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An Iot Based Engineering Solution For Covid'19 Community Spread Using Machine Learning Approach

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Abstract

In the year 2020, the most spoken word by humans are corona. The medical scientists and researchers are in a position to safeguard peoples from the fast disease Covid'19. As per the world health organization analysis, the virus can easily spread through the infected person sneezes, coughs, and physical touch. To safeguard ourselves from Covid'19, social distance is very essential. A proposed engineering 1st solution can prevent the human from Covid'19 by the alert. The IoT based solution is mounted into a tag identity card. The ultrasonic device will measure the distance by passing ultrasonic sound waves. The seriousness is indicated through the buzzer during the social distance violation. The 2nd solution will detect and indicate the person who has not weared the mask. The proposed solution will use the faster R-CNN to classify the images.

Keywords: *Arduino Uno R3, Ultrasonic sensor, Social distance, Covid, CNN.*

1. Introduction

Among the several viruses in medical history, the Covid'19 is the one that spread very faster through contact transmission. There is no special vaccine or treatment that exists to cure the Covid'19 virus so far. A way to prevent ourselves from such a dangerous virus infection is to maintain physical distance. In the fast-growing world fortunately or unfortunately maintaining social physical distance among the human is difficult. Medical scientists are responsible to save the infected people by inventing the vaccine for the virus. At the same time, engineers are responsible to prevent people from contact transmission. At the same time, engineers are responsible to prevent people from the virus affected persons. Because community virus spread will make the entire world into a covid infected. The new IoT based approach will provide an optimum solution to create awareness during the social distance violation. The design is embedded into a compact tag identity card. It also will helpful for blind people to protect themselves. The next solution will notify the person who has not wearing the face mask.

2. Related Work

H. Li et al. (2015) investigated the convolutional neural network. In CNN, An image is segmented into a number of regions which are further changed as classes. Image contains a lot of regions. To classify and filter the images lot of time is required. The system will take 1-2 minutes to train the images.

Girshick et al. (2015) examined the region-based convolutional neural network (R-CNN). The system will use a selective search approach to generate the regions. An image contains 2000 regions approximately. The Computation time is 40-50 seconds. Each region is passed to CNN disjointedly.

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Girshick et al. (2015) investigated fast R-CNN for image classification. Instead of pass the image regions separately, the entire image pixel is passed to CNN that minimizes the processing delay. The usage of a selective search algorithm is somewhat time-consuming. It took 2 seconds to complete the training and classification.

Ren et al. (2015) investigated Faster R-CNN. The system will use the region proposed network with module dependency. The system will take 0.2 seconds to class the images.

S. Srithar et al. (2019) uses the ultrasonic sensor to perceive the speed breaker. The coverage range of the ultrasonic sensor is limited to 3-7 meters. The ultrasonic sensor will transmit the sound pulse to sense the obstacle.

3. COVID-19 ENGINEERING SOLUTION-1: SOCIAL DISTANCE AWARENESS ALERT

The ultrasonic sensor is used to compute the distance from the sensor to an object. The sensor will generate a 40KHZ ultrasonic sound pulse and transmitted it through the air. The sound waves are spring back to the sensing unit if any obstacles. The ultrasonic distance sensor contains a transmitter, receiver, and transceiver. The distance is calculated by the travel time and the speed of the sound waves. The distance between the obstacle object and sensor unit is measured by Equation (3.3). The Equation (3.1) and (3.2) are used to detect the time of light and speed of sound. The process flow of the social distance alert is represented in Figure 3.1.

