COVSTOP:
The door with a brain

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Abstract:

This project tries to address the concern of people regarding rising theft and burglary cases being reported, which are pushing people to look for an alternative, more secure locks for their homes. This project proposes a two-level authentication-based door lock system that incorporates the use of RFID (Radio Frequency Identification) and ESP32 cam module-based Face Detection technology. The RFID detector reads the card id if the RFID card is available with the person, and the face detection checks if the face of the person is registered with the door. If both the authentication levels are cleared, the door is opened. Otherwise, an alert is sent to the owner via telegram app along with a photo of the unauthorized person. The owner can remotely control the door through a telegram app via some commands. Completely contactless authentication and door functioning is the main feature of this project. An additional buzzer alert functionality is provided to alert the insiders if the person entering has a higher temperature than normal. So, using these two authentication levels, contactless, efficient, reliable, and cost-efficient security is provided, and better security is ensured for homes.

1. INTRODUCTION

1.1. Domain in Focus

The domain in focus for our project is the Security of homes which is becoming a matter of concern for most people nowadays. We have tried to work upon new generation Automatic and Smart door locks providing Security and Unauthorized person alert. The increasing cases of theft and robbery in homes, especially in the metro cities, are becoming a cause of concern for the people, and they want enhanced security through smart locks for their homes. Moreover, the automatic and contactless locks contribute a lot to mitigating the risk of covid-19 infection. The control provided to the user through a mobile app notification system helps a lot in intrusion detection, and the door can be controlled from a remote location without any manual effort.

1.2. Target Problem

The target problem is to provide a 2-level authentication-based door lock system for homes, especially flats and closed apartments, through which an authorized person can be easily recognized by the door itself, and an unknown person is immediately reported to the owner through a mobile app notification along with a photo. The two levels of security are RFID and face detection. Along with that, additional functionality of measuring temperature is provided, which alerts the insiders through a buzzer if the temperature of the person entering the house is greater than a fixed threshold and contributes a lot to mitigating COVID-19 threat. Moreover, the remote access to the door provided to the user through the telegram notification system helps a lot in intrusion and theft detection and immediate response to unauthorized entry.

1.3. Motivation & Objectives

The motivation for our project and research came from the fact that the traditional locking

mechanisms, whether mechanical or electrical, are increasingly being breached. Generally, homes in cities are locked in daytime or old age people and children are present, which has led to a surprising increase in theft and robbery cases. The smart locks present in the market are very expensive. So, we have tried to build a reliable and cost-efficient solution to this problem. Through this project, we are attempting to contribute to this domain by providing customers with a 2-level security system through RFID cards and face detection. Our smart door will only allow those individuals into the house who pass both the security levels. Moreover, it is power-saving and also performs a body temperature scan of the individual entering and alerts the insiders through a buzzer if the temperature is found high as he/she could be a potential covid case. A buzzer should alert the insiders if a potential covid patient is entering the house. Moreover, the person entering doesn't need any contact with the door to open it. The security checks and temperature detection are performed in a contactless manner.

1.4. *Contribution*

- Reliable and Affordable Smart Door using RFID and Face Detection
- Contactless Security checks and Temperature Detection
- Remote Access is provided to the user through the Telegram app

1.5. Paper organization

This paper consists of 7 sections, namely Introduction, Study of related literature work done in this field, Background, Methodology, Working of the project, Result analysis, Performance evaluation, conclusion, and future scope.

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2. LITERATURE WORK

Some research has already been done in the field of smart door lock systems and in this section of our paper, we have compiled a list of related research work done to thoroughly study how different researchers are tackling this problem as well as to depict how our product stands out from the rest.

[1] Two Layer Security System Using RFID and Face Detection

Ashok Kumar Yadav, Ramnaresh Yadav, Kumar Abhishek, Akash Kumar

This project includes the two-layer security system implemented using RFID and Face detection for biometric detection. RFID technology deals with the radio frequency waves for transferring data from an electronic tag called an RFID tag, which can be attached to the object which needs to be used as the authentication card or ID card and must be used for authentication purposes. Facial recognition can be done using different features of the face such as eye length, the difference between eyes, nose width, etc. Face recognition can be done majorly using the Holistic approach and the Feature-based approach. Here we have used the Eigen Face Recognizer from the holistic approach where we do facial recognition based on the eigenface, which is obtained using the training set of images. We would use the PCA to extract the features of the faces and more than 80 features of the human face and would store them in the database. Now firstly, we would create the average image using the images, and then we have the eigenface. At the time of detection, we find a new image, and we would add the image to the database if the image is not recognized and would also update the database accordingly. Using this face detection technique, no one would impersonate himself as others, and there would be full authenticity.

