

SOCIAL DISTANCING DETECTOR

Submitted in partial fulfillment of the requirements for

the award of

Bachelor of Engineering degree in Computer Science and Engineering

by

RAGUL KP (37110614)



**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
SCHOOL OF COMPUTING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC
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BONAFIDE CERTIFICATE

This is to certify that this project report is the bonafide work of **RAGUL KP(37110614)** who carried out the project entitled "**SOCIAL DISTANCING DETECTOR**" under my supervision from **August 2020** to **March 2021**.

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DECLARATION

I RAGUL KP (37110614) hereby declare that the Project Report entitled “**SOCIAL DISTANCING DETECTOR**” is done by me under the guidance of **Dr.Mercy Paul Selvan M.E., Ph.D** Department of Computer Science and Engineering at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Computer Science and Engineering.

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ABSTRACT

Social distancing is a recommended solution by the World Health Organisation (WHO) to minimise the spread of COVID-19 in public places. The majority of governments and national health authorities have set the 2-meter physical distancing as a mandatory safety measure in shopping centres, schools and other covered areas. In this research, we develop a generic Deep Neural Network-Based model for automated people detection, tracking, and inter-people distances estimation in the crowd, using common CCTV security cameras. The proposed model includes a YOLOv4-based framework and inverse perspective mapping for accurate people detection and social distancing monitoring in challenging conditions, including people occlusion, partial visibility, and lighting variations. We also provide an online risk assessment scheme by statistical analysis of the Patio-temporal data from the moving trajectories and the rate of social distancing violations. We identify high-risk zones with the highest possibility of virus spread and infections. This may help authorities to redesign the layout of a public place or to take precaution actions to mitigate high-risk zones. The efficiency of the proposed methodology is evaluated on the Oxford Town Centre dataset, with superior performance in terms of accuracy and speed compared to three state-of-the-art methods.

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CHAPTER 1- INTRODUCTION

INTRODUCTION

The novel generation of the coronavirus disease (COVID-19) were reported in late December 2019 in Wuhan, China. After only a few months, the virus was hit by the global outbreak in 2020. On May 2020 The World Health Organisation (WHO) announced the situation as the pandemic^{1, 2}

. The statistics by WHO on 26 August 2020 confirms 23.8 million infected people in 200 countries. The mortality rate of the infectious virus also shows a scary number of 815,000 people. With the growing trend of patients, there is still no effective cure or available treatment for the virus. While scientists, healthcare organisations, and researchers are continuously working to produce appropriate medications or vaccines for the deadly virus, no definite success has been reported at the time of this research, and there is no certain treatments or recommendation to prevent or cure this new disease. Therefore, precautions are taken by the whole world to limit the spread of infection. These harsh conditions have forced the global communities to look for alternative ways to reduce the spread of the virus. Social distancing, as shown in, refers to precaution actions to prevent the proliferation of the disease, by minimising the proximity of human physical contacts in covered or crowded public places (e.g. schools, workplaces, gyms, lecture theatres, etc.) to stop the widespread accumulation of the infection risk. According to the defined requirements by the WHO, the minimum distance between individuals must be at least 6 feet (1.8 meters) in order to observe an adequate social distancing among the people. Recent researches have confirmed that people with mild or no symptoms may also be carriers of the novel Coronavirus infections⁴. Therefore, it is important all individuals maintain controlled behaviours and observe social distancing. Many research works such as ^{5,6,7} have proved social distancing as an effective non-pharmacological approach and an important inhibitor for limiting the transmission of contagious diseases such as H1N1, SARS, and COVID-19. Figure 2 demonstrates the effect of following appropriate social distancing guideline to reduce the rate of infection transmission among individuals^{8, 9}. A wider Gaussian curve with a shorter spike within the range of the health system service capacity makes it easier for patients to fight the virus by receiving continuous and timely support from the health care organisations. Any unexpected sharp spike and rapid infection rate (such as the red curve in Figure 2), will lead to the service failure, and consequently, exponential growth in the number of fatalities.

For several months, the World Health Organisation believed that COVID-19 is only transmittable via droplets emitted when people

sneeze or cough and the virus does not linger in the air. However, on 8 July 2020, the WHO announced: “ There has emerging evidence that COVID-19 is an airborne disease that can be spread by tiny particles suspended in the air after people talk or breathe, especially in crowded, closed environments or poorly ventilated settings. ” Therefore, social distancing now claims to be even more important than thought before, and as one of the best ways to stop the spread of the disease in addition to wearing facial masks. Almost all countries are now considering it as a mandatory practice.

Related Works

Many researchers have worked in the medical and pharmaceutical fields aiming at treatment of COVID-19 infectious disease; however, no definite solution has yet been found. On the other hand, controlling the spread of such an unknown respiratory infectious disease is another issue. Variety of studies with different implementation strategies^{5, 6, 15} have proven that controlling the prevalence is a contributing factor, and social distancing is an effective way to reduce the transmission and prevent the spread of the virus in society. Several researchers such as¹⁶ and¹⁵ use SIR (Susceptible, Infectious, or Recovered) model. SIR is an epidemiological modelling system to compute the theoretical number of people infected with a contagious disease in a given population, over time. One of the oldest yet common SIR models is Kermack and McKendrick models introduced in 1927¹⁷. Eksin et al.¹⁶, have recently introduced a modified model of SIR by including a social distancing parameter, which can be used to determine the number of infected and recovered individuals. Effectiveness of social distancing practices can be evaluated based on several standard approaches. One of the main criteria is based on the reproduction ratio, R_0 , which indicates the average number of people who may be infected from an infectious person during the entire period of the infection¹⁸. Any $R_0 > 1$ indicates an increasing rate of infection within the society and $R_0 < 1$ indicates that every case will infect less than 1 person, hence, the disease rate is considered to be declining in the target population. Since the R_0 value indicates the disease outspread, it is one of the most important indicators for selecting social distancing criteria. In the current COVID-19 pandemic, the World Health Organisation estimated the R_0 rate would be in the range of 2- 2.5¹⁹, which is significantly higher than other similar diseases such as seasonal flu with $R_0 = 1.4$. In²⁰, a clear conclusion is drawn about the importance of applying social distancing for the cases with a high amount of R_0 . In another research based on the game theory on the classic SIR model, an assessment of the benefits and economic costs of

social distancing has been examined²¹. The results also show that in the case of $R_0 < 1$, social distancing would cause unnecessary

costs, while $R_0 \approx 2$ implies that social distancing measures have the highest economic benefits. In a similar research, Kylie et al.²² investigated the relationship between the stringency of social distancing and the region's economic status. This study suggests although preventing the widespread outbreak of the virus is necessary, a moderate level of social activities could be allowed. Prem et al.²³ use location-specific contact patterns to investigate the effect of social distancing measures on the prevalence of COVID-19 pandemic in order to remove the persistent path of disease outbreak using susceptible-exposed-infected-removed models (SEIR). Since the onset of coronavirus pandemic, many countries have used technology-based solutions, to inhibit the spread of the disease ^{24,25,26}. For example, some of developed countries, such as South Korea and India, use GPS data to monitor the movements of infected or suspected individuals to find any possible exposure among the healthy people. The India government uses the Aarogya Setu program to find the presence of COVID-19 patients in the adjacent region, with the help of GPS and Bluetooth. For example, it enables us to understand and predict pedestrian behaviours in traffic scenes, sports actions and activities, medical imaging, anomaly detection, etc. by analysing Spatio-temporal visual information and statistical data analysis of the images sequences. In health-related fields, it would be also feasible to predict the sickness trend of specific areas³², to predict the density of people in public places³³, or determine the distance of individuals from the popular swarms³⁴, using a combination of visual and Geo-location cellular information. However, such research works suffer from challenges such as skilled labour or the cost of designing and implementing the infrastructures. On the other hand, recent advances in AI, Computer Vision, Deep Learning, and Pattern Recognition, enables the computers to understand and interpret the visual data from digital images or videos. It also allows computers to identify and classify different type of objects³⁵ , ³⁶ , ³⁷. Such capabilities can play an important role in empowering, encouraging, and performing social distancing surveillance and measurements as well.