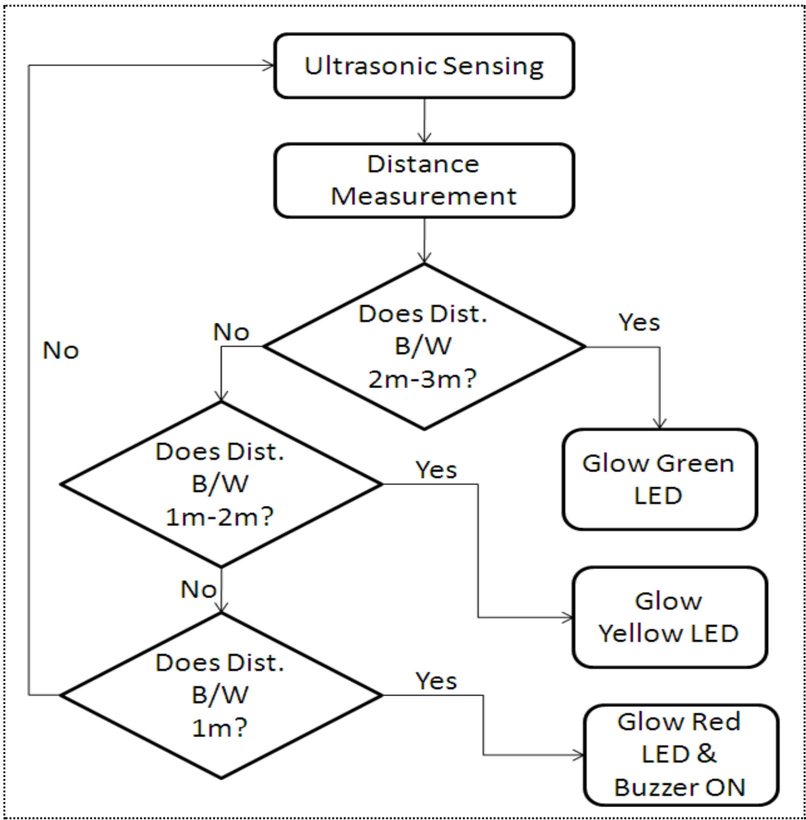

Figure 3.1 Social distance alert process flow

Time of Flight=t1µS (3.1)

Speed of Sound=t µS/cm* (3.2)

Distance= Time of Flight/Speed of Sound (3.3)

3.1. Prototype Design

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The social distance awareness alert prototype is designed using Arduino Uno R3, Ultrasonic Distance Sensor HC-SR04, Neopixel Ring 12, and buzzer. Figure 3.2 shows the social distance alert prototype.

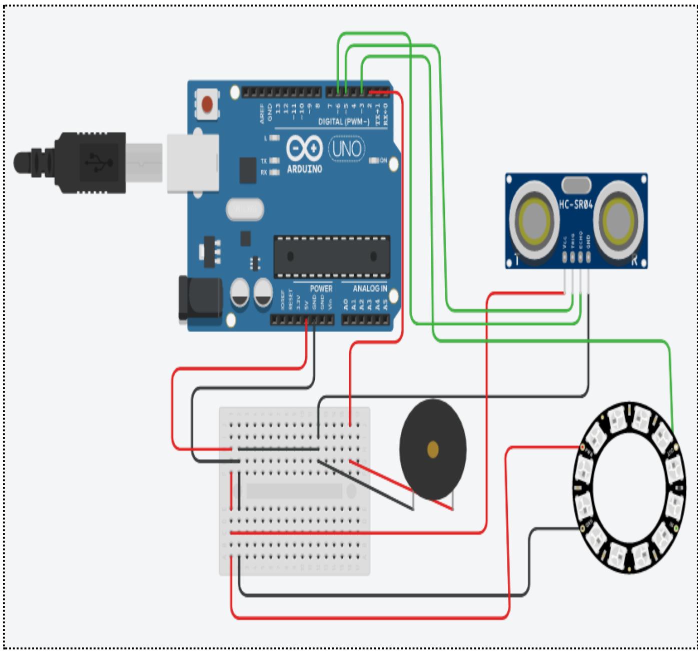

Figure 3.2 Social distance alert prototype design

3.2. Hardware Requirements

- **Arduino Uno R3**

The Arduino Uno R3 is an 8-bit ATmega328 microcontroller that has 14 inputs and output digital pins (6 PWM outputs), 6 pins for input analog, USB connection, a Power jack, reset button, and ICSP header shown in Figure 3.3.

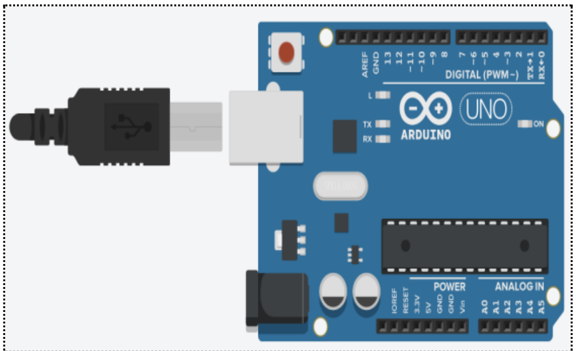

Figure 3.3 Arduino Uno R3

- **Ultrasonic Distance Sensor**

The ultrasonic sensor HC-SR04 uses SONAR to determine the distance of an object. It emits ultrasound at 40000Hz which is transmitted through the air and if there is an object or obstacle on its path. The coverage range of the ultrasonic sensor ranges from 1 to 13 feet. Figure 3.4 shows the pin diagram for HC-SR04.

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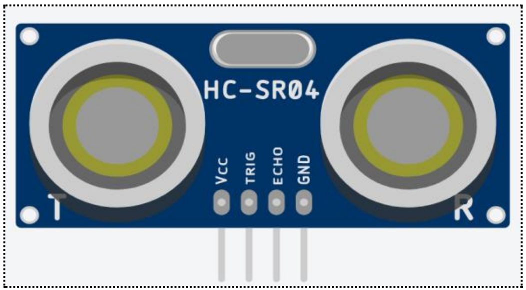

Figure 3.4 HC-SR04 Ultrasonic sensor

- **Neopixel Ring 12**

The 12 ultra ring LED NeoPixel is connected with a 37mm outer diameter where the output pin is an input of another. Figure 3.4 shows the pin diagram for Neopixel Ring 12.

