MST Detector (Face Mask, Social Distance and Body Temperature Detector)

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ABSTRACT
"MST Detector" is the system for preventing the spread of COVID-19. Nowadays, a person hired for detecting mask and temperature, by following this manner a person may be affected by covid and spreading it. MST detector is an innovative approach that has an arrangement that can identify the person who wears a mask and detect their temperature. Additionally, it can detect social distance violations and it also keep records of the people so that their measurements can be searched easily. The main purpose of this system is to make work contactless and automatic. This combined system can be used in hospitals, institutions, organizations, shopping centers, etc. This system is built using the camera, the Arduino Nano and an Infrared Sensor. In organizations, schools and colleges, this system can be used to detect masks and recognize faces using a camera and it can also be used to detect temperature using an infrared sensor. This system needs to be placed at the entrance of the organization so it can detect and identify the people and measure the temperature accurately. It can also be used in large domains for monitoring social distance violations, such as in public places and large private sectors.

General Terms
Detection, Recognition

Keywords
Face Mask Detection, Social distance Detection, Body Temperature Detection, Face Recognition

1. INTRODUCTION
The world is passing through a global pandemic situation. COVID-19. Most countries have been dealing with this situation for nearly two years, but doctors and scientists have yet to find a permanent solution to combat this pandemic. So this MST detector is one small step toward the fight against this pandemic. As per the WHO and Health Ministry of India's guidelines for avoiding risk, people have to wear a mask and maintain social distance properly. Also, the WHO says, they have to measure the oxygen level at a specific time interval and the body temperature should be normal. This detector can be used for mask, temperature and social distance violation detection.

Currently, governments are aware of this virus and are taking care of themselves by following precautions. But in some places, people don't follow the precautions and in some places precautions are strictly followed, but there might be a risk that the virus can be spread by interacting with each other who are involved in measuring these precautions and keeping records of people is also a very thorny task.

To overcome the above situations, this MST detector is very useful to the world. It is a contactless, automatic face mask detection and recognition, body temperature detection and social distance violation detection system. This system was developed by applying neural network-based concepts for detecting social distance violations as well as face mask detection and recognition using the camera. For real-time and contactless body temperature detection, it uses an MLX90614 infrared sensor.

This paper is organized into four sections. Section 2 presents the related work. The proposed framework and the methods are in Section 3. Experiments and results are presented in Section 4 and the conclusion is in Section 5.

2. RELATED WORK
After referring to some patents and the research paper, which have details about face detection, mask detection and temperature detection, the project team got the idea about how to develop this system. For social distance violation detection, there are some blogs [18] [19]. Two research papers describe face detection and both have different ideas. One is based on a neural network [1] and the other one detects with the help of a deep convolutional neural network [2]. The first has social distance monitoring and face mask detection [4], while the second has a solution for creating a standalone vision device for detecting face masks in public places [5]. IoT-based face mask detection is also there [6]. A research paper also shows how to build a combined system for detecting face masks and body temperature [7].

This project is distributed mainly into three modules and the first one is Face Mask detection and recognition. The model needs to be trained for face mask detection. There are so many deep learning models among them. The MobilenetV2 model is used for detecting face masks and the Haar Cascade classifier is used to extract the Range Of Interest (ROI) from a live video frame [8] [9]. This classifier is not efficient at detecting the proper ROI. So, in order to improve efficiency, another deep learning framework, which is the Caffe Framework [10], is used. This Caffe Framework is used for extracting the face from a live video frame [11]. Multiple faces are not detected from live video frames by this framework, so another neural network-based concept is You Only Look Once (YOLO) [20]. Unfortunately, the latest version of YOLO cannot be used because it requires a high GPU, which is very costly. So YOLOv3 (version 3) is used for this project, which is a downgraded version of YOLO [21]. The requirement of YOLOv3 is a custom and labelled dataset. So, after detecting face masks, need to integrate the Recognition [12] algorithm with face mask detection. Now the first module is

ready for face mask detection and recognition [13].

