Security Access Control System Enhanced with Face Mask Detection and Temperature Monitoring for Pandemic Trauma

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***Abstract* — COVID-19 has affected the livelihood of millions around the world. Pass-infection of the virus between the personnel is a large threat factor. During this pandemic, it's mandatory to wear a mask to prevent the spread of the COVID19. Biometrics and face detection are commonly used to track individual employees' attendance but face recognition methods are ineffective because wearing mask obscures a portion of the face. This biometric can be a medium for the transmission of viruses. The proposed system implements COVID preventive measures such as mask detection and monitors body temperature. In addition, the proposed system checks for authorized persons using RFID technology and employs fingerprint verification application via individual mobile phones for attendance purposes. The system predominantly inspects presence of face masks, then keeps track of body temperature and ultimately controls the automatic door associated with it using RFID technology and android app based fingerprint recognition to allow access to people with authorization.**

Keywords — RFID, IOT, COVID-19, Temperature measurement, Mask detection

I. INTRODUCTION

COVID-19 is a contagious disease fostered due to SARS-CoV-2 virus. According to World Health Organization, saliva droplets and liquid particles are the cause for the virus spread when an infected person coughs or sneezes. Coronavirus is the most recent scourge illness to wreak havoc on humanity's well-being in recent times. Infected individuals touch surfaces, which infect others. This has been one of the primary causes of high COVID-19 infection rate [1]. Researcher's confirmed that wearing face covers helps to prevent COVID-19 transmission [2]. The use of human labor for scanning temperatures in workplaces may also expose them to the virus. Monitoring each and every person in a large area is impractical. As a result, automated temperature monitoring and mask detector systems are regarded as superior methods rather than human interventions.

A common COVID - 19 symptom is elevated body temperature. So, examining the human body temperature along with the face mask detection gives a hand in screening the people prone to the virus. During the pandemic, automatic door lock systems premised on face recognition and other methods such as biometric verification have been shown to be ineffective as they have the possibility of infecting others. The goal of this work is to develop a system that uses RFID technology for authentication purposes. Machine learning assists battle with pandemic from various perspectives. Machine Learning (ML) is a subtype of AI that has existed since the 1950s. The power of modern computer technology to solve real time problems makes machine learning more efficient. Machine learning's prominence can also be attributed to an ample supply of rising datasets to work with. The primary goal of this research is to detect face mask using machine learning technique interfaced with image processing.

The reduced complexity and basic components make the proposed design to be efficient and cost-effective. The system also curbs the spread of COVID-19 which can be used in IT companies, shopping malls, educational institutes etc. Flow of this paper follows as given; The following section provides a summary of existing studies in the areas of home security using RFID, body temperature monitoring using Raspberry Pi and COVID-19 prevention measures. The next section discusses the comprehensive stage process details for the system's design and implementation, as well as the hardware resources used

II. LITERATURE REVIEW

Krish Sethi et al. [3] designed a system to curb the escalation of COVID-19 especially in homes. The aim was to use facial recognition for authentication and to restrict unauthorized access. The administrator is given a WhatsApp notification when an unknown person enters the premises and the system takes photo, detects mask and monitors temperature and these data is sent through WhatsApp. The door is then controlled automatically using a WhatsApp bot.

Syed Danish Pasha et al. [4] proposed a model which uses IR sensors to track individual count of people and tests body temperature of people entering, if the temperature is above the threshold value, the door will not open; otherwise, the door will open and mask detection will take place. A Raspberry Pi module is used for this purpose. The system was implemented in such a way that, if an individual is detected wearing mask the door opens. If the person is discovered without a mask, the door remains closed. Glenson Toney et al. [5] developed a system which dispenses sanitizer on arrival and scans temperature. This main target of this work is to eliminate use of biometrics and instead use facial recognition for attendance purposes. HOG algorithm is used by the system for face recognition and it upgrades employee ttendance. The system detects mask detection also and if an employee is found with elevated temperature,an appointment

is automatically made to the physician on campus through an system generated SMS and the employee is attended.

