

# CNN BASED PATHWAY CONTROL TO PREVENT COVID SPREAD USING FACE MASK AND BODY TEMPERATURE DETECTION

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## Abstract:

Airborne diseases cause detriment in the human life. Many were found in history such as TB, SARS, MERS and recently COVID 19. These diseases hit the dead rate and crushes health and wealth of the world population. Mostly, airborne diseases will spread rapidly in crowded places. Especially, in case of COVID-19, Wearing mask and monitoring body temperature by individual is good solution to prevent rapid spread of the disease. So, keeping safety measures in monitoring face mask and body temperature is crucial in crowded places such as Airports, railway stations, Bus Stations, malls, temples, etc. is obligatory. With a focus on emphasizing the health of the people we proposed integrated system that monitors body temperature and face mask of each individual and open/close pathway gate to allow after knee verification. Proposed Prototype uses Raspberry pi to monitor Face mask using CNN and Arduino to monitor body temperature and enable motor drivers to open or close the pathway Gate. Efficiency and loss of Proposed CNN model was trained and tested with multiple epochs.

**KEYWORDS:** Deep learning, CNN, Object Detection Technology, Temperature Sensor, Gate Motor.

## I. INTRODUCTION:

At first coronavirus was identified in Wuhan city, China in 2019 named after COVID 19 by WHO. SARS-CoV-2 strain of the COVID-19 virus later on mutated to delta, omicron, delta Cron and other variants causes severe damage on health and wealth of world population. [1] All these variants are air borne by its nature causes dry cough, fever and severe body pains as symptoms. There are many symptoms which were difficult to incorporate in developing our prototype. There are many parameters to identifying COVID in an individual. Body temperature is the foremost criteria to identify the presence of virus in an individual. Face mask is another parameter to prevent the spread of COVID virus. An individual at the entrance is sufficient to monitor at the gate. But, life of a gate keeper is important and there is a possibility of overlooking when mass population is gathered. To avoid these difficulties, an intelligent contactless gateway control system to scan the temperature and to detect face mask was proposed which scan face mask and body temperature of every individual and allow to enter the gate. Proposed intelligent contactless gateway control system was designed by integrating raspberry pi and Arduino[11][13].

In this system, scanners are directly connected to the passage to scan the body temperature and a camera is adjusted such that it can focused on to the face of person in the pathway. The image captured by the camera is processed through raspberry pi system using Convolution Neural Network- deep learning algorithm. The temperature scanner output and decision from the CNN algorithm were connected to the Arduino. Arduino controls the pathway gate to be open to allow the person or not based on the conditions from scanner and CNN outputs[12][15].

In case if the person was identified with no mask or abnormal body temperature, system will indicate a red light stating the person violating basic need of wearing mask or the person was infected. In such case barrier at the entrance will not open until that person will move away. Also, system will communicate over an IOT to the concern authority to take necessary action and to do COVID test to the person. System allows a person having face mask with normal body temperature. Thus system supports in preventing COVID spread by providing a contactless monitoring through temperature scanning and camera to identify face mask and the body temperature[14].

Basically, there are many parameters need to be focus in avoiding COVID spread. Majorly, Face mask, sanitization hands frequently, cover cough, Self-health monitoring, social distance and hand wash. Figure 1 shows the parameters that can be controlled by third party to avoid COVID spread in the outside mass gathering environments[16].

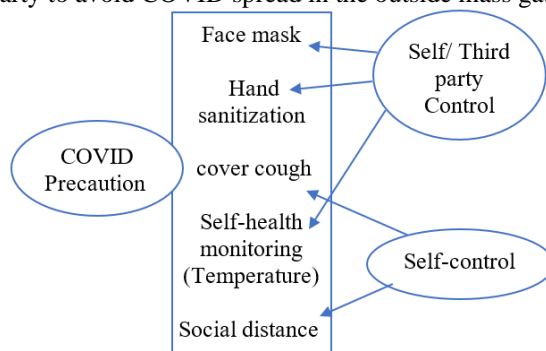


Figure1: Parameters to avoid COVID and identify self-controlled or third party-controlled parameters.

In this paper two parameters face mask and temperature scanning to monitor the health condition of a person are considered to design prototype to control Pathway Gate Control/Gateway to prevent the COVID spread. Rest of the paper is organized as follows. Section II brief out the survey on object detection and the Convolution Neural Networks. Section III gives the block diagram and the description of the proposed system. Section IV gives the performance analysis of the proposed system. Finally in section V focus on future scope of the proposed system[17][19].