The second module of the project is temperature detection. A temperature gun is already in use for detection purposes, but the aim is to make the system contactless. There is a blog that describes a non-contact thermometer [15]. In that, it uses infrared sensors, but the requirement is high efficiency at low cost, so MLX90614 Infrared sensors [14] [16] can be used for measuring the temperature without any physical contact.

The other module of the project is nothing but social distance violation detection. Social distance violations can be detected using neural network-based concepts [18]. The main thing for social distance violation detection is object detection from the live video frame and for that, there are some models like Center Mask, ASFF, ATSS, YOLOv3, YOLOv4 and so on.

The following graph describes the efficiency of object detection [22] and in that YOLOv4 and YOLOv3 have stable efficiency at the specific interval of FPS (Frame Per Second) and AP (Average Precision) compared to all. From this, the lower version of YOLO, i.e., YOLOv3, is used here, which was discussed earlier.

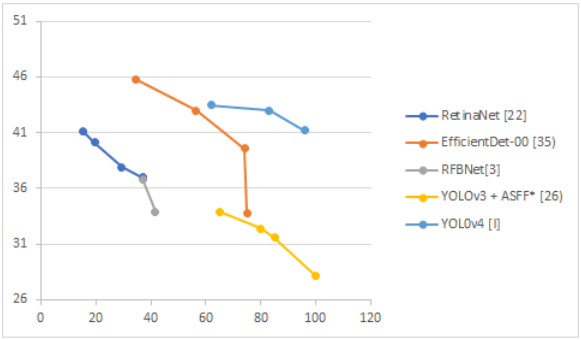

Fig 1:Comparison of the proposed YOLOv4, YOLOv3 and other state-of-the-art object detectors.

3. METHODS

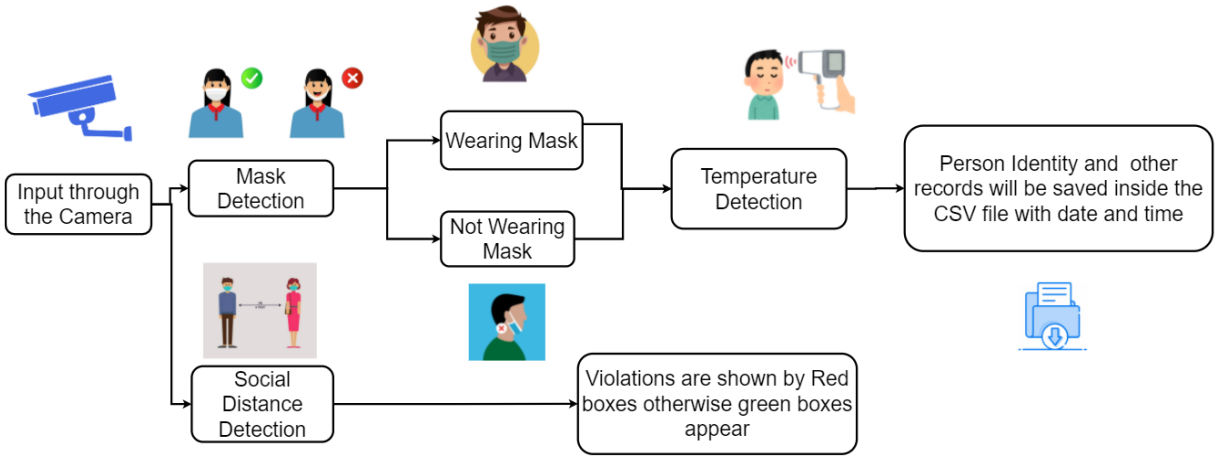

Fig 2: System Flow Diagram

This project is mainly distributed into three modules. The above figure shows the workflow of the system. Firstly, it takes the input from the camera and then it performs face mask detection. If a person wears a mask, then it goes for the further process, which is temperature detection; otherwise, the system recognizes a person's face and goes for temperature detection. After that, it saves the records with the status of the mask and body temperature in Celsius. The last but not the least module is social distance detection, which is performed separately.