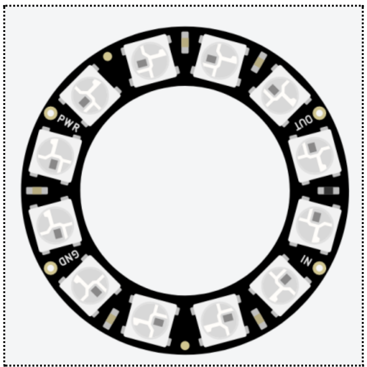

Figure 3.5 Neopixel Ring 12

- **Buzzer**

The buzzer contains two pins that point to power and ground shown in Figure 3.6. Certain crystals will change shape when the current applies to the buzzer. This then causes the surrounding disc to vibrate.

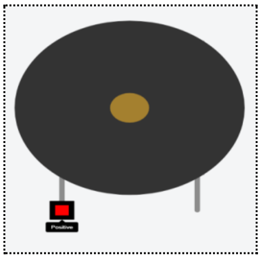

Figure 3.6 Buzzer

3.3. Results and Discussion

The simulation is carried out in Autodesk thinkerkad. The ultrasonic sensor will measure the distance between the sensor and the obstacle. The threshold value is set as 100 meters. Whenever the human obstacle is within 100 meters, the system alerts the human through the buzzer. Figure 3.7 shows the proposed circuit and the Figure 3.8 shows the social distance violation serial monitor.

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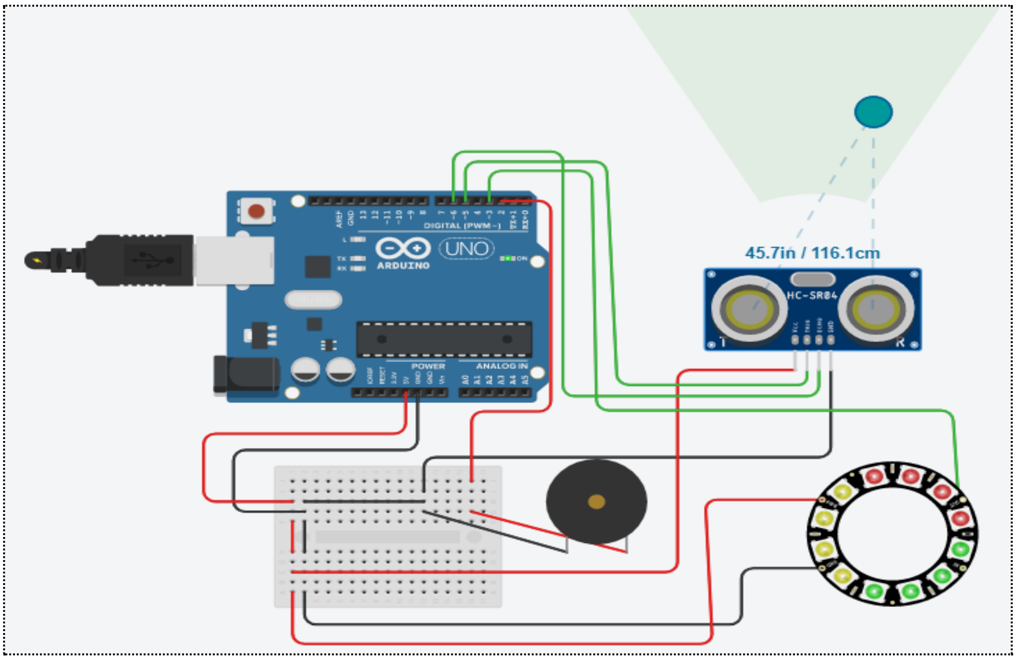