Amritha Nag et al. [6] implemented a system which aims to assist users with improved door security using facial recognition. Human presence is detected using PIR sensor, and the Raspberry Pi serves as central processor. The detected person's image is emailed to the administrative user, and the door is automatically controlled by a Telegram bot. Sudharsan K et al. [7] developed a contactless employment management which includes sensor fusion and face recognition. Onboard cameras are used to detect whether an employee wears mask using deep learning algorithms. Face recognition captures the employee's face and searches the database for their information. If an unregistered face is detected, the system issues a warning and offers the option to register a new employee. Temperature monitoring is performed using thermal camera and the employee is allowed to enter when both temperature and masks are properly maintained. Chaitanya Kangala et al.[8] implemented a tunnel to disinfect people. A person is only permitted to enter the tunnel if he or she is wearing a face mask and has a normal body temperature. Face mask detection is accomplished through the use of a camera that employs a Convolutional Neural Network (CNN), and temperature detection is accomplished through the use of an infrared temperature sensor. If the person meets the requirements in both, he or she is allowed to enter the tunnel, where the disinfectant solution is sprayed from stem to stern on the body.

S.K.Mithra et al.[9] designed a door locking system that allow authorised personnel access using RFID technology and stores all the data in central server. All authorised users are given a serial ID that is burned into their RFID tag and can be read by the reader when the tag is used to unlock the door. When the door is unlatched, it remains open for a certain period of time before being locked. To keep track of all check-in activities, an online monitoring system is used. Ravi Gatti el al. [10] developed a system for face detection and face mask detection. The designed system uses YoLo technique to recognize objects.50 image datasets were experimented to evaluate the performance of the technique. In mask detection, a symbolic method was used to successfully maintain inter and intra class differences. The prototype also employs a temperature sensor for monitoring temperature.

Manasi Mishra et al.[11] implemented a system with masked face recognition,face mask detection and temperature monitoring. Deep learning algorithms are used to recognise faces by discarding the masked face region. The collected data is sent to the cloud and can be accessed by the administrative user via a mobile application and it is also shared with hospitals in case of emergency. Samuel Ady Sanjaya el al. [12] designed a system to stop the spread of virus in work places. Facemask detection is implemented in the system using a machine learning algorithm via the image classification method: MobileNetV2. The model employs surveillance cameras to prevent virus transmission by detecting people who do not wear a face mask. Each camera point is equipped with location data, allowing authorities to be alerted to locations that require additional attention. The model obtained an accuracy of 96.85 % for detecting people with and without mask.

III. SYSTEM OVERVIEW

A. *Proposed system working principle:*

The process flow of the system proposed is shown in fig

1. The proposed system embedded with RFID aims in identification of people who are not wearing masks and with elevated body temperature to curb the transmission of COVID-19. NodeMCU serves as the system's control unit, controlling the entire process. The DHT11 sensor is used to measure human body temperature. If the measured temperature does not fall within the threshold limit set in NodeMCU, the user is prevented from entering. Otherwise, the user is allowed to continue with RFID verification.

RFID access system comprises of RFID reader and RFID tag. So, if a person scans his or her tag in the reader, the system will allow the person if the UID matches the ones stored. This assists in allowing authorized users and granting them access for mask detection. The system is built with an additional layer of protection to further improve the security. Here, Individual user's security is established via a mobile phone app (Fingerprint application) that scans for authorized employee's fingerprints in their respective android devices. This app is provided only to the authorized persons. If the fingerprint matches, the users are permitted to enter.

B. *Mask detection and fingerprint verification:*

Mask detection is performed using teachable machine with the help of ESP-32 cam. Teachable machine is used to create a trained model for mask presence using the Convolutional Neural Network(CNN) algorithm. The NodeMCU and ESP-32 cam are interfaced via Thingspeak, which stores the observation during the mask detection process .If mask is present, ESP-32 returns 1 (a positive constant) to the NodeMCU via think speak. Otherwise, NodeMCU receives a 0 (negative constant). Using these returned values, the NodeMCU controls the system to allow