3.1. Face Mask Detection

Object detection is one type of computer vision task that first localizes one or more objects from an image and then classifies each object in the image. For real-time object detection, You Only Look Once (YOLO) is one of the most advanced and clever convolutional neural networks (CNN) [22]. YOLO applies a single neural network to the full image. It then divides the image into regions and predicts their bounds, boxes and probabilities for each region. YOLO was developed by Joseph Redmon [24]. It uses end-to-end deep learning models that are intended for quick object recognition and detection.

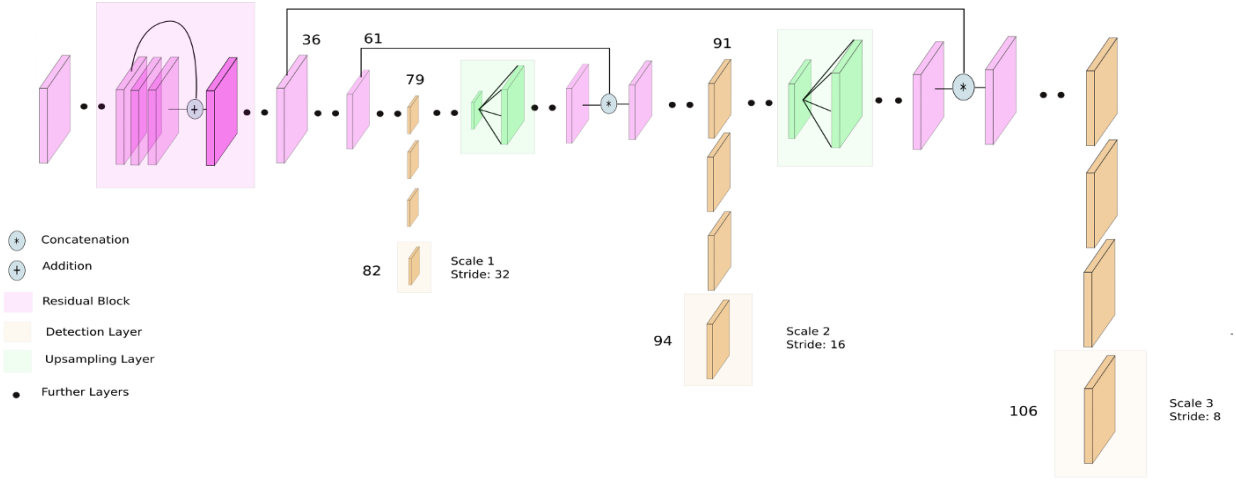

Fig 3: YOLOv3 network Architecture

YOLOv3 uses a variant of the darknet. Darknet has a 53 layer network trained on ImageNet. For detection purposes, 53 layers are stacked onto it, so it has a total of 106 layers which is a fully convolutional underlying architecture for YOLOv3. YOLOv3 is slow because of this reason. The most powerful feature of YOLOv3 is that it makes detection at three different scales, which are precisely given by down sampling the input image by 32, 16 and 8 respectively [21]. We can observe this in the above figure.

YOLOv3 is used for face mask detection, which requires a pre-trained model, which does not exist, so the model must be trained. The custom dataset is labelled and, using that dataset, an algorithm is applied for detecting face masks and generating the weights and config files. It took almost 24 hours to train. After the generation of weights and config files, those files are used for detection and then the face recognition module is merged [12] [13] with the detection module. The below diagram describes the system flow of the project.