Figure 3.7 Social distance violation alert circuit

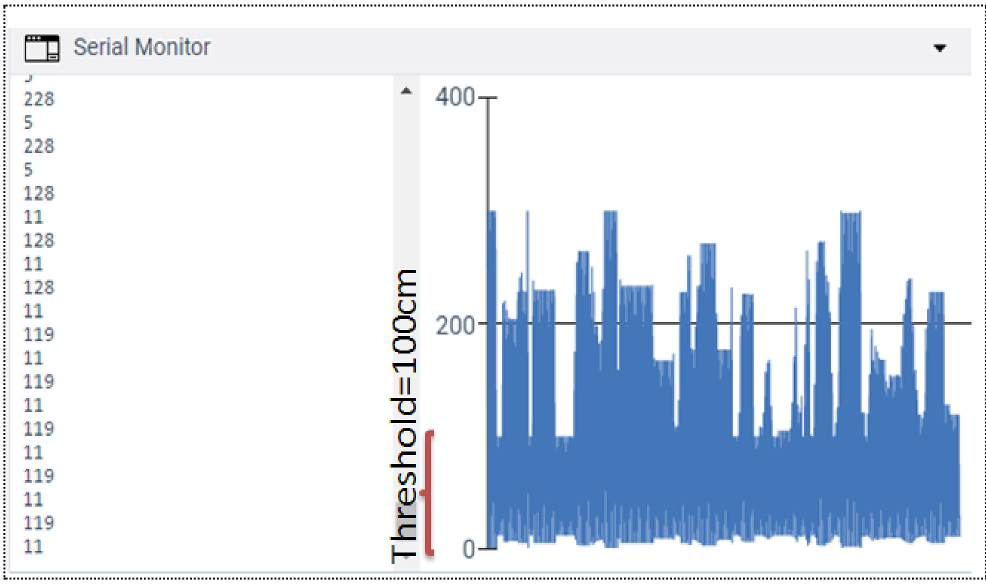

Figure 3.8 Social distance violation serial monitor

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4. COVID-19 ENGINEERING SOLUTION-2: FACE MASK DETECTION SYSTEM

The face mask detection will start with training and classification. To train and classify the images the convolutional neural network is an optimum choice for live stream image processing. The purpose of convolution is to extract the feature or knowledge from the input image. The matrix is formed by sliding the filter into an image and computing a feature map.

4.1. Face mask detection steps

- **Training**

1. Load the image data set contains with and without the mask,
2. Train the model using Keras/tensor flow classifier,
3. Serialize the face mask classifier into a disk.

- **Detection**

1. Export the mask classifier from the disk,
2. Detect the face from the stream of video,
3. Extract the region of interest from the image,
4. Apply faster R-CNN to class the images as with and without the mask.