## II. LITERATURE SURVEY

Object recognition is a task of performing image classification followed by object detection. In order to identify face mask in public place, it needs a strong detection algorithm based on output of Surveillance cam. In [2] author proposed a novel method which was pre-trained and adapt for new categories of objects. Proposed method was tested on MiniImageNet dataset that gives an better performance.

Paper [3] presents a new approach called YOLO a single neural network to detection objects in a real time scenario. Author evaluated the performance and compared with existing R-CNN method.

Author in [4] proposed a new method FacemaskNet to identify or to detect face mask in real time with three class of classifications 1) person with properly wearing mask 2) improper wearing mask 3) no mask. Recognition or detection accuracy of this method was mentioned as 98.6% and suggested to use in crowded places such as Bus/Railway Station, Malls, Streets, Schools, institutes etc.

[5] Author was more precise in implementing simple and scalable detection algorithm. With this algorithm author achieves 50% increase in Mean average precision score on existing. Author combined two ideas to result new method called R-CNN.

Author [6] proposed a novel deep learning algorithm to detect facemask in facial image using depth wise separable CNN model instead of 2D CNN Layers. Proposed model was out performing on DWS mobileNet dataset. But the drawback is limited dataset. Deep learning algorithms are proposed by many researchers to detect small objects[7], fast object detection [8], and in a single shot detection [9] and real time object detection[10][18][20].

## III. PROPOSED SYSTEM

In order to solve the current problem of monitoring face mask and body temperature of each and every person in the public area, we develop a prototype that monitors the face mask using mask detection technics using Deep learning techniques and body temperature check up with landmark on the face using a contact less IR temperature sensor of each and every person in a crud area or in a public place to avoid the COVID spread.

Basic modules of the prototypes are

- A. Raspberry pi module with CCTV
- B. Arduino Module
- C. IR Temperature Sensor
- D. Power Supply
- E. Ultrasonic Sensor

It is completely automated system to monitor body temperature with a contactless IR Sensor and face mask using mask detection technique on the incoming video frame from a CCTV input as shown in Figure 2. When a person

comes close to the entry point, IR sensor measure temperature with a fore head Land mark and check the presence of mask using a CNN algorithm as shown in Figure 3 based on the inputs from the camera.

If the body temperature of the person is  $\leq 97^{\circ}\text{C}$  and if face mask was detected then Arduino opens the obstacle in the entrance and person is allowed to enter inside.

On the other hand, in any other conditions such as he or she is having normal temperature and without mask, normal temperature and with improper wearing of mask, mask with abnormal temperature etc. door will not open and send a message to the concern authority to take care of the person. Complete status of the pathway obstacle at different conditions has been listed in the following Table 1.

Table 1: Details of path status at different conditions.

Case	Details	Status of the obstacle
I	Temp $\leq 97^{\circ}\text{C}$ and Wearing Mask	Open
II	Temp $\leq 97^{\circ}\text{C}$ and Without Mask	Close
III	Temp $\leq 97^{\circ}\text{C}$ and Wearing Mask improperly	Close
IV	Temp $\geq 97^{\circ}\text{C}$ and Wearing Mask improperly	Close
V	Temp $\geq 97^{\circ}\text{C}$ and Wearing Mask	Close
VI	Temp $\geq 97^{\circ}\text{C}$ and No Mask	Close

Step 1- Maintain Data Set.

Step 2- Data Augmentation by rotating images in different angles.

Step 3- splitting to testing and training sets.

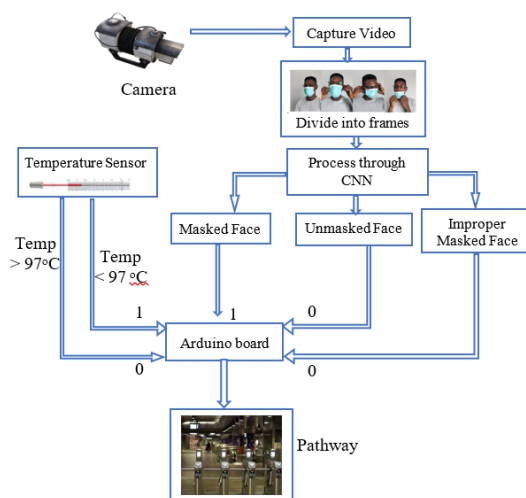


Figure 2: System Architecture for proposed model

Step 4- Build proposed CNN algorithm with multiple layers that includes Conv2D followed by MaxPooling2D followed by Flatten, Dropout, finally Dense Layer. In Dense layer, ‘SoftMax’ function is used to classifies output vector in to two classes.

