be expected such as a shopping mall or movie theater or airport. With the help of this project we can ensure that people follow the process of socialization.

Keywords: YOLO v3, Covid-19, Social Distancing, Pretrained Model, Webcam, CNN.

I. INTRODUCTION

COVID-19 belongs to the family of coronavirus caused diseases, initially reported at Wuhan, China, during late December 2020. On March 11, it spread over 114 countries with 118,000 active cases and 4000 deaths, WHO declared this a pandemic [1], [2]. On May 4, 2020, over 3,519,901 cases and 247,630 deaths had been reported worldwide. Several healthcare organizations, medical experts and scientists are trying to develop proper medicines and vaccines for this deadly virus, but till date, no success is reported. 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 coronavirus pandemic along with minimum loss of economic endeavours, N. S. Punn, S. K. Sonbhadra, S. Agarwal, Indian Institute of Information Technology Allahabad, Jhalwa, Prayagraj, Uttar Pradesh, India; emails: {pse2017002, rsi2017502, sonali}@iiita.ac.in. Fig. 1: An outcome of social distancing as the reduced peak of the epidemic and matching with available healthcare capacity. and propose a solution to detect the social distancing among people gathered at any public place. The word social distancing is best practice in the direction of efforts through a variety of means, aiming to minimize or interrupt the transmission of COVID-19. It 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. A recent study indicates that social distancing is an important containment measure and essential to prevent SARSCoV-2, because people with mild or no symptoms may fortuitously carry corona infection and can infect others.

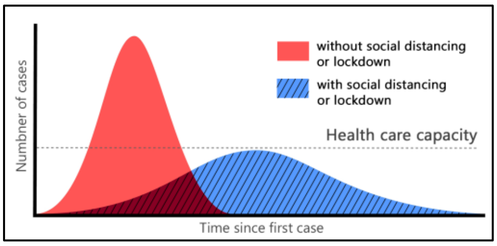

Fig. indicates that proper social distancing is the best way to reduce infectious physical contact, hence reduces the infection rate. This reduced peak may surely match with the available healthcare infrastructure and help to offer better facilities to the patients battling against the coronavirus pandemic. Epidemiology is the study of factors and reasons for the spread of infectious diseases. To study epidemiological phenomena, mathematical models are always the most preferred choice. Almost all models descend from the classical SIR model of Kermack and McKendrick established in 1927. Various research works have been done on the SIR model and its extensions by the deterministic system, and

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consequently, many researchers studied stochastic biological systems and epidemic models. Respiratory diseases are infectious where the rate and mode of transmission of the causing virus are the most critical factors to be considered for the treatment or ways to stop the spread of the virus in the community. Several medicine organizations and pandemic researchers are trying to develop vaccines for COVID-19, but still, there is no well-known medicine available for treatment..

II. MOTIVATION

Object detection helped a lot in this deadly situation. We have investigated the situation to detect various types of objects to help out the scenario. Human detection is an established area of research. Recent advancements in this field had created the demand for intelligent systems to monitor unusual human activities. Despite the fact, human detection is an interesting field because of many reasons like faint videos, diverse articulated pose, background complexities, and limited machine learning capabilities; hence, existing knowledge can boost the detection performance. motivated by the notion of social distancing proposed a deep learning-based structure to automate the task of observing social distance using surveillance video. We used YOLO v3 algorithm with a deep-sort technique for the separation of people from the background and tracking of detected people with the help of bounding boxes. We investigated the relation of COVID-19 growth rates in US with shelter in place orders (SIP). We presented a random forest machine learning model for their predictions and found the SIP orders very effective. Our study showed that SIP orders will not only be helpful for the US but also will help highly populated countries to reduce the COVID-19 growth rate. Deep learning is the popular area to perform object detection which gained a huge interest in the modern research field.

III.RELATED WORK

Social distancing is surely the most trustworthy technique to stop the spreading of infectious disease, with this belief, in the background of December 2019, when COVID-19 emerged in Wuhan, China, it was opted as an unprecedented measure on January 23, 2020. Within one month, the outbreak in China gained a peak in the first week of February with 2,000 to 4,000 new confirmed cases per day. Later, for the first time after this outbreak, there have been a sign of relief with no new confirmed cases for five consecutive days up to 23 March 2020. This is evident that social distancing measures enacted in China initially, adopted worldwide later to control COVID-19.

Since the novel coronavirus pandemic began, many countries have been taking the help of technology based solutions in different capacities to contain the outbreak. Many developed countries, including India and South Korea, for instance, utilising GPS to track the movements of the suspected or infected persons to monitor any possibility of their exposure among healthy people. In India, the government is using the Arogya Setu App, which worked with the help of GPS and bluetooth to locate the presence of COVID-19 patients in the vicinity area. It also helps others to keep a safe distance from the infected person. On the other hand, some law enforcement departments have been using drones and other surveillance cameras to detect mass gatherings of people, and taking regulatory actions to disperse the crowd Such manual intervention in these critical situations might help flatten the curve, but it also brings a 3 unique set of threats to the public and is challenging to the workforce.

