SOCIAL DISTANCING MONITORING SYSTEM FOR COVID-19

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ABSTRACT

Many people are infecting by Conona virus. To break the chain of corona virus, the World Health Origination (WHO) recommended social Distancing. It is non-Pharmaceutical treatment to prevent influence of corona virus. These day's To maintaining social distancing the police playing important role. But due to that many police man's and guard's are infected by corona virus. So we proposed social distancing monitoring project. This system maintain social distancing without human. Through camera it detect people, Getting 360 degree overview of an area and track the people also measure Euclidean distance, If they are Limited (10 or less than 10) people (limitation pre-fixed in Python coding) and violate socially distancing, then it emit laser beam on that particular person those who are not following Social Distancing and buzzer get on. If crowd is detected (more than 10 people) and violating social distancing norms then laser emit laser beam on particular person and announce for to maintain social distance. Up to five announcement if people not separated socially then automatically system will be send alert SMS to Authorized staff.

Keywords: Social Distancing, Covid-19, People Detection, People Tracking, Deep Learning, Monitoring, SMS alert, Video surveillance, Turret.

I.   INTRODUCTION

Now the days Covid-19 goes out of control. World Health Organization (WHO) Announced pandemic situation on May 2020 [1][2]. The India Facing second stage of Corona. It is the most essential to maintain a social Distancing (SD) in a public place Without any emergency work avoid public place also avoid gathering. Many scientist and researchers continuously working on to find out vaccine for corona virus, But no success has been reported yet. So won against Covid-19 without any vaccine SD is very best way. As per guideline of WHO that is 6 feet (2 Meter) minimum distance must be maintain[3]. Because without symptoms can carry Corona virus[4]. So other people can be easily infected. As per many research SD is very best way to break the chain of Covid-19[5][6][7]. To decrease the influence of corona virus, the police playing very important role. But rapidly increase cases of covid-19 many Guards and policeman's are infected by corona virus. It is not easy to watch 24-hour public and To prevent unnecessary movement and forcefully Maintain SD by human. On such a situation the system able to work.

This is advanced project which can use indoor as well as outdoor. It detect people and track them also major distance between them. The raspberry pi (Rpi) is main components of project using night vision camera it is captured video frame by frame. Camera is mounted on 360 degree rotation stepper motor so it covered 360 degree area. After captured the video, by image processing it detect the people and track the position them, also measure euclidean distance. Suppose limited 10 people at any particular area (limitation pre-fixed by coding) and if the system detect 10 people or less than 10 people but they are not following SD then buzzer get on and activate laser Torrent to emit laser beam on particular person those who are not following SD. In another conditions, 10 or less then 10 People detected **but following SD**, system will be stop further process. Now in next condition. If system detected more than 10 people but following SD then system gives automatic announcement. Which are prerecorded like " *Due to increase influence of Corona virus more than 10 people are strictly prohibited in this area, please! do not come in social place without any emergency condition".* In next condition if more than 10 people are detected **but not following SD** then immediately activate laser Torrent and emit laser beam on that particular person those who are not following SD, and announced there like " *do not roam socially, please maintain social distancing. More than 10 people are strictly prohibited in this area otherwise police can take strict action against you*" after five announcement crowed not decrease as well as violate SD norms then automatic alert SMS will be sent to authorized Person.

