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Automated Covid-19 Safety Monitoring System

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ABSTRACT: As we know, this year is the year of pandemic i.e corona virus (SARS-CoV-2). It's the first case was discovered in Wuhan, China in December 2019. Since then it has spread all over the world and affected each and every country in terms of both health and wealth. Covid-19 symptoms are variable but commonly they are Cough, Sneezing, difficulty in breathing and ache in body. Due to this covid-19 pandemic many countries have gone through lockdown. Social Distancing and Wearing mask is the only solution recommended by World Health Organization to escape this Pandemic. And in many MNC Working staff has also been reduced to 50% of their total working strength. The government has initialized the policy of 6-feet distancing between people in hospitals, shopping Malls, schools and different organizations. And it is also mandatory to wear mask all the time outside their home. In this Research we have developed a system which can monitor the people in different places that they are following the government policies (such as maintaining social distancing and Wearing Mask). For this model we are using different deep learning concepts and Yolov3 based framework for accuracy in detecting People and ResNet50 model for more efficient Mapping purpose as it is a 50 layer Network Model. This project will tell us the clustering of people without wearing Mask in high risk Zones. It will show bounding boxes over people and over their face if they are Maintaining Guidelines then a green box will appear on their face and over them too. If they are not following either of the guideline it will show red bounding box in response to that. Further a status bar will appear at the top of the output window which lists the total number of people in the frame and out of them how many are safe and how many are unsafe on the basis of people wearing the mask and maintaining social distancing.

KEYWORDS: ResNet50, Clustering, Yolov3, R-CNN, Face Mask Classifier.

I. INTRODUCTION

A genetic variant hit the world in 2019 lately when everyone around the world was ready for stepping into the next year. World was unaware of this strain until it broke out in 2020 and has been declared as Pandemic. From the streets of Wuhan (china) it spread into the whole world severely affecting the life of many in one way or the other. Almost every country put a travel ban on international travelling, many practiced isolation just to stop the spread of Covid-19.

The term covid-19 is the short form where CO stands for Corona,VI means Virus and D is for Disease followed by numeric 19 which indicates that the virus has been discovered in 2019. Today as per the statistics more than 79 million people around the world have been infected with the covid-19 and over 1.7 million have lost their life to it. The best precaution anybody can take to avoid the spread of infectious disease is to maintain a physical distance of 6 feet from other people around and to wear a mask covering the mouth and nose of the person wearing it. This can help largely to stop the transmission of the virus from person to person. Now when the virus is changing its form so fast in its habitat in some parts of the world the conditions might become much more severe. After a year of the introduction of this novel virus the situation is still worse but people have learned to live and deal with the plight. People have started to get back to their work. Markets and other public places have been opening with regulations like wearing masks and maintaining social distancing. We have tried to design a system which can monitor people if they are following the rules or not. This system reads each frame of a video and tells if the people in the video are wearing a mask and maintaining social distancing and if not so then it shows a red bounding box around the face or the body of the person breaking the rules. With great efficiency the project can detect the people following guidelines and those who are breaking it and

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the system could be of great worth if integrated with the cctv streams coming from various public places. For now the system can be used for the computer based analysis of people in recorded videos.

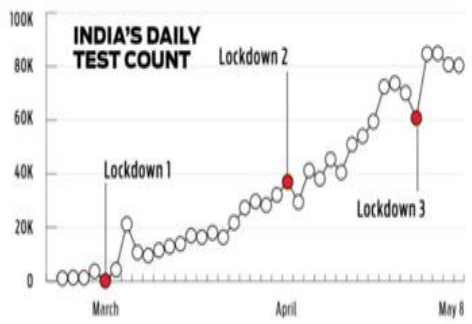

Fig.1 Covid-19 Graph Source: ICMR, Our World in DATA

More details about the system are explained in upcoming sections of the paper .

II. RELATED WORK

As we know there are still many Medical Institutes and Pharmaceutical Companies that are trying to find the cure of Covid-19 respiratory infectious disease. But no definite solution has been found. And Controlling of such a hazardous disease is not possible without proper vaccination. So to decrease its spread worldwide many people have created solutions related to Mask- detection and social distancing Monitoring. First real time Face detection model was created in 2004 and was called viola jones. Since then various practices related to face detection took place. By using Haar feature and cascaded structure it can perform real time Face Detection, as its boons it also has few drawbacks,

i.e. large feature size and low recognition rate for complex situations like multiple faces with some masked and blur once too. And now we are using improvised algorithm such as R-CNN (Region based Convolutional Neural Networks) and SSD that can perform a large range of object detections. R-CNN was developed in November, 2013 .It begins by implementing Selective Search to ROI (Regions of Interest), where ROI represents the boundaries of the object detected in a frame. And for its ROI features we use SVM (Support Vector Machine) to determine the type of Object.

Then Fast R-CNN was introduced in April, 2015. It uses Selective search as Regional Proposals generator. It runs the Neural Network on the Whole frame of Image to increase its performance. And further on Faster R-CNN was introduced in June 2015. It integrates the generated ROI into the neural Networks only.

Initially YOLO9000 was used for object detection which can detect approximately 9000 categories of objects. But then an improved and faster version was developed to cop up with the speed of frames per second and variety of objects that can be detected. With 40 FPS, YOLOv2 gets 78.6 mAP that can easily outperform Faster R-CNN with Resnet and SSD and still it process faster than these two. Then a 53 Convolutional layer was created i.e YOLOv3 that shows an incremental improvement in accuracy and speedy recognitions.