Step 5- Training and validation generators can be create by pre train the CNN model.

Step 6- Train the CNN algorithm to fit our data set in to the training set and test set to built our sequential model with keras library.

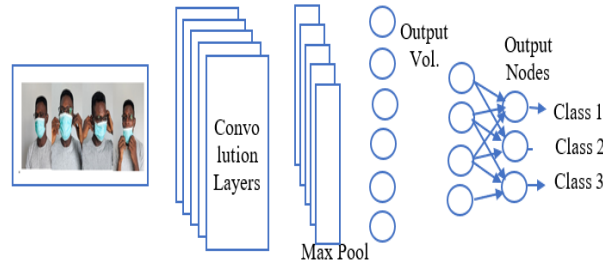


Figure 3: CNN For the proposed system

Step 7- Label the existing Information as 0 and 1. [0-for No mask and 1 for wear mask<sup>4</sup>].

Step 8- OpenCV library is used to detect Face mask by running infinite loop to the samples collected from the web camera by the use of Cascade Classifier.

**Convolution:** It is an initial layer, to extract information from the input image that was captured by the CCTV or web CAM.

**Pooling:** it optimizes the convolved features. The basic reason for optimization is to reduce the power consumption by reducing number of computations to process data sample. It gives better noise suppression.

**Flattening:** it is one step ahead to the classifier or Fully connected Layer. It provide an output in such a way, it will be convenient to process further to classify the given data into either Mask or No mask Classes.

#### IV. DESIGN ANALYSIS

The prototype of our proposed model is shown in the below Figure 4. All our hardware components are connected according to the block diagram and we will see the results by giving various inputs to check the various cases that are involved in our model.

The process mask scanning is done as follows. The person will stand in front of the camera as shown in Figure 5. Face will be captured by the Camera and processed through the CNN algorithm. The system will detect if the person is wearing a mask or not, based on the dataset that has already incorporated in the model.

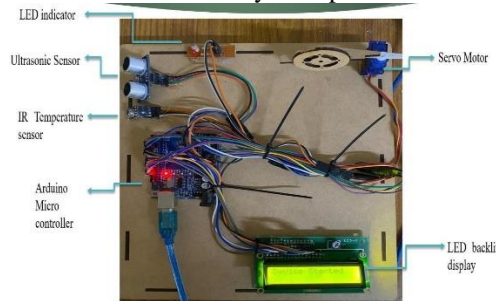


Figure 4: Prototype of proposed system.



Figure 5: Face scanning for mask

When the person standing in front of the camera without mask. The message “pls wear a mask” will be displayed on the LCD as shown in the Figure 6 to warn the person to wear mask.

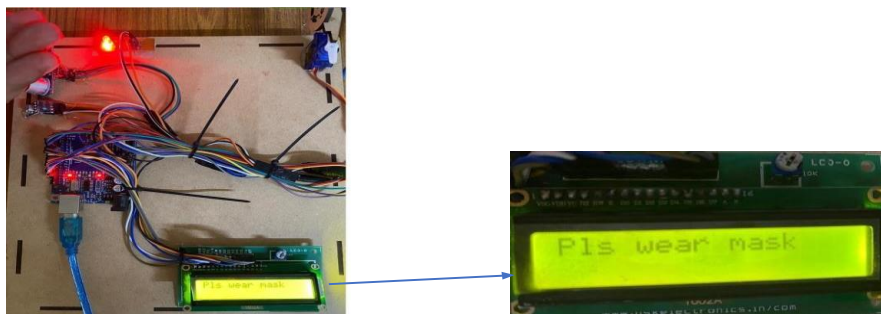


Figure 6: LCD displaying to wear mask.

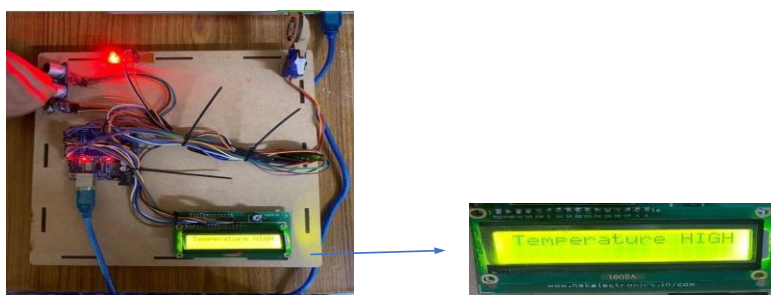


Figure 7: LCD displaying high temperature

The temperature sensor will detect the temperature and if the temperature exceeds the specified value, the message “Temperature High” will be displayed on the LCD as shown in the Figure 7.