II.   LITERATATURE SURVEY

Many researchers are research and introduced their own theory about contagious diseases. In that one research is 2/3 modeling system. This system compute the theoretical number of infected people. It is SIR (Susceptible Infection or Recovered) mode[9][8]. Kermack and McKendrick models are introduced in 1927[8]. It's common SIR model. Now latest model of SIR introduced by Ekset al[9]. It is introduced SD parameter. It determine number of infected and recovered person. In the critical situation of covid-19. The government also involved to making SD project and some practical like only emergency services are opened and nonessentials services like club, bar, border sealed, schools, some businesses are totally closed. Also announcing to maintain SD from each others and telecasting on news channel, advertisements. 1.6 to 2 meters are safe distance to prevent that contagious diseases[11]. But some percentage staff are allowed by government for working like Bank's, hospitals, water supplier, milk suppliers. Because it is essential for life. All over world there are number of scientist and researchers are research on vaccine for covid-19. But not any success has been recorded. There are many countries infected by these virus. It's rapidly increases. So that, the many country's are using different-different technologies to inhabit the influence of covid-19. In some country's using GPS technology gives alert notification on mobile. If any individual are infected in that an area also alert notification of suspected person. Due that infected and suspected individual's are easily know at any area[12][13][14]. The Indian government developed " *Aarogya setu*" Mobile application. Which work on GPS and Bluetooth model. By this applications government can easily find out covid-19 patients in any region and alert to adjacent resident by SMS. So adjacent individual's maintain safe distance from that patients[15]. In some countries are used drone to detection a people and check people are socially separated or gathered. Also noticed that separation of population [16][17]. Some researchers used other techniques like human detection using wireless signal by identifying phase difference and change detection in amplitude waveforms Xin et al[8]. Comparison of some another survey done as shown in Table 1.

Table 1: Comparison Table on some another Survey Done

Sr. No.	PROJECT	TECHNIQUES	RESULT	ISSUE
1	Deep SOCIAL: Social Distancing Monitoring and Infection Risk Assessment in COVID-19 Pandemic	A YOLO based deep natural network	Detect, track and measure distance between people	system not able to Control
2	SOCIAL DISTANCING DETECTION SYSTEM WITH ARTIFICIAL INTELLIGENCE USING COMPUTER VISION AND DEEP LEARNING	ARTIFICIAL INTELLIGENCE	Detect, track the people Handel emergency situation	Can't able to Run time situation inform to people
3	An IoT System for Social Distancing and Emergency Management in Smart Cities Using Multi-Sensor Data	GPS system	Emergency management and inform authorized faculty	System can't be able to to aware to front huge crowd

III.   SYSTEMS ARCHITECTURE

The system operate on Raspberry pi (Rpi). It consists of couple Of components.

- Two axis pan and tilt bracket for laser or Pan/tilt hut.
- 1- Stepper Motor with Stepper Motor controller and 2- Servo motor.
- Speaker, Buzzer, laser.

- Night vision camera module with 15-pin FFC Ribbon cable Strip.
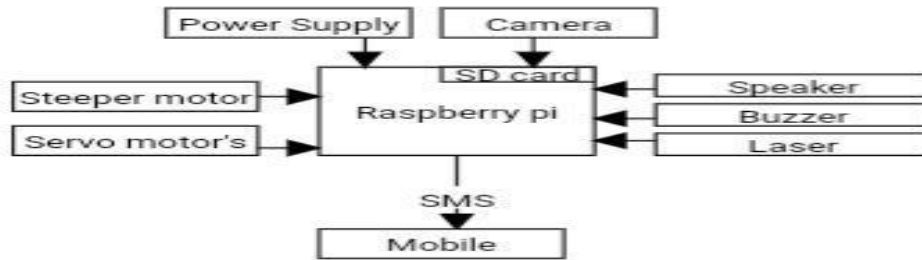- 5 volt output AC to DC charger, Jumper wires and Bread board.

Figure 1: System Block Diagram

IV.   MODELING AND ANALYSIS

1. Camera Module:

For video grabbing and apply image effect we are using **day night vision OV5647 5mp 1080p IR-cut** camera. It captured video and stored in SD card of Rpi. It attach up surface of "camera module port" of Rpi by ribbon cable strip. In camera module IR- cut filter is embedded. It also eliminate color distortion due to IR light in the day light. Plastic clip is on surface of Rpi pull up that clip and insert camera module ribbon cable. Then push clip return to back. On software part goes Into main menu go to the **Raspberry pi configuration** and select **Interface** tab and make camera is enabled.

2. Image Processing:

a) Object detection:

Detection object from grabbed video is main part of internal process. It is lot of challenging work because of probability of object in image or video frame dose exist or not, detecting classes and different colors. As per our observation some object detection algorithm's or model is RCNN[19], Fast RCNN[20], Faster RCNN[21], SSD[22], YOLO v1[23], YOLO v2[24], YOLO v3[25], YOLO v4[26] which is tested on PASCAL-VOC[27], MS-COCO[28].