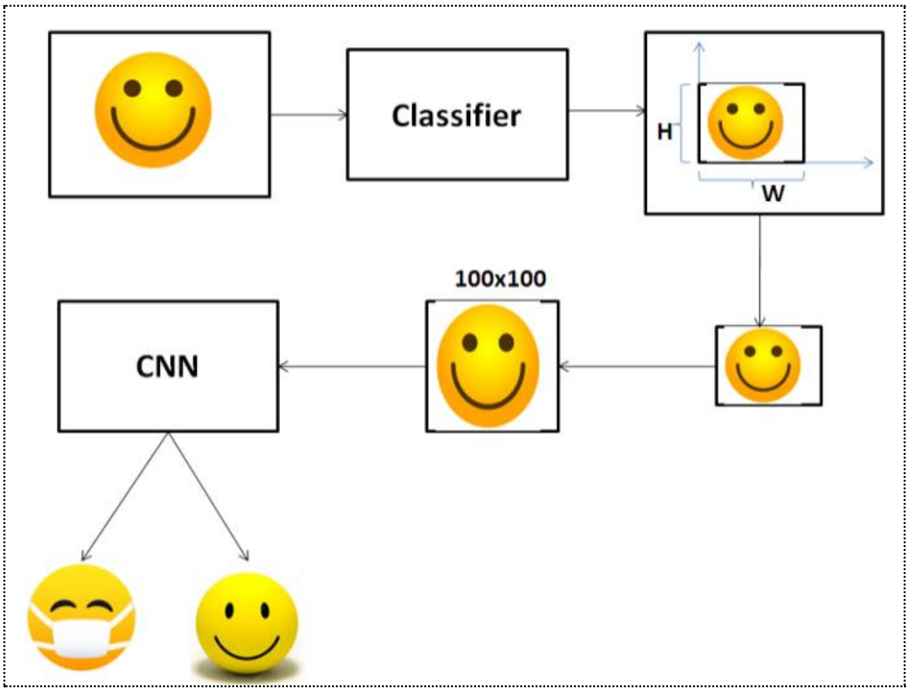

Figure 4.1 Face Mask detection process flow

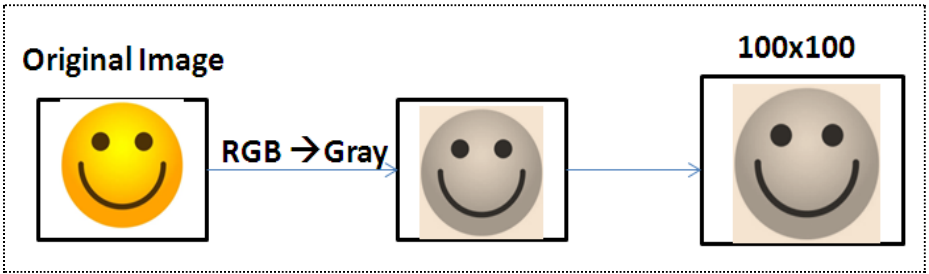

Figure 4.2 Data preprocessing

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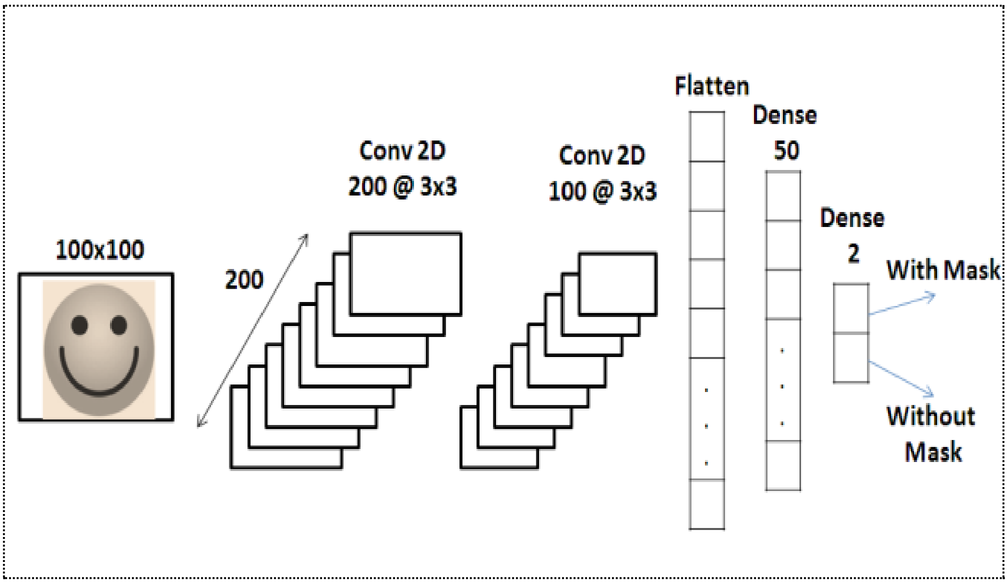

Figure 4.3 Convolutional Neural Network (CNN) classifier

4.2. Region Convolutional Neural Network (R-CNN)

The R-CNN uses the selective search algorithm to generate 2000 regions. And the algorithm extracts the feature vector of the length 4,096. After the feature extraction SVM algorithm will classify the images to identify the object classes. The R-CNN cannot be trained because the components are independent. The selective search algorithm will take lot of time to execute.

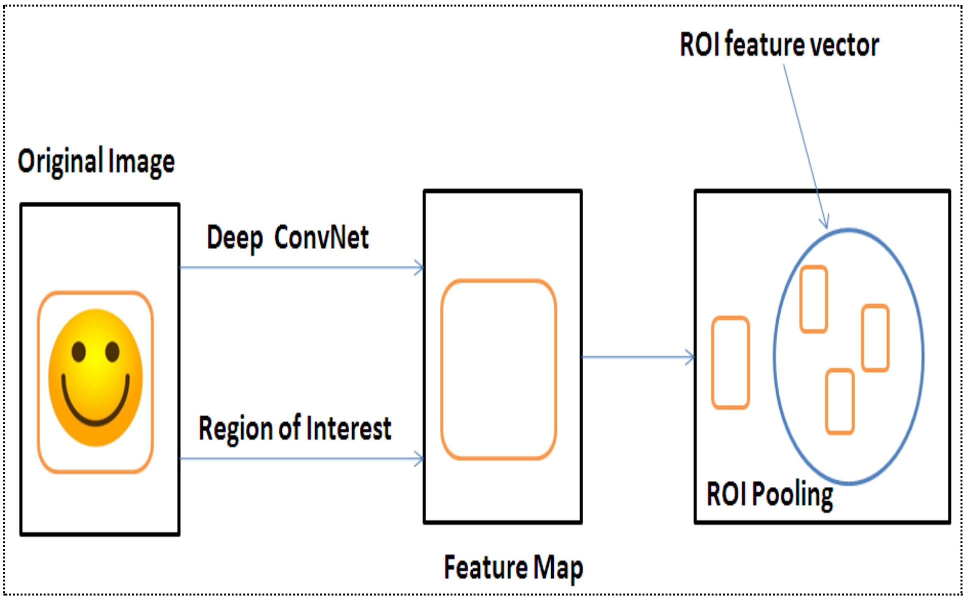

Figure 4.4 Region of Interest (RoI) pooling

4.3. Fast Region Convolutional Neural Network (Fast R-CNN)

The ROI pooling extracts the equal length vectors from the image. The method constructs region formation, feature extraction, and classification in a single stage. Instead of executing the proposals independently, the faster R-CNN dispose the computations to all proposals. The fast R-CNN does not carry the extracted feature and thus it will reduce the disk storage (Girshick et al 2015).