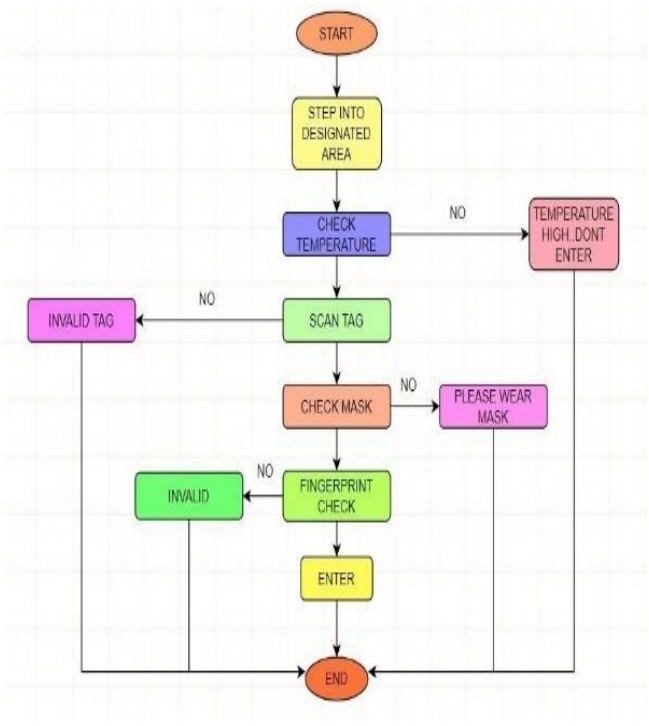


Fig. 1. Logic Diagram of the system presented.

users with face masks to further scan their fingers in their respective mobile application but prevent others from entering. The app is designed in Kodular tool. The app is designed in a way that the person has to enter the local IP of the NodeMCU in the application and scan his/her finger. If the fingerprint matches with the device owner's fingerprint then the validity message is passed to the NodeMCU client using the IP and if the entrant is authorized, then the solenoid lock opens and closes for a fixed time interval in between which a person can enter the room/hall.

C. Hardware Modules:

The proposed system requires a camera for mask detection, two microcontrollers, a battery pack to charge the lock, a stable internet connection and aa RFID reader. The DHT11 sensor and ESP-32 camera will be placed at the entrance. The data is received by NodeMCU and the algorithm for mask detection and temperature measurement starts functioning.

- NodeMCU ESP-8266 has 128Kb of Ram, 4 MB of Flash memory along with WiFi functionalities.
- ESP-32 cam with picture resolution of 1600 x 1200.
- Batteries with combining voltage of 12V to power the solenoid lock.

D. Software Modules:

The regular updates in the system are to be displayed in IOT based mobile application, Blynk. Blynk platform is used to build interfaces for controlling and monitoring the hardware developed from mobile phones. The application provides the user entry details and warning caution messages to the administrative officials when entry of infected and unauthorized people are detected. This application is used to generate a graphical user interface (GUI) or a human machine interface (HMI) by compiling and offering the suitable address on the available widgets.

IV. RESULTS AND DISCUSSIONS

A. Controller And Modules

Fig 2 depicts the hardware configuration of this proposed prototype. The ESP-32 cam gives administrative users visual input and captures images.

The DHT11 sensor is used for contact less body temperature monitoring purpose. The design can be implanted on any door, and the relay module can be used to control the door lock.

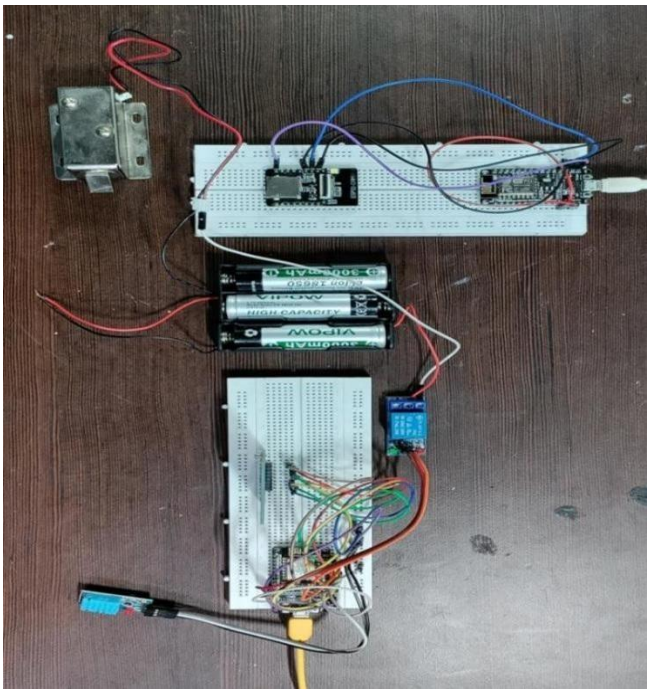


Fig. 2. System model of the proposed work.