RESEARCH AND SIGNIFICANCE

For several months, the World Health Organisation believed that COVID-19 is only transmittable via droplets emitted when people sneeze or cough and the virus does not linger in the air. However, on 8 July 2020, the WHO announced: “ There has emerging evidence that COVID-19 is an airborne disease that can be spread by tiny particles suspended in the air after people talk or breathe, especially in crowded, closed environments or poorly ventilated settings. ” Therefore, social distancing

now claims to be even more important than thought before, and as one of the best ways to stop the spread of the disease in addition to wearing facial masks. Almost

all countries are now considering it as a mandatory practice. During the COVID-19 pandemic, governments have tried to implement a variety of social distancing practices, such as restricting travels, controlling borders, closing pubs and bars, and alerting the society to maintain a distance of 1.6 to 2 meters from each other¹⁰. However, monitoring the amount of widespread and efficiency of the constraints is not an easy task. People require to go out for essential needs such as food, health care and other necessary tasks and jobs. In such situations, Artificial Intelligence can play an important role in facilitating social distancing monitoring. Computer vision, as a subset of Artificial Intelligence, has been very successful in solving various complex health care problems and has shown its potential in Chest CT-Scan or X-Ray based COVID-19 recognition¹¹ , ¹². Besides, deep neural networks enable us to extract complex features from the data so that we can provide a more accurate understanding of the images by analysing and classifying these features. Examples include diagnosis, clinical management and treatment, as well as the prevention and control of COVID-19¹³ , ¹⁴ . The main contribution of this research can be highlighted as follows:

- This study aims to support the reduction of the corona virus spread and its economic costs by providing an AI-based solution to automatically monitor and detect violations of social distancing among individuals.
- We develop one of the most (if not the most) accurate deep neural network (DNN) models for people detection, tracking, and distance estimation called Deep social.
- We perform a live and dynamic risk assessment, by statistical analysis of spatiotemporal data from the people movements at the scene.
- The developed model is a generic human detection and tracker, not limited to social-distancing monitoring, and can be applied for various real- world applications such as pedestrian detection in autonomous vehicles, human action recognition, anomaly detection, and security systems. More details and further information will be provided in the following sections. In Section 2 we discuss the related work, existing challenges, and research gaps in the field. The proposed methodology including the model architecture and our object detection techniques, tracking, and red-zone prediction algorithm will be proposed in Section 3. In Section 4 experimental results and performance of the system is investigated against the state-of-the-art, followed by discussions and concluding remarks in Section 5

CHAPTER 2 - AIM AND SCOPE

OBJECTIVES

With the recent outbreak and rapid transmission of the COVID-19 pandemic, the need for the public to follow social distancing norms and wear masks. According to the World Health Organization, to follow proper social distancing, people in public places must maintain at least the distance which can be specified the user to their own needs and enforce maintaining that same distance between each other. This project helps enforce proper social distancing in real time and send email alerts.

MODULE DESCRIPTION

The modules focuses on how to identify the person on image/video stream maintaining distance with the help of machine learning YOLO algorithm by using the OpenCV, Tensor flow and python. The first module uses ip address to connect footage from the recording device and the computer system processing/computing the data. Social Distancing system finds the gap between two persons detected in the camera. The platform generates notifications and calls an external alarm (via email) to warn if anyone is found violating laws.

OBJECT DETECTION AND TRACKING MODELS

the successful object detection models like RCNN [61], fast RCNN [62], faster RCNN [38], SSD [63], YOLO v1 [40], YOLO v2 [64] and YOLO v3 [65] tested on PASCAL-VOC [66] and MS-COCO [67] 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 [68], ResNet-101 [69], Inception v2 [70], etc.), input sizes, model depth, varying software and hardware environment. A feature extractor tends to encode the models input into certain feature representation which aids in learning and discovering the patterns associated with the desired objects. In order to identify multiple objects of varying scale or size, Table I describes the performance in terms of accuracy for each of these popular and powerful feature extraction networks on ILSVRC ImageNet challenge [71], along with the number of trainable parameters, which have a direct impact on the training speed and time.

CHAPTER 3- SYSTEM DESIGN & METHODOLOGY

EXISTING SYSTEM

A. Social Distancing

1) Definition and Classifications

Social distancing refers to the non-pharmaceutical measures to reduce the frequency of physical contacts and the contact distances between people during an infectious disease outbreak [11]. Social distancing methods can be classified into public and individual measures. Public measures include closing or reducing access to educational institutions and workplaces, canceling mass gatherings, travel restrictions, border control, and quarantining buildings. Individual measures consist of isolation, quarantine, and encouragement to keep physical distances between people [16]. Although these measures can cause some negative impacts on the economy and individual freedom, they play a crucial role in reducing the severity of a pandemic [11].

2) Measurements and Models

The evaluation of social distancing measures is often based on several standardized approaches. One of the main criteria for social distancing measures selection is the basic reproduction number R_0 which represents on average how many people a case (i.e., an infectious person) will infect during its entire infectious period [24]. For example, $R_0 < 1$ indicates that every case will infect fewer than 1 person, and thus the disease is declining in the considered population. Since the value of R_0 represents how quickly the disease is spreading, R_0 has been one of the most important indicators for social distancing measures selection [25], [32]. Mathematically, R_0 can be determined by

$$R_0 = \int_0^\infty b(a)F(a)da, (1)$$

Different combinations of these classes result in different types of models, such as MSEIR, MSEIRS, SEIR, SEIRS, SIR, and SIRS. The acronyms of these models represent the classes that they take into account and the transition of individuals between these classes. The reason for these variations is that some classes are not needed in certain cases, e.g., birth immunity might not exist for a novel strain of virus. For example, the MSEIRS model is similar to the MSEIR model, except that the recovered individuals can be infected again, and thus the MSEIRS is only used for the cases where immunity is not permanent. Among these models, the classic SIR model is the most common. Let $S(t)$ be the number of susceptible, $I(t)$ be the number of infected, and $R(t)$ be the number of recovered individuals in a population at time t . Moreover, let β be the

average number of adequate contacts (i.e., contacts that infect a new case) and $1/\gamma$ be the average infectious period.

SYSTEM CAPABILITIES

To evaluate the effectiveness of social distancing, a common approach is to measure the attack rate which is the percentage of infected people in a susceptible population (where no one is immune at the beginning of the disease) at the time of measurement [27]. The attack rate reflects the severity of a disease at a given time, and thus it has different values during the disease outbreak. Among these values, the peak attack rate is often considered and compared to the current healthcare capacity (e.g., intensive care unit capacity) to see the current system's ability to handle the peak number of patients. After the outbreak is over, data is often collected to determine the final attack rate which is the total number of infected cases over the entire course of the outbreak divided by the total population.