We believe that having a single dataset with unified annotations for image classification, object detection, visual relationship detection, instance segmentation, and multimodal 4

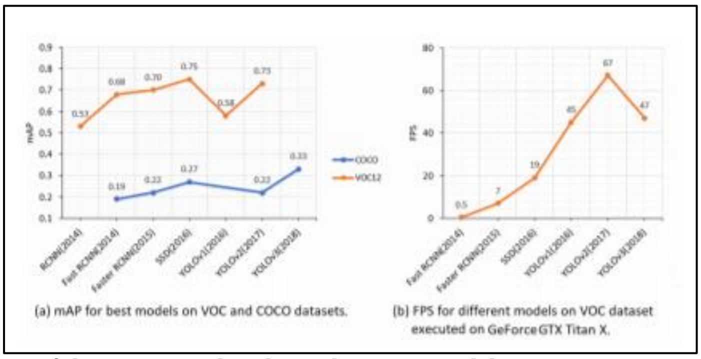

Fig. 2: Performance overview of the most popular object detection models on PASCAL-VOC and MS-COCO datasets.

image descriptions will enable us to study and perform object detection tasks efficiently and stimulate progress towards genuine understanding of the scene. All explored literature and related research work clearly establishes a picture that the application of human detection can easily get extended to many applications to cater the situation that arises presently such as to check prescribed standards for hygiene, social distancing, work practices, etc.

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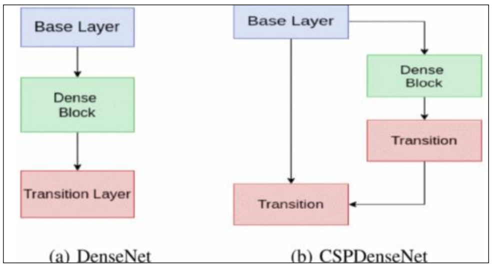
IV. METHODOLOGY

As observed from Fig. 2, the successful object detection models like YOLO v3 tested on PASCAL-VOC and MS-COCO datasets, undergo trade-off between speed and accuracy of the detection which is dependent on various factors like backbone architecture (feature extraction network e.g. VGG-16, ResNet-101, Inception v2, etc.), input sizes, model depth, varying software and hardware environment. A feature extractor tends to encode the model's input into certain feature representation which aids in learning and discovering the patterns associated with the desired objects .
In our study, we propose a solution which performs real-time detection of individuals to track social distancing norms being followed and real-time face detection to track usage. The techniques we used to formulate this solution have been described in this section.

1) YOLOv4 Architecture and Functioning

Bochkovskiy et al in 2020 proposed YOLOv4 with some major changes from its predecessor YOLOv3, resulting in significant improvements in both speed and accuracy. YOLOv4 is extremely fast, easy to train, robust, stable and gives promising results even for tiny objects; hence, we selected it as our object detector of choice. For an input image/frame, it detects objects belonging to three classes — unmasked faces, masked face and people. This effectively means that the same model is used for both person detection to track social distancing and for masked-face detection for face-mask monitoring.
This significantly boosts overall efficiency and simplicity significantly.



2) Tracking Social Distancing

The solution proposed in our paper includes 2 steps: calibration and testing. In calibration, there are 2 steps:

- The user is required to input the focal length, and the sensor dimensions of the camera to be used.
- The user is then required to position these 2 individuals at the minimum social distance that is to be maintained, henceforth referred to as the reference social distance.

The advantage of this is that authorities can actually select the social distance they want maintained, according to the specific guidelines that they wish to follow. For eg.: WHO guidelines mention the recommended amount of social distance to be a minimum of 3 ft. [1], while CDC guidelines recommend the minimum to be 6 ft [21]. The social distance between 2 people is solely judged relative to the initial calibration, and the absolute distance need not be provided to the model.
This Social Distancing model uses the principle that a camera lens is essentially a convex lens, where the image is essentially captured on a screen. For this model, as aforementioned, we need the focal length and sensor dimensions.

The focal length of a lens is the distance from the optic center of the lens to its focus. In optics and photography, the focal length is measured in millimeters(mm). Longer the focal length, higher the magnification, but lower the angle of view.
An image sensor is a device found in the hardware of a camera, that uses light to detect information to convert a view into an image. The sensor essentially functions as screen where all the pixels in an image are mapped. Greater the pixels mapped, greater the image quality.
Let field width, i.e., the observed width of a real life object be w and measured distance of an object from the camera be d.
Let the people between whom the distance is being measured be: Person 1 and Person 2, that stand at positions (x1,y1) and (x2,y2) in a given image. These coordinates are detected at the feet of the individuals. Through Fig 4, using similarity, we can show that [23]
sensor dimensionfocal length=field dimensiondistance to field(2)