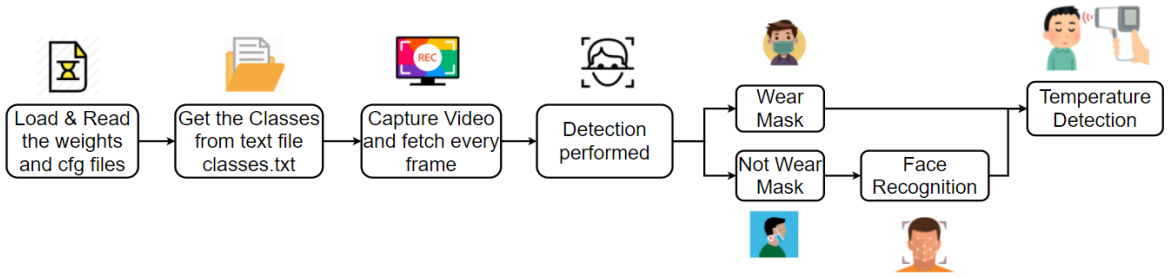

Fig 4: System Flow Diagram of Face Mask Detection

3.2. Body Temperature

Body temperature detection is implemented after face mask detection and recognition. For that, the MLX90614 non-contact IR Sensor [16] is used. The Arduino Nano (Microcontroller) and Arduino IDE [14] [15] are used to communicating with sensors. The below figure shows the connection between the MLX90614 IR sensor, the Arduino Nano and the buzzer.

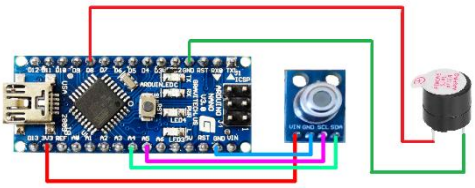

Fig 5: Connection of MLX and Arduino Nano

Now, the Arduino is connected to the system. The Adafruit MLX90614 Library [23] must be installed before uploading the sketch (Code). Then the sketch is uploaded with the help of the Arduino IDE.

```
#include <Wire.h>
#include <Adafruit_MLX90614.h>
Adafruit_MLX90614        mlx        =
Adafruit_MLX90614();
const int buzzer=8;
const int threshold=35;

void setup() {
  Serial.begin(9600);
  pinMode(8, OUTPUT);
  mlx.begin();
}
void loop() {

Serial.print(mlx.readObjectTempC()+5
);

  Serial.println();
    if
(mlx.readObjectTempC()>threshold){
    digitalWrite(buzzer, HIGH);
  } else {
    digitalWrite(buzzer, LOW);
  }
  delay(1000);
```

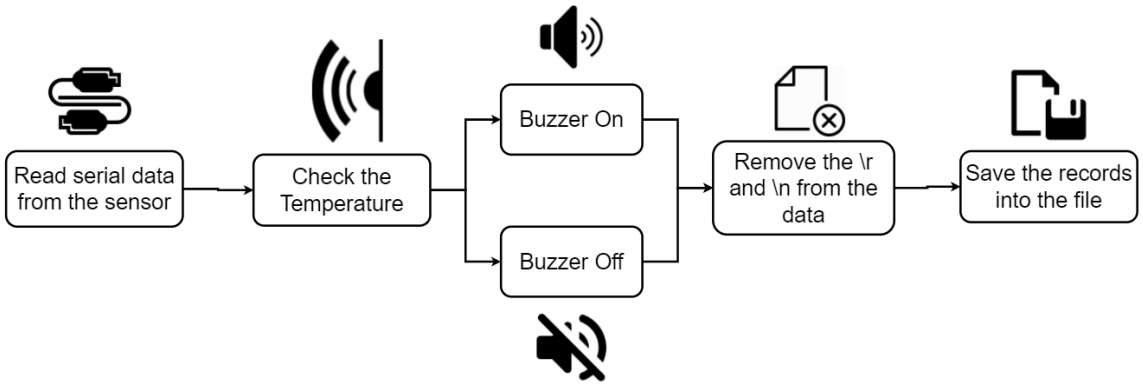

Fig 6: System Flow of Body Temperature Detection

Once the sketch has been uploaded, the sensor starts measuring body temperature. When the sensor measures body temperature, the input data is encoded. So that needs to be decoded and from that data, remove carriage return and new line feed. Then the decoded data is checked to see whether it is greater or less than the threshold. If data is greater than the threshold, then the buzzer will be on. Elsewhere, the buzzer remains off and the data is also stored.

As mentioned in the system flow diagram [Figure 2], face mask detection, recognition and temperature detection work together. So these two modules get merged and get output with accurate efficiency.