Social distancing measures are proven to be effective when implemented properly [27]–[28][29][30][31][32][33]. Different types of social distancing measures may have diverse levels of effectiveness on the disease spread. In [27], the effect of social distancing measures at workplaces is evaluated by an agent-based simulation approach. In particular, six different workplace strategies that reduce the number of workdays are simulated. The results show that, for seasonal influenza ($R_0=1.4$), reducing the number of workdays can effectively reduce the final attack rate (e.g., up to 82% if three consecutive workdays are reduced). Nevertheless, in pandemic-level influenza ($R_0=2.0$), reducing the number of workdays has a significantly weaker impact, i.e., 3% (one extra day off) to 21% decrease (three extra consecutive days off). Several other studies present similar results. In [28], it is shown that workplace social distancing can reduce the final attack rate by up to 39% in a $R_0=1.4$ setting. Similarly, [29] shows that different types of measures can reduce the attack rate from 11% to 20% depending on the frequency of contacts among the employees.

For school closure measures, studies also show positive effects. In [30], a modeling technique is employed to examine the effects of four different social distancing measures under three varying R_0 settings. Among different types of measures, the school closure measure is shown to be able to reduce the final attack rate by 20%, 10%, and 5%, and the peak attack rate by 77%, 47%, and 32% in the cases where $R_0 < 1.9$, $2.0 \leq R_0 \leq 2.4$, and $R_0 > 2.5$, respectively. Similarly, it is shown in [31] that prolonged school closure in a pandemic context can reduce the final attack rate by up to 17% and the peak attack rate by up to 45%.

Another common social distancing measure is the isolation of confirmed cases and cases with similar symptoms. In [32], large-scale epidemic

simulations are performed to evaluate different strategies for influenza pandemic mitigation. Among the simulated strategies, the results show that the proper implementation (such that an isolated individual reduces 90% of its contact rate) of isolation can reduce the final attack rate by 7% in a $R_0=2$ setting. Similarly, it is shown in [30] that isolation can reduce the final attack rate by 27%, 7%, and 5%, and the peak attack rate by 89%, 72%, and 53% in the cases where $R_0 < 1.9$, $2.0 \leq R_0 \leq 2.4$, and $R_0 > 2.5$, respectively.

For household quarantines, studies have shown that this measure can be effective if the compliance level is sufficient. In [32], the effects of voluntary quarantine of household for a duration of 14 days are examined. Simulations are carried out with the assumption that 50% of households will comply, which leads to a 75% reduction of external contact rates, while the internal contact rate will increase by 100%. The results show that this measure can reduce the final attack rate by up to 6% and the peak attack rate by up to 40%. Similarly, in [33], simulations are performed to examine the impacts of different measures. For household quarantines, the result shows that this measure can reduce the final attack rate by 31% and the peak attack rate by 68% with $R_0=1.8$ and a compliance rate of 50%.

Apart from the abovementioned measures, the effectiveness of the other social distancing measures either received limited attention or was often considered in combination with another approach. In [32], the effectiveness of travel restrictions and border control measures are examined. However, the results only show that different levels of travel restrictions (from 90% to 99.9%) can delay the peak attack rate by up to six weeks, while how travel restrictions affect the attack rate is not examined. Another type of measure that does not receive much attention is community contact reduction measures (e.g., avoiding crowds and mass gatherings cancellation). In [30], it is shown that this type of measure can reduce the final attack rate by 17%, 14%, and 10%, and the peak attack rate by 72%, 49%, and 38% in the cases where $R_0 < 1.9$, $2.0 \leq R_0 \leq 2.4$, and $R_0 > 2.5$, respectively.

When combined together, social distancing measures are proven to be even more effective [30], [32], [34]. It is shown in [30] that when all four measures, i.e., school closure, isolation, workplace nonattendance, and community contact reduction, are in effect, they can drastically reduce the attack rates in all the considered R_0 settings. In particular, the final attack rate can decrease from 65% to only 3% and the peak attack rate from 474 cases per 10 thousand to only five cases, in the highest R_0 setting. Similarly, [32] examines the effects when household quarantines, workplace closures, border control, and travel restrictions are combined. The results show that the final and peak attack rates are three times and six times, respectively, lower than when no policy is implemented. Moreover, the peak attack rate can be delayed by nearly three months in

a $R_0=1.7$ setting. In [34], it is also shown that when four types of measures (i.e., school closure, household quarantines, workplace nonattendance,

and community contact reduction) are in effect, the final attack rate can be reduced 3–4 times depending on R_0 .

There are several studies focusing on the negative impacts of social distancing. In [35], simulations are performed based on a standard SIR model to evaluate the benefit and cost of different social distancing strategies. In this study, simulations are carried out without and with social distancing under different caution levels settings. Simulation results are evaluated based on the benefits of the reduced infection rate and the economic cost of reducing contacts. The main finding of this work is that a favorable result can only be obtained by implementing social distancing measures with a high caution level. Since the economic cost is also considered, it is shown that implementing social distancing with an insufficient caution level gives worse results than that of the case without social distancing. In [36], a game theoretical approach based on the classic SIR model is proposed to evaluate the benefits and costs of social distancing measures. Interestingly, the results show that in the case where $R_0 < 1$, the equilibrium behaviors include no social distancing measures. Moreover, social distancing measures are shown to achieve the highest economic benefit when $R_0 \approx 2$.

WAYS OF REPORTING

There are many ways of reporting. Some of the methods of reporting alert are as follows:

- Through virtual
- Through email or messaging

MODULES

- The modules focuses on how to identify the person on image/video stream maintaining distance with the help of machine learning YOLO algorithm by using the OpenCV, Tensor flow and python. The first module uses ip address to connect footage from the recording device and the computer system processing/computing the data.
- Social Distancing system finds the gap between two persons detected in the camera. The platform generates notifications and calls an external alarm (via email) to warn if anyone is found violating laws.