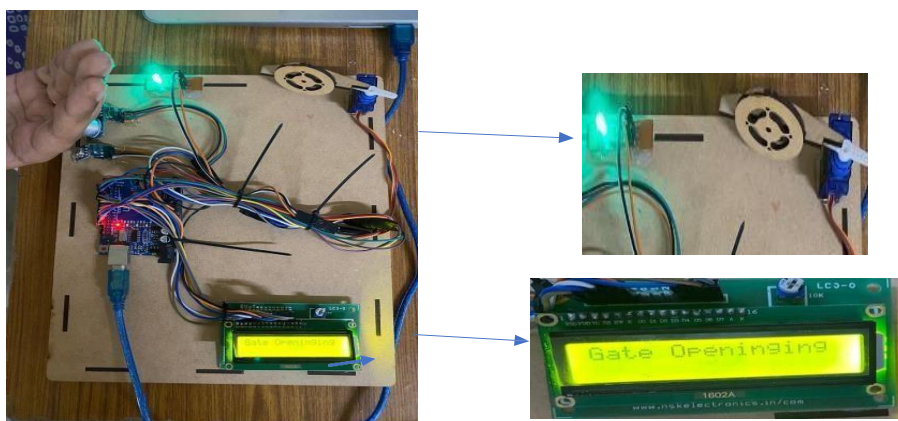


Figure 8: Opening of gate.

When both the conditions satisfy i.e., the mask is detected and also the temperature is within the range the gate will open and a message “gate opening”, will be displayed on the LCD. In Figure 8 the face mask of the individual is being detected and the input is given to the Arduino.

If the mask is not detected then the LCD screen displays to wear mask as shown in Figure 6. Now the body temperature is read by the temperature sensor, if the temperature is high LCD displays high temperature as shown in Figure 7, else the gate is opened and closed after few seconds as displayed in Figure 8 & 9.

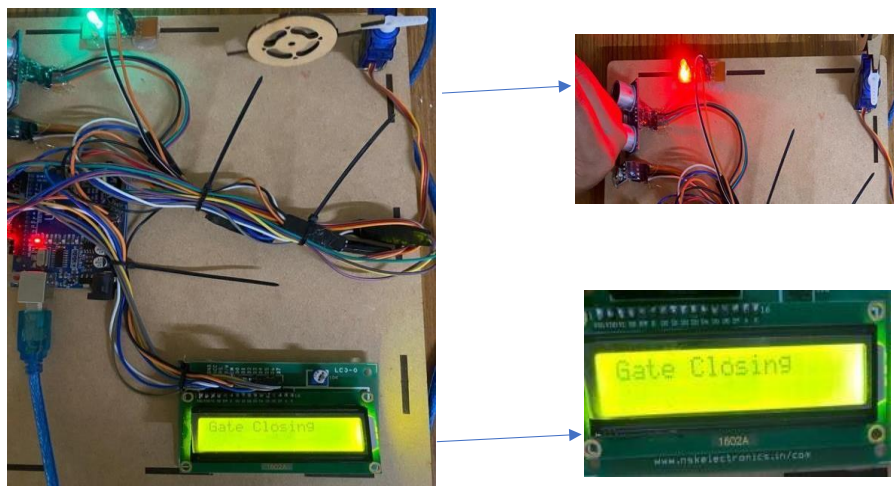


Figure 9: Closing of gate.