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4.3. Faster Region Convolutional Neural Network (Faster R-CNN)

The proposed approach uses faster R-CNN to generate region proposals (Ren et al. 2015). The image feature is extracted by the ROI pooling. After that, the vector feature is classified with fast R-CNN, and the anchor bounding box scores are returned. The convolution layer image of sliding window n*n is passed to the ROI pooling to detect the invariant features of anchor layer boxes. The anchor will give positive and negative scores based on Intersect-Over-Union (IOU).

Table 4.1 Intersect-Over-Union Score

Value	State
>0.7	Positive
0.5 -0.7	Positive
<0.3	Negative
0.3-0.5	Non Negative/Positive

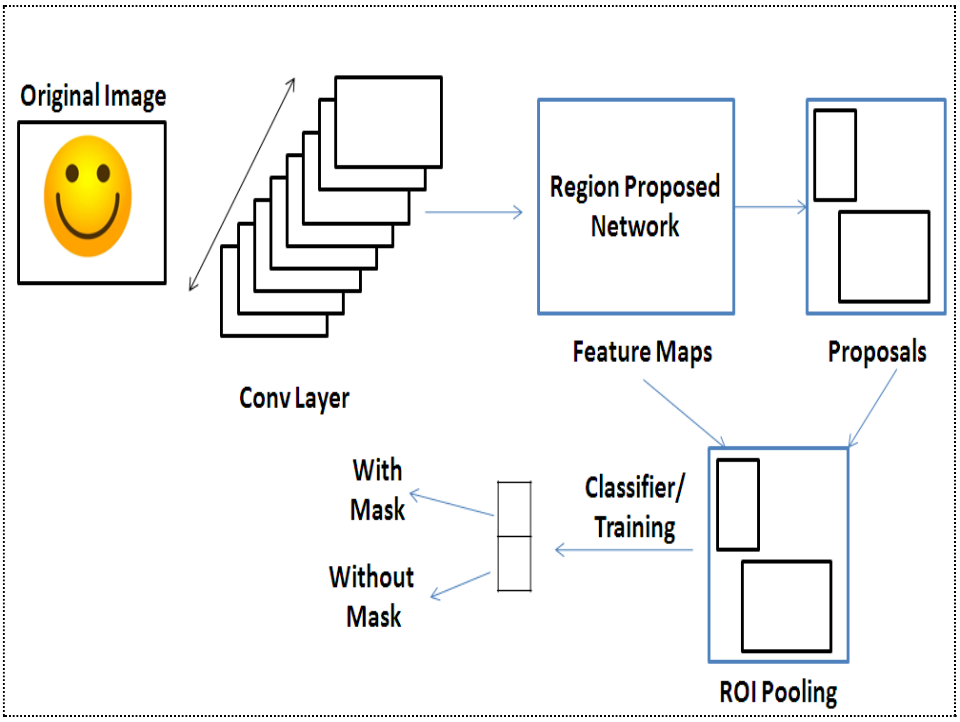

Figure 4.5 Region Proposed Network model

The method non-max suppression will clean up multiple bounding boxes around one object and gives one bounding box per object. We can discard all the boxes with pc<=0.6 among the number of bounding boxes. The anger box with the highest IoU is considered as a true object.

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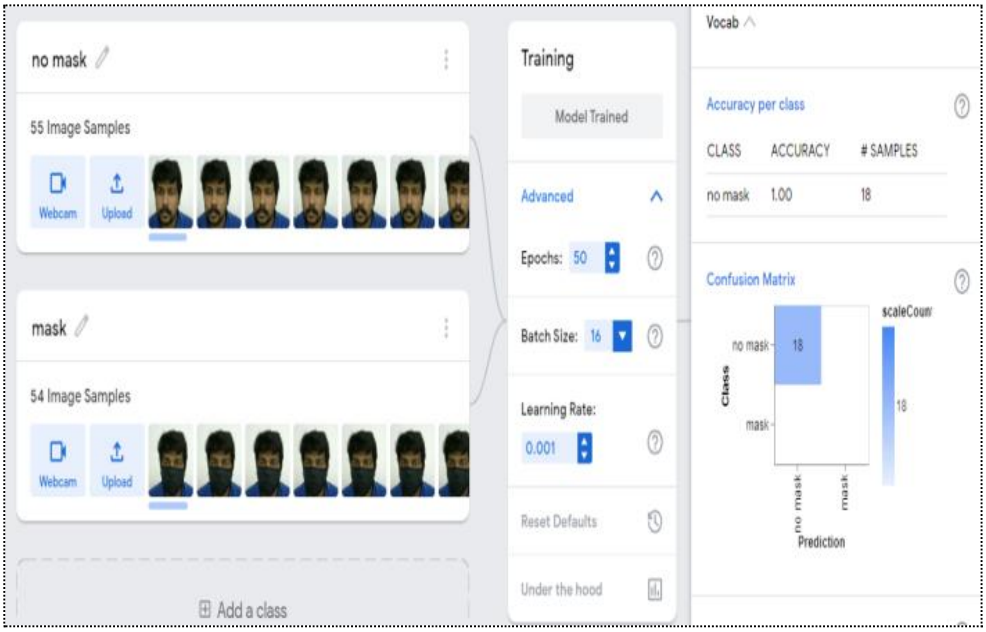