ARCHITECTURAL DESIGN

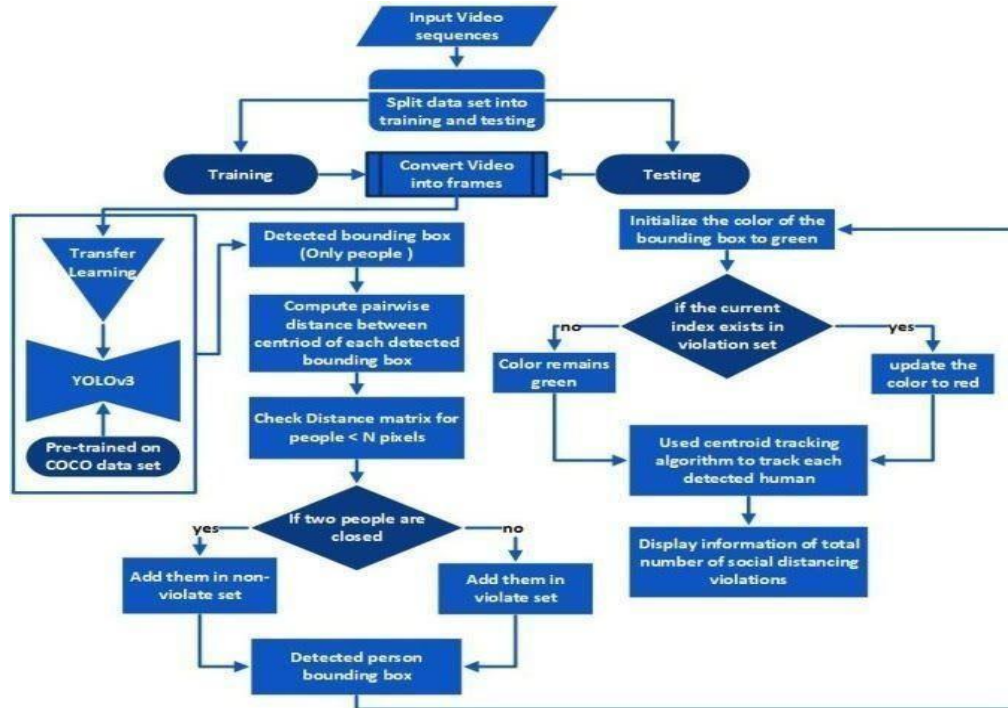


Fig 4.1: BLOCK DIAGRAM

The flow diagram of the framework is shown in Fig 4.1. The recorded overhead data sets are split into training and testing sets. A deep learning-based detection paradigm is used to detect individuals in sequences. There are a variety of object detection models available. Due to the best performance results for generic object detection, in this work, YOLOv3) is used. The model used single-stage network architecture to estimate the bounding boxes and class probabilities. The model was originally trained on the COCO (Common objects in context) data set . For overhead view person detection, transfer learning is implemented to enhance the detection model's efficiency, and a new layer of overhead training is added with existing model.

After detection, the bounding box information, mainly centroid information, is used to compute each bounding box centroid distance. We used Euclidean distance and calculated the distance between each detected bounding box of peoples. Following computing centroid distance, a predefined threshold is used to check whether the distance among any two bounding box centroids is less than the configured number of pixels or not. If two people are close to each other and the distance value violates

the minimum social distance threshold. The bounding box information is stored in a violation set, as seen in Fig 4.1, and the color of the bounding box is updated/changed to red. A centroid tracking algorithm is adopted for tracking so that it helps in tracking of those people who violate/breach the social distancing threshold. At the output, the model displays the information about the total number of social distancing violations along with detected people bounding boxes and centroids.

In this work, YOLOv3 is used for human detection as it improves predictive accuracy, particularly for small-scale objects. The main advantage is that it has adjusted network structure for multi-scale object detection. Furthermore, for object classification, it uses various independent logistic rather than softmax. The model's overall architecture is presented in Fig 4.1; it can be seen that feature learning is performed using the convolutional layers, also called Residual Blocks. The blocks are made up of many convolutional layers and skip connections. The model's unique characteristic is that it performs detection at three separate scales, as depicted in Fig 4.1. The convolutional layers with a given stride are practiced to downsample the feature map and transfer invariant-sized features (Redmon & Farhadi, 2018). Three feature maps, as shown in Fig. 4.1, are utilized for object detection.

The architecture shown in Fig. 4.1 is trained using an overhead data set. For that purpose, a transfer learning approach is adopted that enhances the efficiency of the model. With transfer learning, the model is additionally trained without dropping the valuable information of the existing model. Further, the additional overhead data set trained layer is appended with the existing architecture. In this way, the model takes advantage of the pre-trained and newly trained information, and both detection results further deliver better and faster detection results.

After calculation of the bounding box information, the result is used to compute each bounding box centroid distance. We used Euclidean distance and calculated the distance between each detected bounding box of peoples. Following computing centroid distance, a predefined threshold is used to check whether the distance among any two bounding box centroids is less than the configured number of pixels or not. If two people are close to each other and the distance value violates the minimum social distance threshold. The bounding box information is stored in a violation set, as seen in and the color of the bounding box is updated/changed to red. A centroid tracking algorithm is adopted for tracking so that it helps in tracking of those people who violate/breach the social distancing threshold. At the output, the model displays the information about the total number of social distancing violations along with detected people bounding boxes and centroids.

After detecting people in video frames, in the next step, the centroid of each detected person bounding boxes shown as green boxes are used for distance calculation, as shown. The detected bounding box coordinates are used to compute the bounding box's centroid. It demonstrates accepting a set of bounding box coordinates and computing the centroid. After computing, centroid, a unique ID is assigned to each detected bounding box. In the next step, we measure the distance between each detected centroid using Euclidean distance. For every subsequent frame in the video stream, we first compute bounding box centroids shown and then calculate the distance (highlighted with red lines) between each pair of detected bounding box centroids. The information of each centroid is stored in the form of a list. Based on distance values, a threshold is defined to check if any two people are less than pixels apart or not. If the distance violates the minimum social distance set or two people are too close, then the information is added into the violation set. The bounding box color is initialized as green. The information is checked in the violation set; if the current index exists in violation set, the color is updated to red. Furthermore, the centroid tracking algorithm is used to track the detected people in the video sequence. The tracking algorithm also helps to keep track of people who are violating the social distance threshold. At the output, the model displays information about the total number of social distancing violations.

METHOD FOR EQUATING THE OUTPUT

In the grid cell, if the person is detected then $= 1$, otherwise equals to 0. The conditional class probabilities for class in grid cell are represented as p_c . The localization loss estimates the failures in the predicted bounding box sizes and locations. The bounding box containing the detected object, i.e., a person, is added. It is defined as (Redmon & Farhadi, 2018) which is used for object detection, otherwise it is equal to 0. Instead of predicting simple height and width, the model predicts the square root of the bounding box width and height. The scale parameters is used for predictions of bounding box coordinates and equals to 5 as (Redmon, Divvala, Girshick, & Farhadi, 2016). The predicted positions are represented with in the cell of detected bounding box, while the actual positions of bounding box in the i th cell is defined using p_i . The Equation measures the loss function of predicted bounding box having coordinate value p_i . To represent the possibility of the detected person in the i th bounding box is used. The value of p_i is constant, the function in Eq. (5) calculates sum over each bounding box, using as predictor for each grid c . The bounding box confidence score in cell c and is used to weight down the loss during detecting background. As in most cases detected, bounding boxes do not contain any objects that cause a class imbalance problem; therefore, the model is more frequently trained to detect background rather than detect objects. To solve this, the loss is weight down by a factor.

IDENTIFYING THE ACTORS

Even just in case of multiple individuals, everyone is taken base reference with various to the latter gift eleven in their locality. As an example, 10 persons, A, B, C, D, E, F, G, H, I, J. If A, B, C, D area units along, all of twelve of them could be a base of relevance to one another. This multiple freelance reference approach will offer correct results thirteen while not exploiting any leaf turned down.

USE CASES

The experiment finally offers output in two ways in which one could be a series of pictures with info concerning the number of individuals violating the social distancing rule. The authorities or employees accountable will read these pictures and regulate the watching. The pictures have all details like no individuals, time and place. the opposite output is in variety of associate degree alert message sent which might apprise the individual that they're presently violating and quickly reposition themselves..