III. METHODOLOGIES

Four step solution is proposed in the research for the implementation of this model to be beneficial and accurate for measuring the risk level in different places.This model includes person detection, face mask classifier, Data augmentation and social distancing monitoring. The system can be connected to all type of video footage taken from a CCTV cameras. With any resolution from 480P to 4K with real time performance and real time data from CCTV. Hence, the further detail explained below:-

$$b_x = \sigma(t_x) + c_x$$
$$b_y = \sigma(t_y) + c_y$$
$$b_w = p_w e^{t_w}$$
$$b_h = p_h e^{t_h}$$

Fig.**2** Flow Chart For the Working of Project

A. Person Detection:-

It is the first stage in developing the system. The main aim of the system is to detect people based on the parameters such as when they are stationary and when they are in motion. For the purpose of object detection we have used the YOLO (you only look once) model to overcome the scenario of fast changing frames of the video. Version 3 of the YOLO model was used to get the bounding boxes around the people in the video. Different resolution videos can be processed through the system to get the output. Lesser the resolution of the video leads to more speedy results but a lesser amount of accuracy whereas on increasing the video resolution results with higher accuracy can be obtained. YOLO v3 is based on a 53 layered network which is a variant of the

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darknet and is trained on imagenet. For the detection task another 53 layers are stacked onto it leading to a 106 layered convolution architecture which is the main reason for the slowness of the YOLO v3.

For obtaining the bounding box prediction over each person we are using the following formulas.

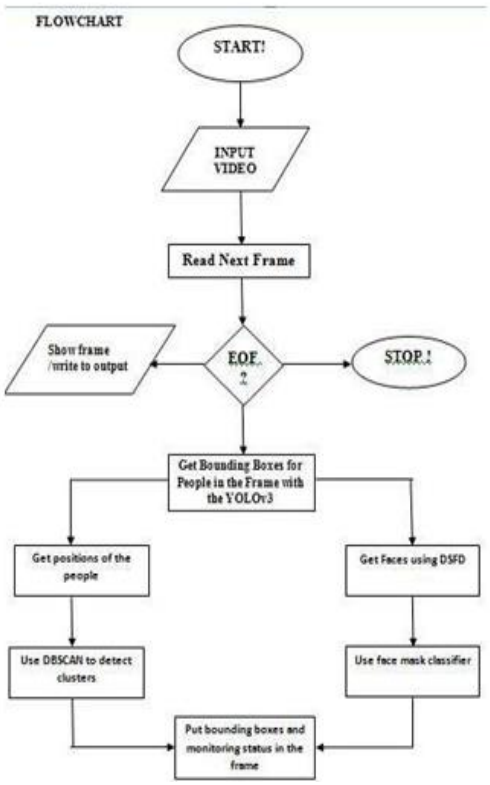

Fig.3 Formula for bounding boxes in YOLOv3
Source: Stack overflow

The coordinates of the predictions are bx, by, bw, bh which denotes the x, y center coordinates, width and height and tx, ty, tw, th are the network outputs. cx and cy are the top left coordinates of the grid. pw and ph are the anchors dimensions for the box.

B. Face Mask Classifier:-

It is the second step in the implementation of the solution. We are using Resnet50 (that stands for Residual Networks) Keras model for this purpose. It is a 50 layers deep convolutional neural network. A million number of images have already been trained in this ImageNet database. The images can be classified into 1000 object categories, such as keyboard, mouse, pencil, and many animals using this pretrained network.

For Working of this model accurately. It requires a diverse dataset which includes various orientations, various lighting conditions and blurring effects.such as Gaussian blur effect, motion blur, average blur. They have been used in order to reduce the image noise and increase the accuracy of the system to detect the people whether they are wearing masks properly or not.In it a mask classifier model is created in which we are passing face-coordinates in the image. If mask Classifier prediction value is less than 0.5 then a green bounding box will appear on the face which indicates that the person is wearing a mask else not wearing one.

C. Data Augmentation:-

It is used in projects to increase the amount of relevant data from given dataset. To achieve data augmentation we just need to make some minor changes or alters inour existing data like translation, viewpoint, rotation and implementing different types of blurring effects such as Gaussian blur, Average blur , Motion Blur. In real time projects we may have a limited dataset but the demand for output needs much more variety in data to predict accurate solution and we can achieve that by training our usual original data with synthetically created augmented data.

D. Social distancing monitoring:-

Social distancing is the next important parameter in order to control the spread of covid-19. For monitoring physical distancing in the system each frame of the video has been examined. Next step is to find the coordinates of the people detected in the frame and after we get the coordinates, DBSCAN which is a clustering algorithm has been applied to the coordinates of the people to form the clusters of the coordinates. DBSCAN algorithm works on two constants namely epsilon value and minimum points, the epsilon value was set equal to the threshold distance (the minimum distance needed to be maintained between two people) which can be altered according to the video being captured as this value can affect the results of the system largely and the minimum point is set equals to two for the formation of the cluster. Due to the robustness of the DBSCAN algorithm the outlier can be separated very easily from the clusters. After the formation of the clusters, people who were lying outside the cluster were considered to be safe and those lying inside the clusters were bound by red boxes showing unsafe distancing.

IV. CONCLUSION

The system developed using various deep learning algorithms can be used during the

pandemic time over public places to monitor the physical distancing and having masked faces to lesser the probability of spreading of corona virus. First of all YOLO model was used to capture and process each frame of a video for object detection then using Resnet50 classification model it compares the detected faces with pretrained dataset for different situations like blurred images or when the person is in motion . Using DBSCAN clustering for recognizing the people forming clusters or disobeying physical distancing were marked with red bounding boxes and those following the safe distancing and wearing a mask were marked with green bounding boxes. We can use this system for many places like hospitals, banks, offices, schools, colleges and malls etc.

The main limitations faced by the system is that if high resolution video is processed then it provides the high accuracy results but the speed of the system becomes very slow and to obtain faster results the quality of the video can be compromised but it eventually leads to the lesser result accuracy.

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