Figure 4.6 Accuracy and Confusion matrix

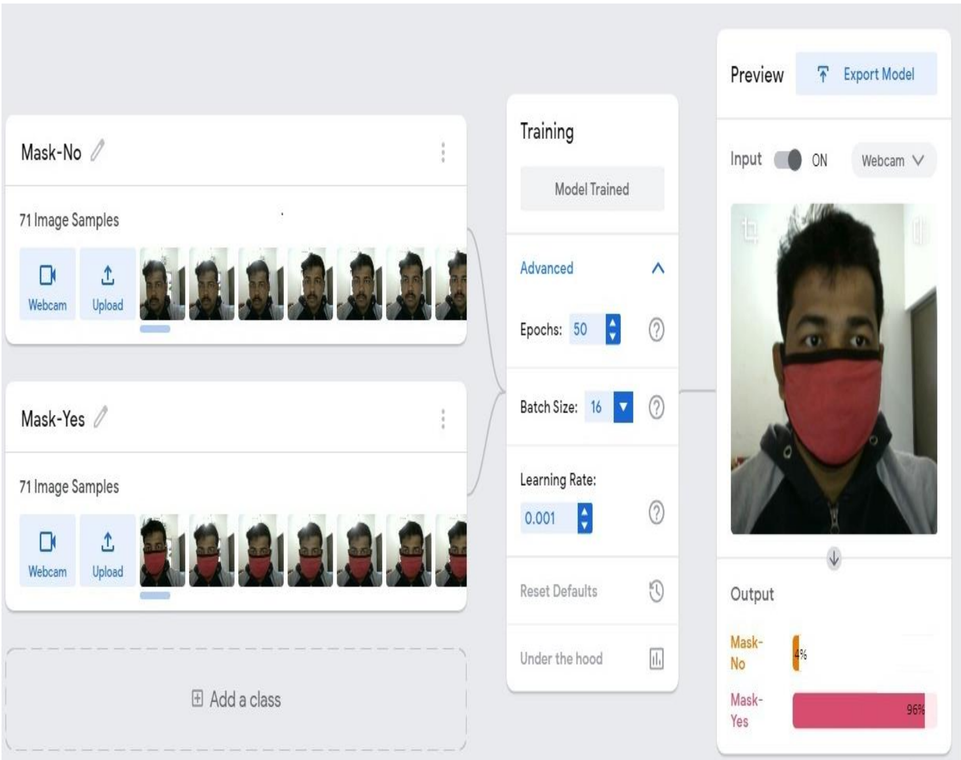

Figure 4.7 Face mask detection sample output

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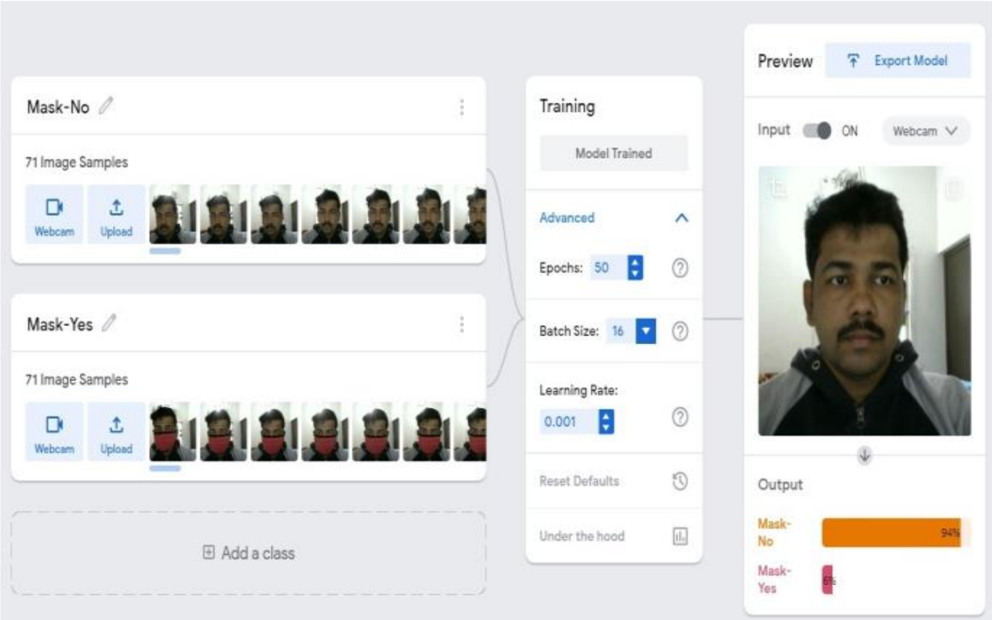