IMPLEMENTATION DETAILS

Initially we decided to build our framework on the YOLO model. Each bounding box object that's detected is the design output, its score of confidence and cluster that area unit a group of systemically spaced coordinates and for various ratios and scales of rectangles named boxes. YOLO method might create the prediction of its kind Associate in Nursing position of an object simply by seeing the image one time. YOLO takes under consideration object identification issues as regression jobs in situ of category verification to portion anchor class chance boxes. one convolution predicts the network and also the bounding boxes for every category beside their category potential faults.

PERFORMANCE EVALUATION

We have compared the newly trained YOLOv3 with other deep learning models. The True detection and False detection rate of different deep learning models are depicted in Table . From the results, it can be seen that transfer learning improved the results significantly for the overhead view data set. The false detection rate of different deep learning models are very small, about 0.7–0.4% without any training, which reveals the effectiveness of deep learning models. Different pre-trained object detection models are tested on the overhead data set. Although the models were trained on the different frontal data sets, they still show good results by achieving an accuracy of 90%., the comparison results of different state of the art detection are outputted.

The experiment finally offers output in two ways in which one could be a series of pictures with info concerning the number of individuals violating the social distancing rule. The authorities or employees accountable will read these pictures and regulate the watching. The pictures have all details like no individuals, time and place. the opposite output is in variety of associate degree alert message sent which might apprise the individual that they're presently violating and quickly reposition themselves..

To achieve this, stopping the fast and wide spreading is only the sole possibility neglected to any or all nations. Hence, strict police work is the foremost priority for the governments to confirm human-to-human transmission doesn't occur, particularly thanks to breaking social twenty one distancing norms. The long run work lies in deploying mask detection and temperature detection of every person within the crowd. twenty three Combining multiple models in an associate ensemble learning framework is instrumental for the end-to-end pipeline for complete watching of every person. an individual inadvertently might have covid symptoms, and may be copied simply and stop the unintentional transmission.

FURTHER OPTIMIZING THE METHODOLOGY

The transfer learning methodology is applied to improve the accuracy of the detection model. Using an overhead data set, the model is additionally trained using 500 sample frames. The epoch size 40 and batch size 64 is set for training of the model. The training loss and accuracy curves are shown in model diagram above . A new layer is obtained after training the model; that is further appended with a pre-trained model. The model is now tested for the same test video sequences, as discussed in the above sub-section. The experimental findings reveal that transfer learning significantly increases the detection results, as seen. From the sample images, it can be visualized that the model detects the individuals at various scene locations. People with various characteristics are effectively-identified due to close interactions between people, violation is recorded by automated system. The same behavior can be found in output where people are around dozen in both and and violation in is three times as compared to multiple people are walking, and entering in the scene are detected and monitored. The framework effectively detected the breach of social distance between people and marked the bounding box as red rectangles if people are too close to each other.

Results of social distance monitoring, using transfer learning. It can be seen that the detection performance of the model is improved after transfer learning. In sample frames, the people in green rectangles maintain social distancing while in red rectangles are those who breach/violate the social distance

CHAPTER 5-RESULTS AND DISCUSSION

In this work, a deep learning-based social distance monitoring framework is presented using an overhead perspective. The pre-trained YOLOv3 paradigm is used for human detection. As a person's appearance, visibility, scale, size, shape, and pose vary significantly from an overhead view, the transfer learning method is adopted to improve the pre-trained model's performance

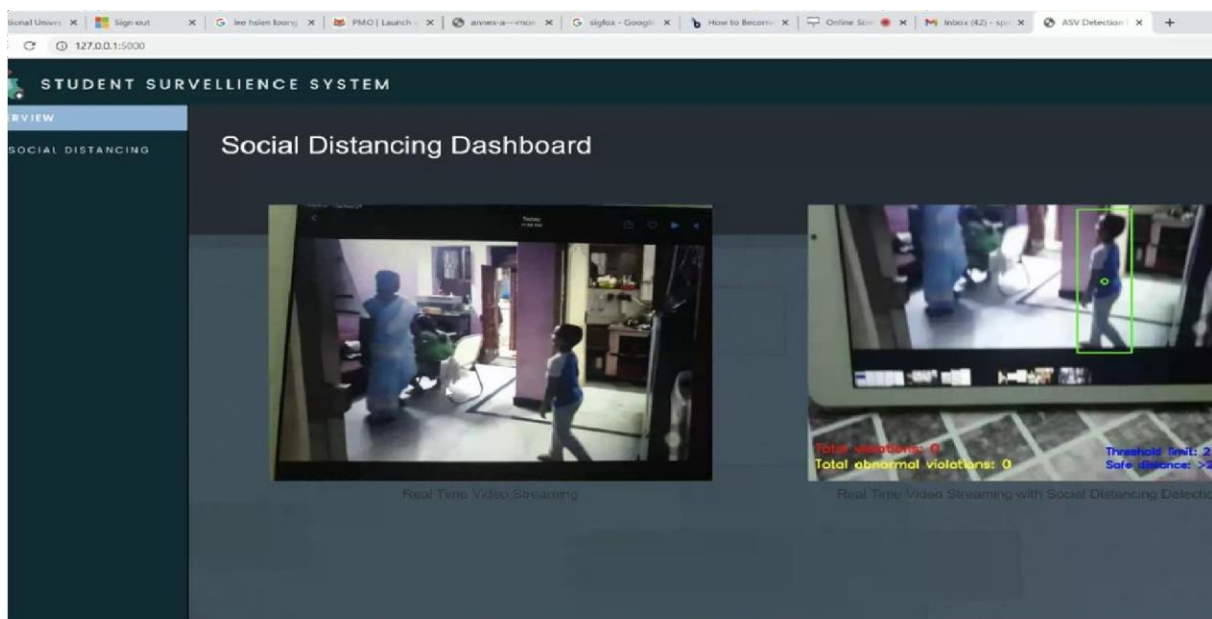


Fig 5.1: Home Page

The Fig 5.1 is the home page of the project. This page will appear once the user or the admin make a log-in into the portal. It is the frontend of the project or it can also be termed as user interface. Here the user gets the multiple options to execute or access their task as per need. It also contains the news feed from where we can get various types or different types of information.

The model is trained on an overhead data set, and the newly trained layer is appended with the existing model. To the best of our knowledge, this work is the first attempt that utilized transfer learning for a deep learning-based detection paradigm, used for overhead perspective social distance monitoring. The detection model gives bounding box information, containing centroid coordinates information. Using the Euclidean distance, the pairwise centroid distances between detected bounding boxes are measured. To check social distance violations between people, an approximation of physical distance to the pixel is used, and a threshold is defined. A violation threshold is used to check if the distance value violates the minimum social distance set or not. Furthermore, a centroid tracking algorithm is used for tracking peoples in the scene. Experimental results indicated that the framework efficiently identifies people

walking too close and violates social

distancing; also, the transfer learning methodology increases the detection model's overall efficiency and accuracy

```
* Debug mode: off
* Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
127.0.0.1 - - [25/Feb/2021 05:34:06] "GET / HTTP/1.1" 200 -
127.0.0.1 - - [25/Feb/2021 05:34:07] "GET /video_feed HTTP/1.1" 200 -

[INFO] Sending mail...
[INFO] Mail sent

[INFO] Sending mail...
[INFO] Mail sent

[INFO] Sending mail...
[INFO] Mail sent
```

Fig 5.2: program output in interactive mode

The model is trained on an overhead data set, and the newly trained layer is appended with the existing model. To the best of our knowledge, this work is the first attempt that utilized transfer learning for a deep learning-based detection paradigm, used for overhead perspective social distance monitoring. The detection model gives bounding box information, containing centroid coordinates information..