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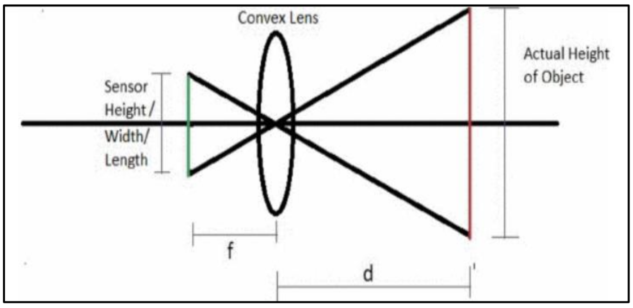

Fig. 4: Basic visualisation of the working of a camera

To find the depth of an object in a photograph, the following formula can be obtained from equation 2:

d=actual ht of object(mm)×focall length(mm)ht of object on sensor(mm)

where height is ht. Since we only have the height of the object in pixels(px.) in the image, we can use the following formula to obtain the height of the object in the image on the sensor in millimeters. Here, the height of an actual human is assumed to be 1.6m in this model, since the average height of a human is estimated to be that much.

object ht on sensor(mm)=object ht in image(px.)×pixel size

where px is measurement in number of pixels. Hence, the depth of a person would be equal to the distance a person stands from the camera. This distance from the camera for the 2 people will be represented as d1 and d2. To measure the approximate distance between these two people in the image, the difference of their x-coordinates are taken to be the social distance width.

Social distancing width(mm)=(|x1−x2|)×pixel size

We can hence find out the actual field width using eqn. 2

w=sensor width×social distancing width(mm)
focall length(mm)

If person 1 is assumed to be at (0, d1) and person 2 at (w,d2)

social distance=$\sqrt{}$ $((w-0)^2+(d2-d1)^2)$

To obtain the pixel size, the following formula must be used:

pixel size = ((sensor width(mm)/width of image(px.)) + (sensor height(mm)height of image(px.))) / 2

The social distance, which is first calculated in calibration mode, will be used as the reference social distance. In testing mode, the social distance between 2 individuals will be calculated using the equations shown above. If the calculated social distance is lesser than the reference social distance, the pair of individuals will be identified as violators.

V.EXPERIMENTS AND RESULTS

- **Experimental Setup**

YOLOv4 was built on the Darknet Framework and was trained using NVIDIA Tesla P100 PCIE Graphics Processing Unit (GPU) with 16 gigabytes of memory, and 2.30GHz Intel Xeon CPU. For training, we set the hyper-parameters of the network as follows:

- Number of Steps: 8000
- Batch-Size: 64
- Mini Batch-Size: 64
- Momentum: 0.949
- Decay: 0.0005
- Initial Learning Rate: 0.001

We trained models, one with all three classes person and the other. The models were trained on 6,120 images. The total number of iterations for which the model was scheduled to train for was 8000. After every 680 iterations, the current

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state of the model was evaluated by recording the AP for every class, precision, recall, F1 score and the mean AP (mAP). The weights of the model were saved for every 100 iterations completed, for future evaluation.
To test the social distancing model, we used a camera of:

- Focal length: 4.15mm
- Sensor dimensions: 4.80mm×3.60m

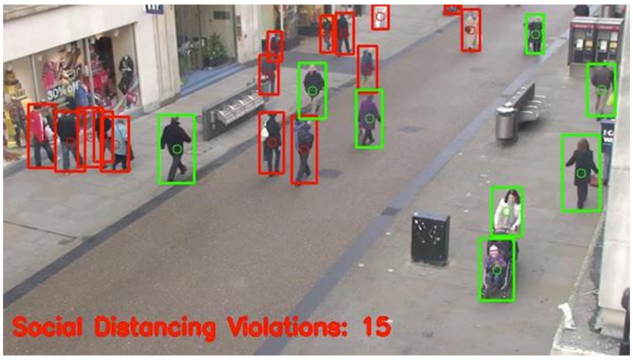

Fig. 5:Inferences of social distance tracking on our customized set of pictures

- **Camera Height: 2.2 M**

The calibration reference image involved two people standing at a distance of 1m, while the testing images consisted of people standing at varying positions with respect to each other.

RESULTS

Below are some of the snapshots of the output of the working program model. It is categorized into two stages, stage one is where the pedestrians are detected from the inputted video and the total count is displayed in the right bottom corner.In stage two we have added the warning notification which can be seen in the right bottom corner of the screen.

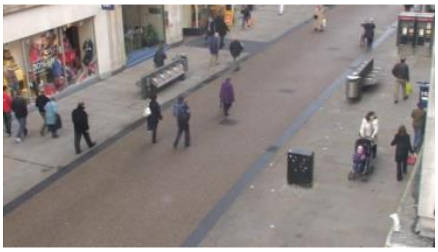

Fig: Input Video

Fig: Stage 1 Detection

Fig: Stage 2 Detection with Warning

Fig: Stage 2 without Warning

CONCLUSION

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. The proposed approach was confirmed using a video showing pedestrians walking down the street. The visual

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results showed that the proposed method is It is able to determine measures of social isolation that can be developed for use in other environments such as office, restaurant and school. In addition, the work can be improved by expanding the pedestrian detection algorithm, integrating other detection algorithms such as mask detection and human body temperature detection, improving computer hardware power, and measuring camera view.

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