3.3. Social Distance

After Face Mask and Body Temperature detection, social distance violence detection is implemented. For that, the YOLOv3 Object Detection model [21] is used. Please find the below steps that are performed to implement the Social Distance Violence Detection [18] [19]:

1. Filter out person object class among other object classes and get person object from a live video frame and consider that person object as a point.
2. Now Calculate the Euclidean distance between two points.
3. Convert center coordinates into rectangular coordinates and get a bounding box for each person detected.
4. Check which person bounding boxes are close to each other.
5. Show risk analytics and indicators.

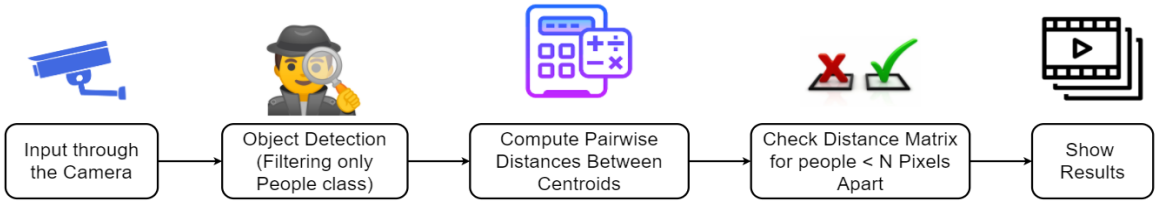

Fig 7: System Flow of Social Distance Violence Detection

Algorithm for Euclidean distance calculation:

```
D = []
    for i in centroids:
     inD = []
     for j in centroids:
     dist1=math.sqrt((j[0]-
i[0])**2 + (j[1]-i[1])**2)
             inD.append(dist1)
         D.append(inD)

    D = np.array(D)
```

Algorithm for converting a centroid into the rectangle, that shows to check which person bounding boxes are close to each other and display risk analytics and risk indicators.

```
for i in range(0, D.shape[0]):
  for j in range(i+1, D.shape[1]):
     if D[i,j] < 75:
            #75 - min distance
       violate.add(i)
        violate.add(j)

for(i, (prob, bbox, centroid)) in
enumerate(results):
   (startX, startY, endX, endY) =
bbox
    (cX, cY) = centroid
    color = (0, 255, 0)
```

```
    if i in violate:
        color = (0 , 0, 255)

    cv2.rectangle(frame,   (startX,
startY), (endX, endY), color, 2)

    cv2.circle(frame, (cX, cY), 5,
color, 1)
```

```
text    =    "Social    Distancing
Violations:
{}".format(len(violate))

cv2.putText(frame,    text,    (10,
frame.shape[0] - 25),

cv2.FONT_HERSHEY_SIMPLEX, 0.85, (0,
0, 255), 3)
```

The mandatory thing is that the camera needs to be pointed at a place from where the system can detect the data with high accuracies, like one of the top corner areas.

4. EXPERIMENT AND RESULT

4.1. Experiment

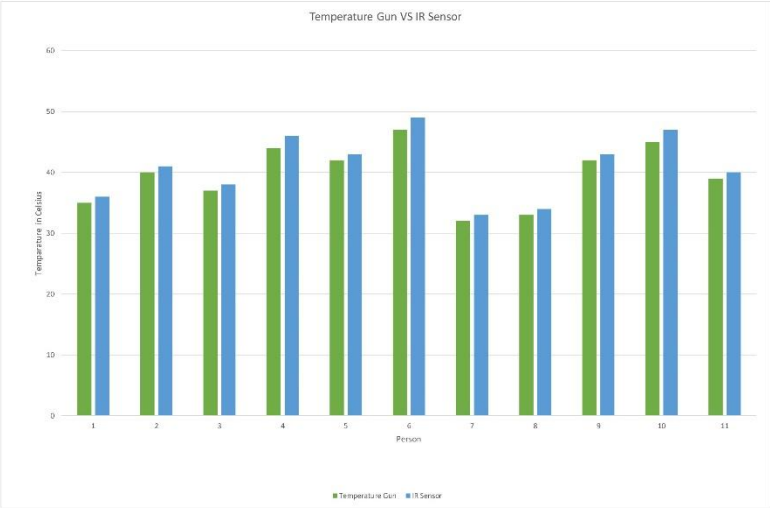

Fig 8: Temperature Gun vs IR Sensor Graph

The above chart illustrates the inspection of body temperature using a temperature gun and an infrared sensor (MLX90614). From the observation of the above graph, the measurement of the IR sensor has an approximately 1° C difference from the temperature gun. Also, the face mask detection accuracy is above 90%.