We are using YOLO v4 [26]. Full form of YOLO is " You Only Look Once" which is combination of various technique. First version of YOLO was invented in 2016 after that in 2017, 2018 and 2020, YOLO updated it's version that is version 2, version 3 and version 4 respectively. Speed of YOLO determine in Frame Per Second (FPS). YOLO v4 has 62 FPS. This techniques achieve very good result. Result achievement depend on Backbone architecture, software, hardware and inputs. 416×416 and 608×608 are two standard size provide at input port of YOLO v4. It has 10%mAP (Main Average Precision) and 12%FPS (Frame Per Second). As we discussed achievement result depend on Backbone because of it is used to extract the essential features. That's why it performed better object detection. When object is detected YOLO enclosed detected object in abounding box which is nothing but "Anchor Box". It assign centroid for each detected object and make anchor box around detected object. But there are some challenges like it may be assigned more than one centroid on same detected object and also may be drew more than one anchor box. So it solved by "Non Max Suppression method" (NMS method). It compute " Intersection Over Union " (IOU)[30]. Suppose YOLO detect one person which has three anchor box that is Anchor Box-1, Anchor Box-2, Anchor Box-3. And qAnchor Box-3rd one is accurate for this person. But neural network can't be identify which one Anchor Box is accurate. So that's why NMS method are used. Anchor Box-1 and Anchor Box 2 are less intersected than anchor box-3. So by computing with IOU the NMS method will be select Anchor Box-3rd one is accurate.
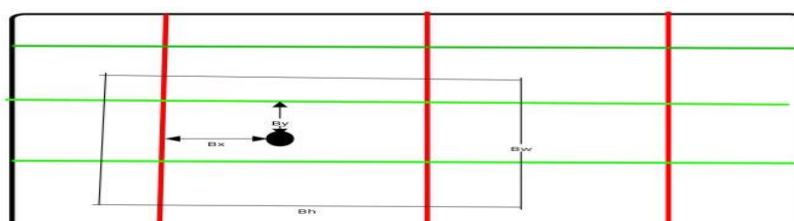

Figure 2: centroid localization

It work on Convolution Neural Network (CNN). Which present performance of PASCAL-VOC[27], MS-COCO[28] such model. Neural network train by thousand number of image. If it want to detect people class detect then before detection it train thousand number of images of the people shown in different angles. So it can detect people class with very less inaccurate. Output of CNN is in the vector form. Like [Pc Bx By Bh Bw C1 C2]. Where "Pc" for to detect probability of class, "Bx" for X-coordinate and " By" for Y- coordinate of centroid in grid cell, "Bh" is Height and "Bw" is Width of anchor box, also C1, C2 is define class whether it is person or dog or cat or car. Let's take one example [1 0.32 0.03 4 3 0 1] where Pc=1 it means probability of class is 1. So it can easily predict there are some object is present in the image. If Pc = 0 then remaining file doesn't matter. Bx and By is 0.32 and 0.03, Bh is 4, By is 3 and C1=1 so person dose exit in Image and C2 =0 so dog dose not exist. In figure 4: Shown 4×4 Grid. It has 16 cell. Here at 10th cell centroid is present. It gives out put in the from vector [29].

b) Object tracking:

It detect people and locate centroid with bounding anchor box for ever detected person. assign new ID for every centroid . Let's consider ID1 when it moves from previous location to next location it assigned same ID for both Centroid because this is same person only location has been changed. So it consider closest pair of centroid is same person. In such a way it track every old person assign ID for new person[31][32]

c) Distance measurement:

Once we detect person and track them we calculate Centroid of person 1 to other remaining centroids of persons that is "Euclidean Distance". To measuring Euclidean distance from ID1 then calculate from ID1 to ID2, ID3, ID4, ID5 and so on, except reverse pair. If that distance is less than threshold value then it will change color of anchor box from green to red. Anchor Box using "maths.sqrt()" function in "Python". It can easily find out distance between centroid or Euclidean distance. We are using here "Pair wise distance" method to measure Euclidean distance. This method is used for map pixels to measurable units[33].