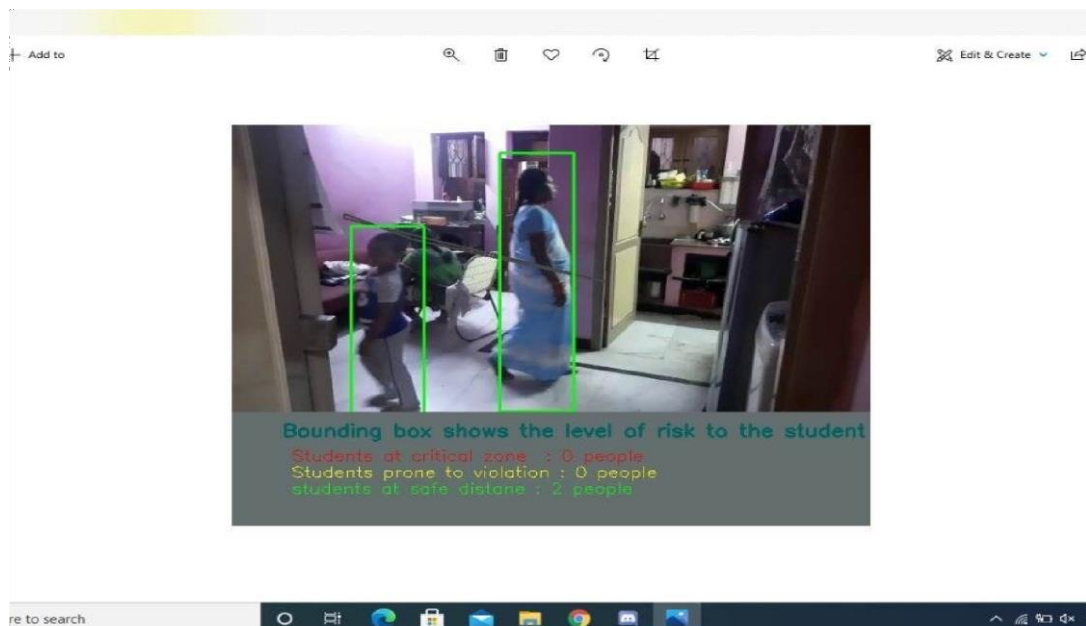


Fig 5.3: Log-In Page

The Fig 5.3 the module detects the human objects. The difference between this case is that it is tracking a live footage directly from sources like cctvs or cameras. It also provides real time information such as number of human objects detected, location and all such details. Results of social distance monitoring, using transfer learning. It can be seen that the detection performance of the model is improved after transfer learning. In sample frames, the people in green rectangles maintain social distancing while in red rectangles are those who breach/violate the social distance

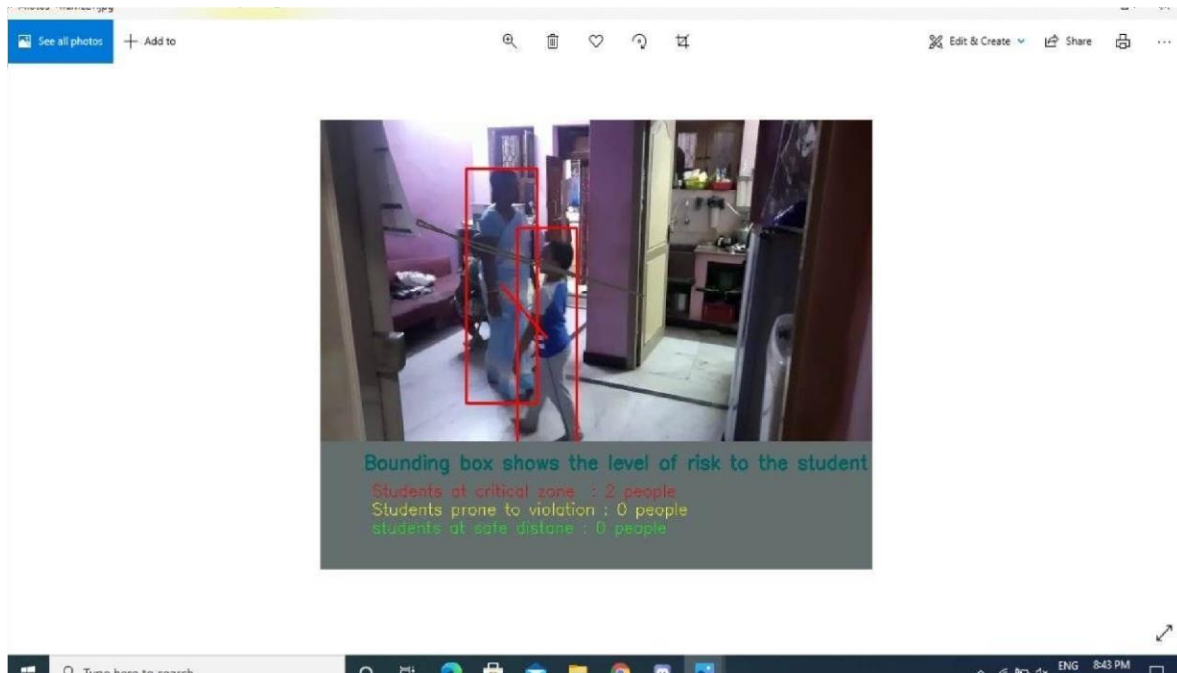


Fig 5.4: Negative detection

The Fig 5.4 shows that the human objects within the frame are inside of the threshold range and hence they are marked by a red aura. Note that this is still real time tracking and the output changes constantly live. However, in some cases, the person's appearance is changing; therefore, the model gives miss detections. The reason for miss detection may be, as the pre-trained model is applied, and an individual's appearance from an overhead view is changing, which may be misleading for the model.

Social distance monitoring from an overhead view using a pre-trained detection model. In sample frames, the people in green rectangles are those who maintain the social distancing. The people who violate the social distance threshold are shown red in rectangles. The manually labels yellow positive cross shows miss detections.

In this work, a deep learning-based social distance monitoring framework is presented using an overhead perspective. The pre-trained YOLOv3 paradigm is used for human detection. As a person's appearance, visibility, scale, size, shape, and pose vary significantly from an overhead view, the transfer learning method is adopted to improve the pre-trained model's performance. The model is trained on an overhead data set, and the newly trained layer is appended with the existing model.

To the best of our knowledge, this work is the first attempt that utilized transfer learning for a deep learning-based detection paradigm, used for overhead perspective social distance monitoring. The detection model gives bounding box information, containing centroid coordinates information.

Using the Euclidean distance, the pairwise centroid distances between detected bounding boxes are measured. To check social distance violations between people, an approximation of physical distance to the pixel is used, and a threshold is defined.

A violation threshold is used to check if the distance value violates the minimum social distance set or not. Furthermore, a centroid tracking algorithm is used for tracking peoples in the scene. This portal can be logged in by both admin and the user.

The admin can log-in to check the working of the portal and to maintain the database. The user log-in to access the portal and report crime. The admin provides the required security to the users so that the data does not get deleted or leaked. The user interface contains the log in or registers form.