4.2. Result

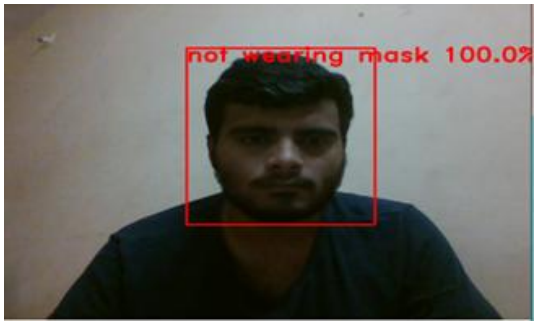

Fig 9: Face Mask Detection 1(without mask)

Fig 10: Face Mask Detection 2(with mask)

Fig 11: Social Distance Violence Detection

Table 1 . Records of Mask and Temperature Detection and Recognition

Detected Person	Wearing Mask Or Not	Timestamp	Temperature	Temperature High or Normal
Jash	Not Wearing	08-05-2022 19.28	35	Normal
Jash	Wearing	08-05-2022 19.30	40	High
Rutvik	Wearing	08-05-2022 19.35	37	Normal
Harsh	**Not Wearing**	09-05-2022 20.28	44	High
Rutvik	**Not Wearing**	09-05-2022 15.07	42	High
Rutvik	Wearing	09-05-2022 15.15	47	High
Harsh	Wearing	09-05-2022 15.28	32	Normal
Swayam	Not Wearing	10-05-2022 18.10	33	Normal
Swayam	**Not Wearing**	10-05-2022 18.15	42	High
Harsh	Wearing	10-05-2022 18.20	45	High
Jash	Not Wearing	10-05-2022 20.58	39	Normal

Table 2 . Records of Social Distance Violence Detection

Timestamp	No. Of Detected Violations
08-05-2022 19.28	10
08-05-2022 19.30	15
08-05-2022 19.35	12
09-05-2022 20.28	5
09-05-2022 15.07	8
09-05-2022 15.15	7
09-05-2022 15.28	14
10-05-2022 18.10	11
10-05-2022 18.15	6
10-05-2022 18.20	10
10-05-2022 20.58	11

5. CONCLUSIONS

The MST Detector detects real-time and contactless face masks, body temperature, and social distance violations and recognizes the person using a camera and the MLX90614 Contactless Infrared Temperature Sensor. The efficiency of the detector will increase. To increase accuracy, the Arduino Nano can replace by the Raspberry Pi. Additionally, the efficiency of face masks can be increased, like whether wearing a mask is proper or not. Notifications via email or SMS can add for organizational purposes. The oximeter can also combine with this system to measure the oxygen level in the body. Currently, the system is developed using hardware like the Arduino Nano, an IR sensor, and software, but in the future, this can combine into a single system, that can move anywhere like a mobile.

6. ACKNOWLEDGEMENT

Apart from the effort, the success of this project largely depends on the encouragement and guidance of many others. We take this opportunity to express our gratitude to the people who guided us in making this project. Firstly we would like to thank our guide PROF. NEELAM SURTI with her experience has guided us on every stage of the project and she constantly motivated us to think about new ideas and complete the project. We would also like to thank DR. AMI TUSHARKANT CHOKSI our Department In-charge and also our co-guide who supported us throughout this project. We would also like to take this opportunity to acknowledge and express our gratitude to all the people who are directly or indirectly involved with us in making our project a success.

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