3. Steeper Motor and driver:

We mounted pan/tilt laser turret and camera module on stepper motor. This set up is use to capturing video in 360° overview. We used model **28BYJ-48 stepper** motor and **ULN2003A** steeper motor driver. The Stepper motor operate on 5 volt DC power. It has 1/64 gear's and moves by 0.087890625 per step. This takes 4096 steps for 360° rotation. Our application for steeper motor is not heavy so it will not wear overtime . The motor "28BYJ-48" has four wire which is connected to driver 'ULN2003A' again connected driver to Rpi. GPIO pin of Rpi is 17,18,21,22 are connected to In Wire that is 1IN (blue), 2IN (pink), 3IN(Yellow), 4IN(Orange) respectively.

4. Buzzer for Buzzing:

If limited people detected on service line area but they are violating SD, then laser beam emit on that particular persons those who are not following SD norms simultaneously, buzzer will start to buzzing . We are using Active Buzzer. An active buzzer can be connected just like as LED. First of all we import the library for GPIO and sleep. The next step is to initialize pin 23 as output pin with **GPIO.setup() function**. The while true loop run over and over, forever the much loop, we make a beep sound with **GPIO.output() function** and "**pause**" the program for SD violation. With **sleep()** function[37]. Pin connection of laser model with Raspberry pi is to connect GND (black) and Vcc (red) of buzzer to Rpi of GND and Pin no. 23 respectively.

5. Laser turret or Pan/tilt Hat:
a) Laser sensor/module:

We use laser emitter Model **KY-008**. It operating voltage is 5volt and current is less than 40mA. Which emit laser beam on those person who are not fallowing. Laser module Pin connection with Rpi is connect GPIO pin 11 and GND Pin are connect to Signal (S) and GND respectively.

b) Pan and tilt turret or Pan/tilt Hat:

Figure 3: Pan and Tilt bracket/case for laser module holding

We used pan/tilt Bracket to hold laser module. There are two **SG-90 servo** motor used. Which is rotate 180° Pan angle and 180° Tilt angle. Operating Voltage servo motor +5V typically. Torque is 2.5kg/cm and Operating speed is 0.1s/60°, Rotation is 0°-180°. Due to it's 9 gram light weight we selected specially this type of motor because this set up fixed on BYJ-48 steeper motor. It gives exact target location of centroid of red anchor box (CrAB) to laser module. Laser will get accomplished movement. It moves tilting (up-down) and panning (left-right) due to Servo motor. pin interface with Rpi is ti connected +Vcc, GND, and GPIO pin to servo motor pin that is +Vcc (red), GND(Brown), PWM (Orange). We used software part is OpenCV, smbus, pantilthat, imutils. We set laser point at the center of frame. Here to calculate servo angle we used PID controller. "P" is proportional, present (large correction), "I" is integral ,"in the past" (Historical), D is derivative dampening (anticipates the future). PID controller. PID controller is closed loop feedback system. The PID controller calculate an "error" (difference between desired set of point and sensor reading) and has a goal of compensating for the error. Sensor output is knowns as Process Variable (PV). We passed value to the process so that the process has access to keep track of where the target is for panning (Left-Right) it is an an X-coordinate, Similarly for tilting (up-dpun) it is Y-coordinate. "CenterCoord" used to calculate "error". Here error is nothing but different between "Centercoord value" and Objcoord value. Now to start and stop servos, we input some value but it's need within range. So we fixed range of servos. Here value need to update for Pan and Tilt value. This value adjust via "PID Process" until a signal is caught. We start our infinite loop By "signal Handler" Pan and Tilt angle values are made negative to accommodate the orientation of the servos and laser. We coded in python to enabled servos by the this two line which is **path.servo_enable (1,True)** and **path.servo_enabled (2,True).** The frame center coordinate are integer "i" and initialized to "0", similarly Object Center Coordinate that is CrAB also integer "i" and initialized "0". We set zero degree angle. Which start from center point of frame and it change Pan and Tilt angle as per requirement value. We set constant P,I,D value for panning and Tilting. It make process safe. For suitable value to panning and Tilting we used PID tuning section. So passing required process safe value we have four process:

1) To find target in the frame in our case it is CrAB.