## V. Performance Analysis

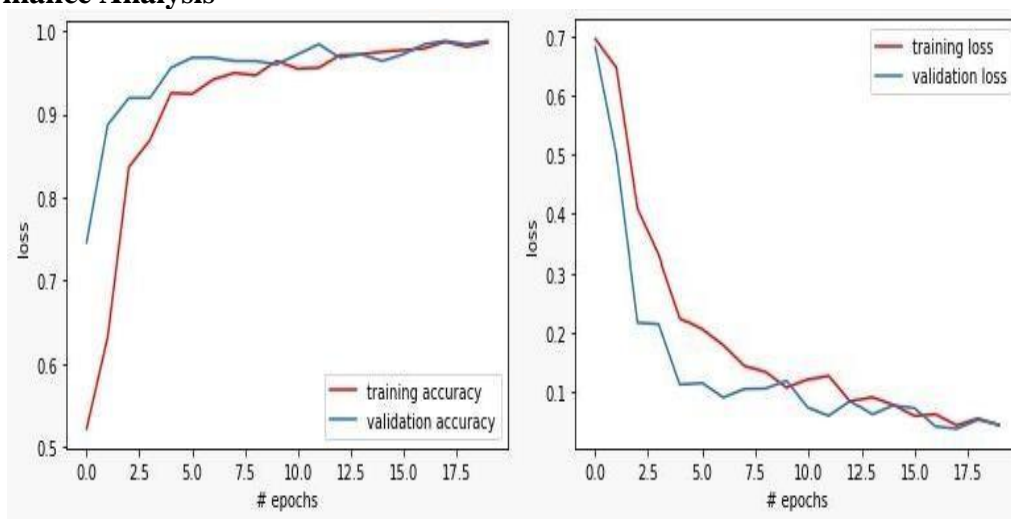


Figure 10: a) Accuracy Plot, 6 layers 3x3 kernel, 20 epochs b) Loss Plot, 6 layers 3x3 kernel 20 epochs

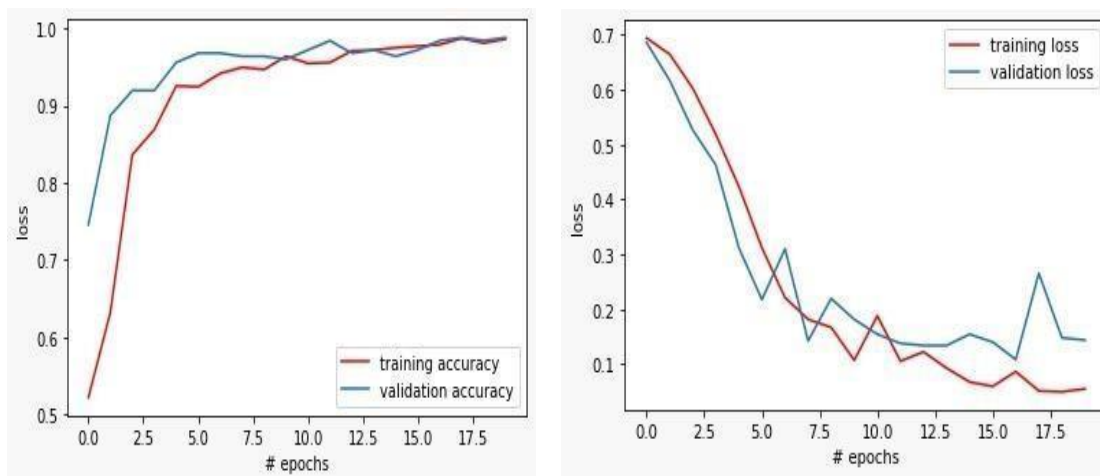


Figure 11: a) Accuracy Plot, 6 layers 5x5 kernel, 20 epochs b) Loss Plot, 6 layers 5x5 kernel, 20 epochs

Table 2: Accuracy and Loss Comparison table for 3x3 Kernel

Layers	Runtime	Accuracy	Loss
6 layers	225 msec	0.9928	0.035
4 layers	168 msec	0.9638	0.0839
2 layers	109 msec	0.9130	0.3400

Table 3: Accuracy and Loss Comparison table for 5x5 Kernel

Layers	Runtime	Accuracy	Loss
6 layers	204 msec	0.9783	0.0451
4 layers	146 msec	0.9928	0.071
2 layers	85 msec	0.8986	0.2853

In Table 2 for fixed kernel size 5\*5 the accuracy is increasing as the number of layers increases. The same pattern can be observed in Table 3 for fixed kernel size 3\*3.

Considering the results from these tables we can observe the maximum accuracy and minimum loss for the trained model is obtained for the data trained with 6layers, 3\*3 kernel.

## VI. CONCLUSION AND FUTURE SCOPE

This work was a successful design and implementation of proposed prototype to avoid the COVID Spread. Prototype has two modules for detecting face mask using CNN deep learning technique and to monitor body temperature using IR temperature sensor. These two modules are further integrated by Arduino to control the pathway gate based on the outputs of faced detection module and temperature sensor module. The pathway gate will be open only when person wearing face mask and the body temperature is less than 970C. In any other case prototype will close the gate and will not the person. According to the achieved results, the proposed prototype is suitable for the current pandemic situation and is usable in the public places.

In future, proposed work can be extended with various deep learning algorithms and efficient object detection techniques to improve the frame per second. We can also include one more parameter Such as sanitization of hands using other smell sensors to monitor before entering in malls, etc.

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