Experimental results indicated that the framework efficiently identifies people walking too close and violates social distancing; also, the transfer learning methodology increases the detection model's overall efficiency and accuracy. For a pre-trained model without transfer learning, the model achieves detection accuracy of 92% and 95% with transfer learning. The tracking accuracy of the model is 95%. The work may be improved in the future for different indoor and outdoor environments.

Different detection and tracking algorithms might be used to help track the person or people who are violating or breaches the social distancing threshold. From the results, it can be seen that transfer learning improved the results significantly for the overhead view data set.

The false detection rate of different deep learning models are very small, about 0.7–0.4% without any training, which reveals the effectiveness of deep learning models. Different pre-trained object detection models are tested on the overhead data set.

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SOCIAL DISTANCE ALERT SYSTEM

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ABSTRACT

The World Health Organization (WHO) has concluded coronavirus as an epidemic. The huge number of proper vaccines helps to lower levels of immunity against COVID-19. Due to lack of needed vaccine treatment, the sole options left to the last fight against this pandemic are lockdown selfcare and social distance. This work offers an easy autonomous monitoring system on social distancing using machine learning techniques. The proposed architecture helps detect humans as objects here identify their distance between each other. This surveillance detects the 9 future violations of social distance utilizing webcam or CCTV cameras. The proposed framework uses the infamous YOLOv3 object-detection 10 model built on the COCO dataset and went to classify human class among classes. The bounding-box's dimensions and centroid coordinates are computed within the two-dimensional feature space from the pairwise vectorized L2 norm and a 12 threshold is fixed for computing the space maintained between each other. We illustrate the superior performance of our framework and check it against other states of the humanities regarding inference speed, mean average precision and loss defined 14 from the localization.

Key words: coronavirus, social distancing, YOLO, COCO, classroom monitoring, real-time detection.

1. INTRODUCTION

The major concern of this time and age is covid-19 and its uncontrollable rapid spread. Although there are several kinds of means being discovered and being implemented, the coronavirus case seems too hard to be controlled properly. Until and unless we have a solid means to properly discover and distribute adequate vaccines, we will not stop the spread of this disease. Even if we overcome this pandemic, we will be faced with another challenge just like this sooner or later. In this day and age of technology revolution, we must try to utilize the maximum efficiency of technology to find a solution to this problem. Machine learning, Big data, Deep learning are all rising rapidly and they are all of great use for solving the pandemic problem. This project is inspired by technology and computer science and the main goal is to find a good solution for humans to maintain and regulate the spread of disease. Social distancing is a way to control the spread so we have decided to technically aid the process of social distancing with help of computer science technologies such as machine learning and

programming. This project gives the identification of human objects and social distance observing as a careful step in diminishing actual contact between humans. This examination centers around recognizing individuals in territories of interest utilizing the Single Shot Multibox Detector (SSD) object following model and OpenCV for picture preparation. The distance will be registered between the people identified in the caught film and afterward contrasted with a fixed pixels' qualities. The distance is estimated between people in the divided following territory. With the identification of perilous distances between individuals, alarms or alerts can be given to protect the distance. Notwithstanding friendly distance measures, another critical component of the framework is recognizing the presence of individuals in confined territories, which can likewise be utilized to trigger alerts.

2. BACKGROUND

The effect, and the entrance of online media have significantly adjusted the range of object detection and machine learning. The presentation of reasonable contraptions, and an extremely low worth web esteem has extra to its span. In Asian nations even distant

towns approach reasonable telephones and internet providers. Despite the fact that this square measures different benefits of these administrations. Anyway it comes at a worth, the expense of expedient spread of adulterated information alongside validate data. Most recent ten years have seen complex increment inside the quantity of clients via online media, and the microblogging. The information/text possible on these locales in the sort of information , online journals, posts , audits, conclusions, ideas, contentions, remarks, and so on gives development inside the field of methods and ways inside the legitimacy of those posts. A few computer scientists have been directed to any place and AI is utilized to precisely locate the false news things. Likewise, hardly any investigation works are led investigating profound learning for motorcar highlight extraction in fake news identifiers.

2. LITERATURE REVIEW

Two examples for the foremost thought ways in which on the one stage cluster are you merely Look Once [4] eleven and Single Shot Detector architectures. The outputs of the 2 architectures are the bounding boxes on each discovered issue, with the category name and therefore the confidence score of it, but not the all of the icon. These are places to heaps of habitually divided locations and to numerous scales and aspect-ratio of rectangles named boxes. In 2017, Dr. Kandy pazman and his co-researchers came up with a planned a system for human detection and crowd International analysis [5].

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mistreatment of raspberry pi and OpenCV. A unique classifier was trained for human detection from the scene and it's trained mistreatment Haar classifier technique over the OpenCV. The main plan of their objective was to record the human crammed scene mistreatment of the camera and Raspberry pi that incorporates a four core ARM version eight electronic equipment that processes the video each frame by frame. The count variety of humans is measured and therefore the human crowd is detected and analysed by analysing every single unit of pixels. The worth with our specific threshold that we've set and if it crosses over the edge then the interference are often done consequently [4] . In 2016, David Joseph

Joel and his co-researchers articulated a system of traffic dense detection that was primarily based upon image/object process. The length of sequence and its densities were detected by mistreatment from the pictures taken from the cctv-camera. The video capture was recorded and developed then formal logic was enforced over the recording to handle the thought of ultimate outcome of image detection. The partial truth concept's result is also fully true or utterly false. Mark Tash Knickerman wrote an editorial in 2020 a few social distancing detectors centered on OpenCV, COCO dataset and Machine learning. The article focuses on social distance trailing through CCTV cameras mounted throughout the pandemic amount and sheds light-weight on social distancing throughout the pandemic amount. The module focuses on social distance watching through the employment of CCTV cameras settled throughout the region. As a social distancing detector, the camera records the space between individuals in pixels and compares it to a typical measure. The principle for this social distance detector application is held within the code. This file and therefore the python script are answerable for process over frames in an exceedingly video stream and guaranteeing that none of them are getting ready to one another that ultimately results in the quick unfold of sickness.

3. METHODS

In this section, we tend to initially begin with the article detection pipeline. As illustrated in linguistics, the network is constructed on top of the classic convolutional neural network. Afterwards, the details are provided of the neural network architectures used for this job. Eventually, implementation details and lost performance are introduced.