B. Data Collection And Preprocessing

Teachable machine is a online Google platform that generates the model for the user requirements using CNN algorithm. Here, two datasets namely 'Mask' and 'Mask absence' are uploaded in the teachable machine. To distinguish between people wearing masks and those who do not, use the model trained on the data set.

C. Mask Detection Results

Fig 3 shows the mask detection outcomes. The model successfully distinguish between persons who wore masks and those who didn't as shown in Fig 3(a) and Fig 3(b).

When the model for mask detection was tested, all 200 tests predicted correct output when a person was actually wearing a mask, but only 185 tests predicted correct output when a person was not wearing a mask, and the remaining 15 tests resulted in fatal output. As a result, the accuracy rate when the mask is present is 100 percent, while the accuracy rate when the mask is absent is 92.5 percent. The accuracy matrix for the facial mask prediction method is shown in Table 1. The bar graph from the mask detection observation is shown in Fig 4.

TABLE I. ACCURACY MATRIX

S. No	Expected result	No. of tests	No. of correct observations	Accuracy level	No. of incorrect observation	Inaccuracy level
1	With Mask	200	200	100 %	0	0 %
2	Without Mask	200	185	92.5 %	15	7.5 %

Fig. 3. (a). Mask detected

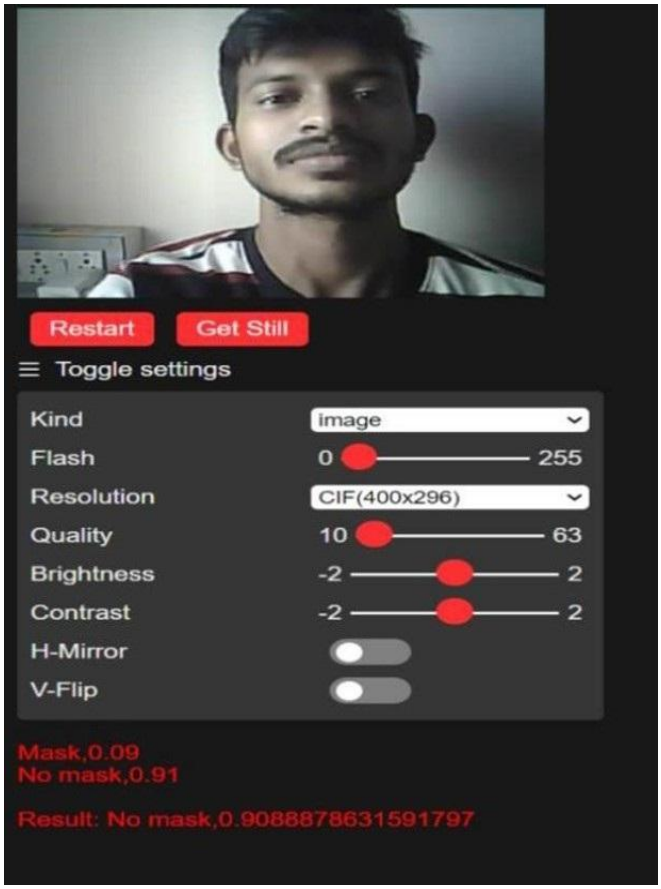


Fig. 3. (b). No mask detected

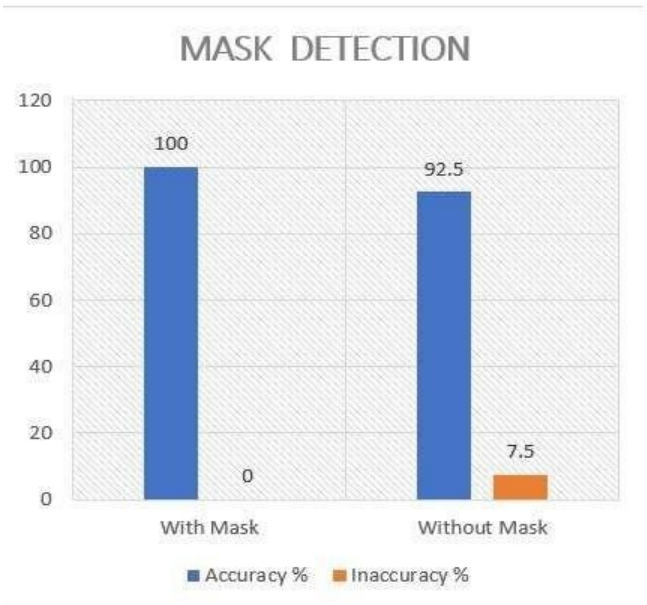


Fig. 4. Accuracy level bar graph

D. Thingspeak Interfacing

Fig 5. Shows the interfacing observation between NodeMCU and ESP-32 cam .The graph rises to bit 1 while mask is present or else it remains bit 0 which signifies mask absence.NodeMCU uses this data to control the lock mechanism in the system.

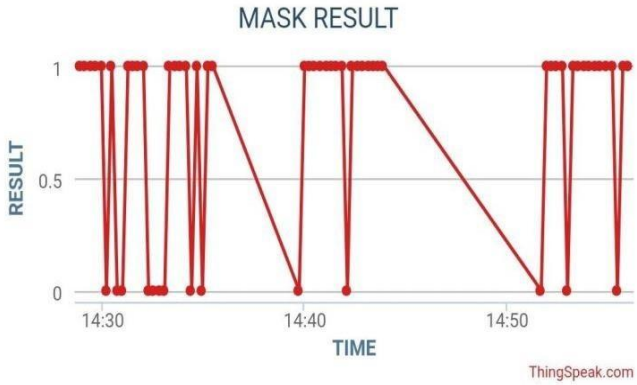
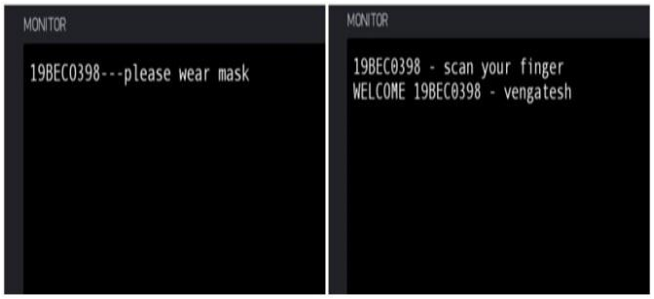


Fig. 5. Illustrates Thingspeak channel

E. RFID AND BLYNK NOTIFICATION

As demonstrated in Fig 6, warning messages and caution alerts are delivered via email and the Blynk interface.

(a) (b)



(c) (d)

Fig. 6. (a) Alert on unauthorized person entry (b) Entry denial for person with high temperature (c) Warning for person without mask (d) Access for user with mask and authentication.

