SOCIAL DISTANCING DETECTOR USING YOLO AND OPENCV

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***Abstract*— The practice of social distancing is vital to curbing the spread of contagious diseases and has been globally adopted as a non-pharmaceutical prevention measure during the COVID-19 pandemic. Social distancing has been proven as an imperative measure against the spread of the infectious coronavirus disease 2019 (COVID-19). Coronavirus is generally spread between people during close contact. People are not used to track the required 6-feet (2-meters) distance between themselves and their surroundings. Social distancing is one of the feasible approaches to fight against this pandemic. Motivated by this notion, an active video surveillance system capable of detecting distances between individuals and warning them can slow down the spread of the deadly disease. The proposed system takes the video input and considers the region of interest for measuring the social distancing. It utilizes YOLO v3 algorithm which is used for measuring and classifying the distance between persons and to automatically check if social distancing rules are respected or not. YOLO v3 object detection model is used to segregate humans from background and OpenCV approach to track the identified people with the help of bounding boxes and measure the distance between them. Furthermore, measuring social density in a region of interest (ROI) and modulating inflow can decrease social distancing violation occurrence chance.**

***Keywords*— YOLO v3 (You only look once); OpenCV; Region of Interest (ROI); Coronavirus; Social Distancing.**

1. Introduction

The COVID-19 spreads primarily from person to person through small droplets from the nose or mouth, which are expelled when a person with COVID-19 coughs, sneezes, or speaks [1]. People can catch COVID-19 if they breathe in these droplets from a person infected with the virus. In Public and Crowded areas there is a high chance of spread of the virus. Social distancing is claimed as the best spread stopper in the present scenario. However, the general public is not used to keep an imaginary safety bubble around themselves [5]. Social distancing has been proven as an imperative measure against the spread of the infectious coronavirus disease [7].

A surveillance system capable of detecting distances between individuals can slow down the spread of the deadly disease [2]. Furthermore, measuring social density in a region of interest (ROI) and modulating inflow can decrease social distancing violation occurrence chance[8].

The proposed system uses YOLO v3 algorithm and Open CV approach which could detect the objects and measure the distance between them. An active video surveillance system capable of detecting distances between individuals and warning them can slow down the spread of the deadly disease. Measuring social density in a region of interest (ROI) and modulating inflow can decrease social distancing violation occurrence chance.

Advantages of Proposed Model

1. It detects objects and capture their motion frame by frame.
2. Region of interest is defined and inflow and outflow could be noticed.
3. Bounding boxes are drawn across the objects and the level of risk is shown i.e. (High Risk, Low Risk, Safe).

2. Literature Survey

- **Mohd Zafri, Salman Yussof, Sumayyah "Social Distancing Detector with Deep Learning Model", IEEE , 26 Aug 2020.**
  The paper presents a methodology for social distancing detection using deep learning to evaluate the distance between people to mitigate the impact of this coronavirus pandemic. The detection tool was developed to alert people to maintain a safe distance with each other by evaluating a video feed. The video frame from the camera was used as input, and the open-source object detection pre-trained model based on the YOLOv3 algorithm was employed for pedestrian detection.[1]

- **Narinder Singh Punn, Sanjay Kumar, Sonali Agarwal "Monitoring COVID-19 Social Distancing with Person Detection and Tracking via fine tuned YOLO V3 and Deepsort Technique", arXiv, 4 May 2020.**
  The rampant coronavirus disease 2019 (COVID-19) has brought global crisis with its deadly spread to more than 180 countries, and about 3,519,901 confirmed cases along with 247,630 deaths globally. The absence of any active therapeutic agents and the lack of immunity against COVID-19 increases the vulnerability of the population. Since there are no vaccines available, social distancing is the only feasible approach to fight against this pandemic.[2]

- **Rinkal Keniya, Ninad Mehendale "Real-time Social Distancing Detector using Social Distancing Net-19 Deep Learning Network", SSRN, 7 Aug 2020.**
  The COVID-19 pandemic has put the world to a halt. The virus is spreading quickly and is a danger to the human race. Using the model named SocialdistancingNet-19 for detecting the frame of a person and displaying labels, they are marked as safe or unsafe if the distance is less than a certain value. This system can be used for monitoring people via video surveillance in CCTV.[3]