3.1. NETWORK ARCHITECTURE

Initially we decided to build our framework on the YOLO model. Each bounding box object that's detected is the design output, its score of confidence and cluster that area unit a group of systemically spaced coordinates and for various ratios and scales of rectangles named boxes. YOLO method might create the prediction of its kind Associate in Nursing position of an object simply by seeing the image one time. YOLO takes under consideration object

identification issues as regression jobs in situ of category verification to portion anchor class chance boxes. one convolution predicts the network and also the bounding boxes for every category beside their category potential faults. YOLO got four main versions: v1, v2, v3 also v4. v1 of YOLO is impressed by the designed Google Net (Startup network) for classification of objects within the photograph. Twenty four rolled-up layers and 2 connected fully method layers consist of the network. YOLO in situ of modules for origin used via Google Net v1 is four square layers for reduction and it follows layers that's con41 evolutionary. Then, YOLO v2 considerably improved the accuracy and became additional quick. YOLO v2 utilizes Darknet-19 for the most network. classification of objects utilizes Associate in Nursing output soft max layer, nineteen convolution two layers, and 5 most pooling layers . YOLO V2

3.2. COCO DATASET

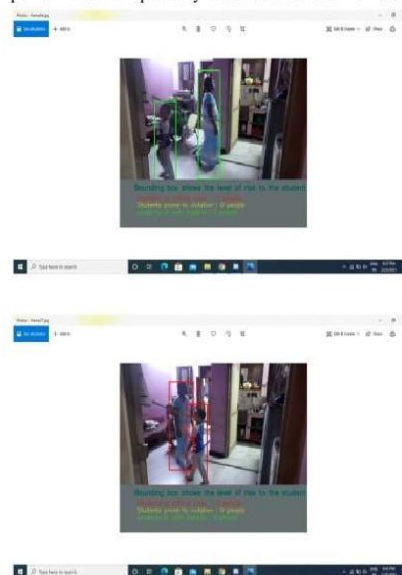
For a stronger performance of preciseness (mAP), a fashionable dataset is needed. The model was trained on Cocos nucifera information set with a complete sixty four thousand 100 and fifteen picture of individuals that solid mAP improvement on Pascal VOC data set within the company of 2 thousand pictures of individuals. the quantity of the thirteen categories doesn't notably result in the speed of the reasoning. The model of one category rumored to be zero. The independent agency additional quick from the model of eighty categories. However, the amount of parameters directly impacts the reasoning time. The absolutely connected layers quantity parameters are directly accomplished by the categories suppression on the network, that though could be a little a part of the entire model.

3.3. IMPLEMENTATION DETAILS

The footage was taken in my house with my family members walking close and from a distance off from each different to check the operating and detection of the model. Also just in case of quicker RCNN, the pictures from the dataset and evaluating photos are size modified to pixels of P within the edge that is shorter that has 600 and one thousand and twenty four to low and top quality, throughout the time that ten on YOLO the photos get scaled to the stable dimension p x p among p valued four hundred and

performed considerably higher than its last version (YOLO three v1). improvement in AP, classification of objects score and independent agency. As opposed, YOLO V makes multiple label four classifications victimization supplying classifiers instead of utilizing softmax. in contrast to Darknet-19, Darknet-53 currently that is consisted from blocks (short links) within the company of high sampling layers to change of integrity additionally for the depth of half dozen network. YOLO V3 produces three predictions to each abstraction position in varied scales in one picture and takes away the difficulty of not detecting tiny objects expeditiously . every forecast is calculated and half-track. Figure one shows safe distance and figure two shows restricted distance.

sixteen. within the time of coaching, the models performance is repeatedly watched and result is noted



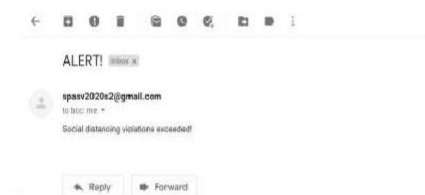
3.4 DISTANCE ESTIMATION

The trained model of YOLO V3 is then used for look at the social distance on the investigation camera which can be used by any public or private fifteen and even will be deployed edgy devices for

a period of time standalone police investigation. We have tested the model with sixteen oxford city center dataset and period of time CCTV footage deployed at many civil areas .The video is nothing but a sequence of frames. The model plots the gap between every and each person in seven the frame. Suppose person 'A' is within the locality of person 'B' and also the model computes the gap between eight of them. If the gap is within the vary of the fastened threshold , it marks as quick values, if it lies outside the vary, it nine marks as a safe zone. In this case, the human object B(2nd one relative) is taken as a base object. The similar approach is followed for multiple ten individuals. Even just in case of multiple individuals, everyone is taken base reference with various to the latter gift eleven in their locality. As an example, C, D, E, F, G, H, I, J. If A, B, C, D area units along, all of twelve of them could be a base of relevance to one another. This multiple freelance reference approach will offer correct results thirteen while not exploiting any leaf turned down.

3.5 RESULTS FROM EXPERIMENT

The experiment finally offers output in two ways in which one could be a series of pictures with info concerning the number of individuals violating the social distancing rule. The authorities or employees accountable will read these pictures and regulate the watching. The pictures have all details like no individuals, time and place. the opposite output is in variety of associate degree alert message sent which might apprise the individual that they're presently violating and quickly reposition themselves..



4. DISCUSSION

We suggest a way for person detection furthermore as distance estimation in videos. This work aims to provide a vision-based work for all situations and plots the space between everyone that was captured within the video frame. we have a tendency to create a comparison of state-of-the-arts on detection of objects architectures fifteen and YOLO V3 outperformed SSD and quicker RCNN in terms of logical thinking independent agency and accuracy. The model conjointly provides a footing device compatibility which might be deployed as a standalone device and may be monitored remotely anyplace and anytime. moreover the distances non inheritable from the model are often used as applied math parameters. Statistical physics and epidemic processes analysis got a powerful history along with conversant predictions concerning epidemic spreading are often created victimized values obtained from basic mathematical models fitted to the applied math information.

The biggest impact from this work would be a foreign watching police work on social distancing within the lcivilian areas. This police work may facilitate in watching the areas whether or not social distancing is maintained so as to prevent the human-to-human transmission of coronavirus. several governments are lifting up the imprisonment, however the social distancing norm remains constant in the majority countries. Hence, the models are often deployed close to airports, looking complexes, workplaces, restaurants, transport depots, markets, and many civilian prone areas wherever dense crowds are often expected throughout their economic

activity. Because the vaccines have not nonetheless been shaped, a lot of care is needed to take care of the 2 dimensional corona curve.

To achieve this, stopping the fast and wide spreading is only the sole possibility neglected to any or all nations. Hence, strict police work is the foremost priority for the governments to confirm human-to-human transmission doesn't occur, particularly thanks to breaking social twenty one distancing norms. The long run work lies in deploying mask detection and temperature detection of every person within the crowd. twenty three Combining multiple models in an associate ensemble learning framework is instrumental for the end-to-end pipeline for complete watching of every person. an individual inadvertently might have covid symptoms, and may be copied simply and stop the unintentional transmission.

8. CONCLUSION

Social Distancing would without doubt be the foremost necessary issue as COVID spreads through shut contact with infected ones. As so much as individuals are a unit maintaining a secure distance they might be indicated with no alert and because the cctv captures additional and additional crowd gathering, Email would pop-up and therefore the state of affairs will return in check forthwith. As for the second module, the observations made by someone like faculty workers or authorities within the public areas like theatres, malls etc will quickly browse once and they can easily locate wherever the person violating the social distancing is present and might do their individual jobs respectively. So implementing this research and models is a simple, cheap and hassle free solution for observing and regulating social distancing. It is very efficient and an easy solution for any public gatherings with places where they could afford a separate human workforce to monitor the systems. Another crucial and important factor about this project is that this project can be expanded and furthermore developed with help of more technical implementation such as AI which can automatically monitor the people and find individuals respectively. It is an easy to do module but as we lack enough resources we have decided to not implement the AI module but the project can be expanded by other institutes with AI if they wish to do so with

availability to more resources. The main objective of the project was to provide a helpful and useful method to maintain social distancing in places where it is most necessary with the already existing simple/easy to access technologies such as cctv cameras, webcams, etc..

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B.JOURNEY PAPER

SOCIAL DISTANCE ALERT SYSTEM

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