2) A process which calculate panning (Left-Right) angle with a PID

3) A process which calculate Tilting (up-down) angle with PID.

4) A process which drivers the servos.

Each process is started and the joined. We set are disabled when all process exit. For tuning we set Ki and Kd to zero.

• Increase Kp from zero until the output oscillate.

• Increase Ki until offset are correct quickly.

• Increase Kd until the output settle on the positive Target output reference quickly after a load disturbance.

When servos achieved its target location then laser will start emitting laser beam on target location. It get continues On -Off. It emit laser beam 4-5 time on one location then servo move toward another target locations. But target is not found to movement for servos, then it come on its original position that is center of frame and laser stop the working.

6. Announcement Set-Up and alert SMS sending:

We make our project more smart by announcement and alert SMS For handing emergency situation. It will be announce when norms of Social Distancing (SD) are violated. As we pre-coded in python, that is limitations of people in frame. When individuals cross limitations and do not maintaining SD then system announce for to maintain SD. After first announcement video grabbing frame - by - frame continuously and detecting SD simultaneously. Again if it detect people are not following SD then it make second announcement. It will make continuously up to five time. But within delay between previous to next announcement it detect SD are not violated then the system break the loop of first to last announcement and start loop form first announcement toward fifth announcement. We used speaker to announcement. Which has 3.5mm to 3.5mm stereo audio cable and USB power cable. Another hardware is Ethernet cable which is use to install library form internet. Now to play sound in python through the Rpi on speaker we used most popular libraries is " playsound module " first of all we install the package that is "pip install playsound". It contain only single function named that name is "playsound()". It required only one argument. In which we fixed path for file with the SD announcement sound.

e-ISSN: 2582-5208

International Research Journal of Modernization in Engineering Technology and Science
Volume:03/Issue:06/June-2021   Impact Factor- 5.354   www.irjmets.com

We have to play it. It can play with "mp3" file[36]. When social distancing violation goes out of limit then the system announce to maintain social distancing and count it continuously.

If it make announcement five time continuously without breaking loop (first to fifth announcement). It send text SMS to Authorized Staff. We used "NEXIMO" to send SMS[35]. Neximo is software. Which is library for Python. Which gives the API key and API secret code to every user. We signing up for neximo. We can sent SMS to multiple numbers using neximo. After adding our number on Neximo website. We installed library for Python that is "**pip install neximo**". We connect neximo using the API key and API Secret that we received when we signed up for account. Next we created function that we call whenever five announcement counted. When message send successfully, it send us a response that is was successfully sent. Otherwise it shows unsuccessful/error message. We used "**sent_sms function**" and gives delay "3" second. In such method system sent alert SMS automatically to authorized staff and call to intervene for maintaining social distancing.

V.   CONCLUSION

Hence, we proposed advanced social distancing monitoring system. Here we used YOLO algorithm for People detection, People tracking and Euclidean measurement. System detect social distancing norms are followed or Violate. If people are following norms then those people would be bounded in green anchor box in frame and those who are violating norms, would be indicate in red anchor box and emit laser beam on that particular person with buzzer get buzzing to aware them. If system detect crowed (more than limited individuals), then the system announce to maintain social distancing. Simultaneously, laser also working. Laser get exact target location by laser turret or pan/tilt hut. The system gives continues five announcement in loop (first to last) if crowed is detected in frame continuously. After fifth announcement it will be send alert SMS to Authorized faculty and call them to intervene for handling this critical situation. The outcome of these project is to prevent policeman's, guards, and public also form this contagious disease. It suitable for indoor, outdoor and different service line system.

ACKNOWLEDGEMENTS

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List of Abbreviations:

[1]   Rpi = Raspberry pi.
[2]   SD = Social Distancing.
[3]   FPS = Frame per second.
[4]   mAP = Main Average Precision.
[5]   NMS = Non Max Suppression.
[6]   IOU = Intersection Over Union.
[7]   CrAB = Centroid of Red Anchor Box.
[8]   WHO = World Health Organization.
[9]   COVID 19 = Corona Virus Disease, December 2019.
[10]   SIR = Susceptible Infection or Recovered.