- **Savyasachi Gupta, Rudraksh Kapil, Goutham "SD-Measure:A Social Distancing Detector", arXiv, 4 Nov 2020.**
  The practice of social distancing is imperative to curbing the spread of contagious diseases and has been globally adopted as a non-pharmaceutical prevention measure during the COVID-19 pandemic. This work proposes a novel framework named SD-Measure for detecting social distancing from video footages. The proposed framework leverages the Mask R-CNN deep neural network to detect people in a video frame.[4]

- **Vishnu Renganathan, Dongfang Yang, Ekim Yurtsever "A vision-based Social Distancing and Critical Density Detection System for COVID-19", arXiv, 7 July 2020.**
  Social distancing has been proven as an effective measure against the spread of the infectious CoronaVirus Disease 2019 (COVID-19). However, individuals are not used to tracking the required 6-feet (2-meters) distance between themselves and their surroundings. An active surveillance system capable of detecting distances between individuals and warning them can slow down the spread of the deadly disease. Furthermore, measuring social density in a region of interest (ROI) and modulating inflow can decrease social distancing violation occurrence chance.[5]

3.Design Methodology

YOLO V3

The YOLO (You Only Look Once) real-time object detection algorithm, which is one of the most effective object detection algorithms that encompasses many of the most innovative ideas coming out of the computer vision research community.

YOLO is an algorithm that uses convolutional neural networks for object detection. YOLO is one of the faster object detection algorithms. It is a very good choice when we need real-time detection, without loss of too much accuracy.

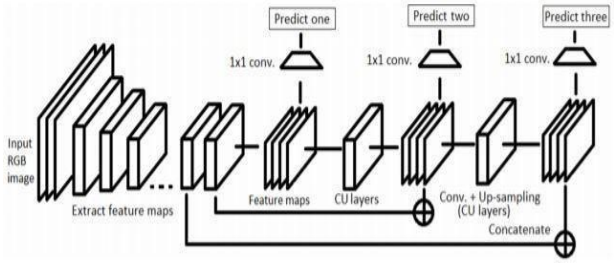

Fig.1: Schematic representation of YOLO v3 architecture

As shown in the Fig.1, the detection network has 24 convolutional layers followed by 2 fully connected layers. Alternating 1 × 1 convolutional layers reduce the features space from preceding layers. We pretrain the convolutional layers on the ImageNet classification task at half the resolution (224 × 224 input image) and then double the resolution for detection[6].

Bird Eye View

A **bird eye view** is a basically a top-down representation of a picture. OpenCV has great built-in functions to apply this method to an image in order to transform an image taken from a perspective point of view to a top view of the video.

As shown in the Fig.2, the people who are far from the camera seems to be merging and distance could not be measured accurately. To overcome the problem bird eye view is used. This increases the accuracy of measuring the distancing between the people in the video.

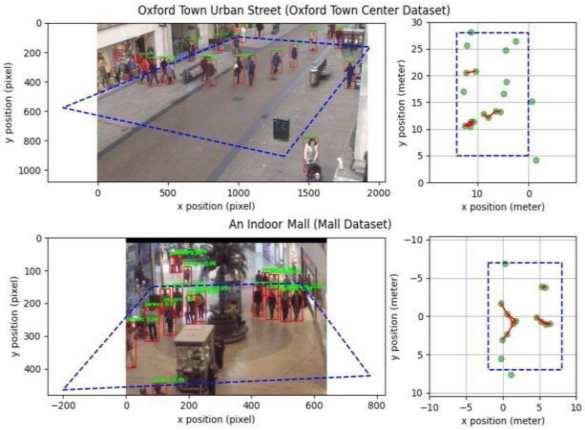

Fig.2: Bird Eye View of Image

4. Implementation

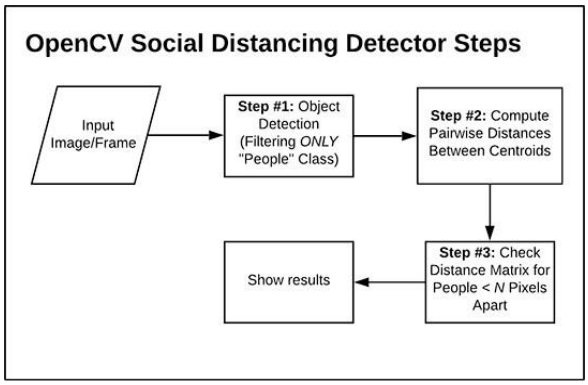

Fig.3: Block Diagram of OpenCV for Social Distancing Detector

Video Input

As shown in Fig.3, the input should be a video and the first frame of the input is taken from the video. It is used for considering the region of interest.