Fig. 7. Fingerprint app

When an authorized user scans his/her finger, the personal app recognizes the user as shown in fig. 7 and passes the message to the blynk as shown in fig.6(d).

In [3], the system architecture is developed based on residency idea where authorized people can enter without mask and unauthorized people with mask has to wait till the acknowledgement from the owner which may take some time. The proposed system in this paper is completely automated, the person will be allowed to enter if they are masked. In [7] the algorithm of the security system is developed on face recognition which is a disadvantage during pandemic, the proposed system in this paper includes security system based on android app fingerprint technology which is an advantage during pandemic. In paper [8] only facemask and temperature is detected and no security measures are indulged which may be a threat and requires human labor, the proposed system in this paper is equipped with two layer security along with temperature and mask detection.

V. CONCLUSION

The COVID-19 outbreak has posed numerous security difficulties. For system security implemented based on fingerprint scanning and facial recognition, physical contact is essential, which becomes a factor in virus transmission. The proposed system is self-contained and contact-free, preventing the spread of pass infection. The designed system is cost effective and efficient because it uses low-cost components and requires little assembly time. The system is especially designed for use in areas such as IT companies, colleges, and schools. Employees and students are encouraged to live in a safe and peaceful environment as a result of this.

As a future work, use of Thingspeak reduces the accuracy of the system,instead alternative methods such as http get option can be implemented to interlink both systems. Advanced camera modules and contactless temperature sensors can be used to reduce the error rate. Entry data can be stored in cloud storages which can be used further for tracking attendance details.

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