Figure 4.8 Face mask detection sample output

Figure 4.9 Export model

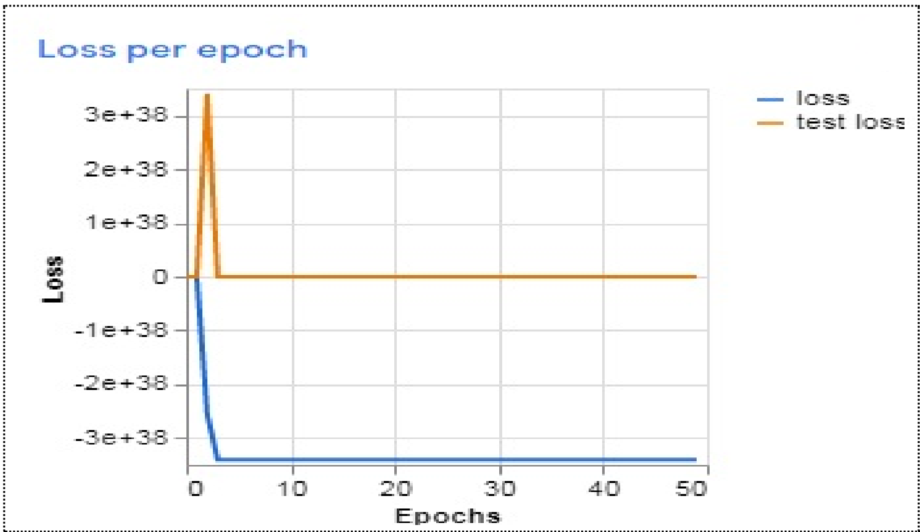

Figure 4.10 Epochs Vs. Loss

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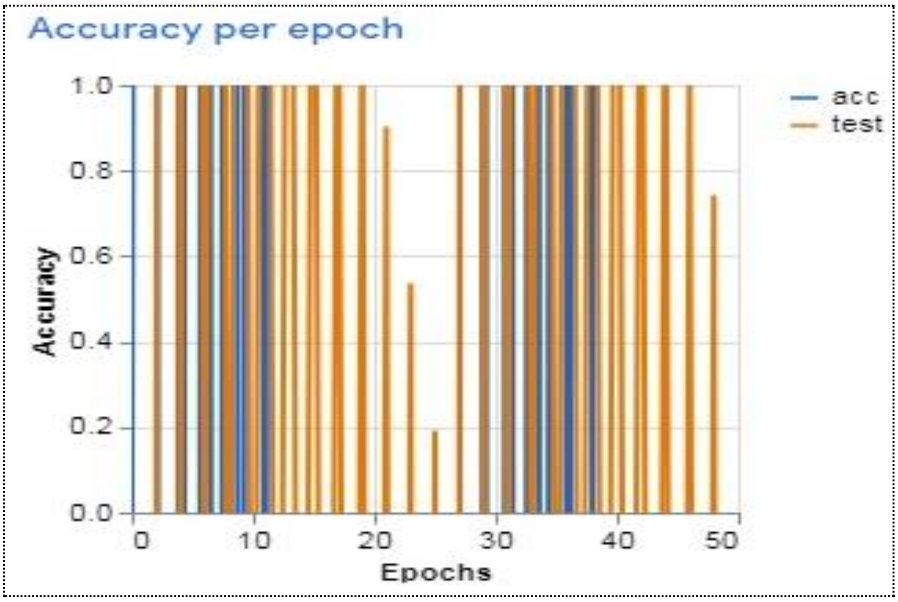

Figure 4.11 Epochs Vs. Accuracy

5. CONCLUSION

Covid'19 is the biggest threat to human life in the year 2020. The virus can easily spread from person to person by social contact. The engineering solution can able to prevent the people from the virus affected persons. We have formulated two solutions to protect against the community spread. The first solution is a social distance alert application that creates awareness during the social distance violation. The compact ultrasonic sensing unit measures the distance between the device and the human obstacle. Whenever the person is closer who violates the threshold distance is alerted by the buzzer. The second solution is to detect the person who has not weared the mask and the system will act accordingly. The model is trained and examined using the network faster R-CNN classifier. The method is experimented to evaluate the loss per epoch and accuracy per epoch.

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