Region of Interest

Region of Interest is the area where the social distancing detection is monitored. It will take 8 points on first frame using mouse click event. First four points will define ROI where we want to monitor social distancing. Also, these points should form parallel lines in real world if seen from above (birds eye view). Next 3 points will define 6 feet (unit length) distance in horizontal and vertical direction and those should form parallel lines with ROI. Unit length we can take based on choice. Points should be in predefined order bottom-left, bottom-right, top-right, top-left, point 5 and 6 should form horizontal line and point 5 and 7 should form vertical line. Horizontal and vertical scale will be different.

Transform perspective to Bird Eye View

Transform perspective of ROI so that it has top view of scene or ROI. This top view or bird eye view has the property that points are distributed uniformly horizontally and vertically (scale for horizontal and vertical direction will be different). So for bird eye view points are equally distributed, which was not case for normal view.

Object Detection

Human objects are detected and classified from the rest of the objects using YOLO V3 algorithm. Bounding boxes are drawn around the human objects.

Calculating Distance

The distance between the humans are found by taking the horizontal and vertical pixels of the centre of the bounding boxes and calculating it using Pythagoras theorem. Calculating the number of pixels apart in horizontal and vertical direction and then finding the distance between all the bounding boxes. The distance lines are drawn between the objects and the risk of humans is calculated.

Risk Assessment

According to the distance between the objects by considering the pixel distance the risk of the humans are assessed. The red bounding box indicates high risk, the yellow bounding box indicates low risk and the green bounding box indicates that the humans are safe.

5. Testing and Results

Testing is a very important module in the software development to verify, validate and provide quality and service for different components of software. It is used to minimize the risks by efficient use of resources in the development life cycle. This module can be employed at any point of the development process. It is efficient for the testing phase to be implemented at initial level to lower down the risks of defects and failures.

The video in mp4 format is taken as the input for testing the social distancing between the people. In the first frame the region of interest is considered and perspective is changed to bird eye view and after identifying the human objects the distance is measured and level of risk is assessed.

Fig.4: Region of Interest of Test Video1

In the Fig.4, the region of interest of the first frame of the test video is considered. The region of interest is drawn by marking four pixel which are parallel to each other.

Fig.5: Social Distancing Detection

In the Fig.5, the social distancing is detected by drawing the coloured bounding boxes around the humans showing the level of the risk.

Fig.6: Region of Interest of Test Video2

In the Fig.6, the density of people is higher and the region of interest of the first frame of the test video is considered. The region of interest is drawn by marking four pixel which are parallel to each other.

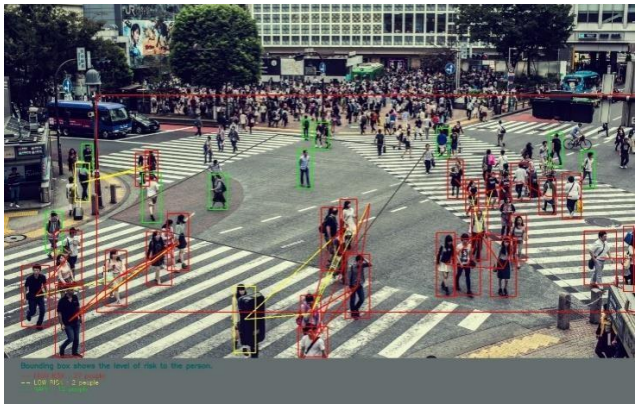

Fig.7: Social Distancing Detection

In the Fig.7, identifying the humans in a very dense region and the social distancing is detected by drawing the coloured bounding boxes around the humans showing the level of the risk.

Results

The proposed model outputs the processed frame by frame images of the video as shown in Fig.5 and Fig.7 with identified humans confined in bounding boxes and showing the statistical analysis of people who are abiding the social distancing norms and who are not by showing the level of risk.

6. Conclusion

This work proposed an AI based real-time system to monitor the social distancing. Using the proposed critical social density to avoid overcrowding by modulating inflow to the Region of Interest (ROI) and 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. The generated bounding boxes aid in identifying the clusters or groups of people satisfying the closeness property computed with the help of pairwise vectorized approach.

7. Future Scope

Since this application is intended to be used in any working environment, accuracy and precision are highly desired to serve the purpose. To further speedup the pipeline, consider utilizing a Single Shot Detector (SSD) running on your GPU that will improve frame throughput rate considerably. It can be implemented by an IOT device which is embedded by a sensor which alerts an alarm whenever there is a close contact between the people.

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