[2] Study of Implementing Automated Attendance System Using Face Recognition Technique

Nirmalya Kar, Dr. Mrinal Kanti Deb Barma, Ashim Saha, Dwijen Rudra Pal

Biometric verification is one of the best and most efficient methods through which we can ensure the authenticity of the person, and biometric recognition includes a fingerprint scanner, eye retina scan, and face recognition. The traditional system of verification is generally time expensive and also not very accurate. Here we also maintain the log file to record the entry of each and every entry gone via the facial recognition process. Here we have used the eigenface approach for face recognition. In this method, we compute the faces which are composed of the eigenvectors. Eigen's faces are used to identify the presence of a face and its identity. Whenever any face is to be verified, then the eigenface is calculated for that image by comparing it with a similar eigenface and using statistical analysis to determine whether the image is a face or not. The final step includes whether the face is recognized by the system or not, and if the face is recognized, the person ID number is returned. Here initially, the frontal face is extracted from the image, then PCA is performed, and the eigenvalues are stored in an XML file. And then, the eigenvalue is calculated, the nearest image eigenvalues stored in the database are matched, and the face is recognized.

[3] Smart digital door lock for the home automation

Yong Tae Park, Pranesh Sthapit, Jae-Young Pyun

In this paper, we propose a clever system for locking digital doors for home automation. A digital door lock system is a device that uses digital information such as secret codes, semiconductors, smart cards, and fingerprints as a guarantee instead of a legacy key system. In our proposed system, the ZigBee module is embedded in a digital door lock, and the door lock serves as the main controller for the entire home automation system. Technically, our proposed system is a network of sensor nodes and actuators with digital doors as the primary channel. The proposed door lock system here includes an RFID user verification reader, LCD touch, car door opening and closing module, indoor sensor modules, communication module, and control module to control other modules. Environmental sensor nodes are used in appropriate areas of the home. The status of ZigBee's individual modules can be monitored and controlled by a central controller, a digital door lock. Since the door key is the first and last thing people encounter when entering and leaving a house in a row, the function of home automation in the digital door lock system enables the owner to control and monitor the home environment and situation simultaneously before entering or leaving the house. In addition, it also allows users to remotely monitor the situation inside the house via the Internet or any other social network. The advantage of our proposed system is that it can be easily installed, if necessary, without the need for any infrastructure and proper planning.

[4] Smart Door Lock System With Automation And Security

Ibshar Ishrat, Wajiha Muzaffar Ali, Sana Ghani, Sadia Sami, Maria Waqas, Fakhra Aftab

This system is designed mainly for home door locks; this design can be customized for different kinds of locks as per the need. It uses Raspberry pi as the main device with Raspbian as the operating system to be installed near the lock. Different sensors have been interfaced to detect doorbells and knocks. It also notifies if any suspicious person is sensed. The system also keeps track of the door status, i.e., opened or closed. It notifies the user of the visitor or the suspicious person detected through the mobile application along with the picture. For notification, the system has made use of the Google Cloud Messaging service. The user, if intended to, can unlock the door for the known visitor or make an emergency call in case of suspicion. The door would be unlocked after the verification of the pin code. One Application would be capable of controlling and monitoring different locks.

[5] IoT-Enabled smart doors for monitoring body temperature and face mask detection

B Varshini, HR Yogesh, Syed Danish Pasha, Maaz Suhail, V Madhumitha, Archana Sasi

This research paper contains details about the implementation of IoT-enabled smart doors for monitoring body temperature as well as face mask detection. Hardware required for this smart door project is Raspberry Pi, Raspberry Pi Camera, IR Sensor, Temperature Sensor, and Servo Motor. TensorFlow, PuTTY, and VNC viewer are the software requirements. A deep learning algorithm is used to identify face mask recognition. The face of an individual is captured, and the blob is constructed from the captured image that depicts people with and without wearing masks. This blob is passed via CNN to achieve face detection from the extracted blob, and probability is also associated with extracted detection. The extracted face is now sent via the mask detection algorithm to detect whether the individual is wearing a face mask or not. The MLX90614 sensor is connected to the RPi's GPIO Pin for temperature. An appropriate code is written for the sensor. The output is in Celsius. Sensors that are used to monitor the number of people entering and leaving the room are IR sensors. So, the IoT technology keeps track of the number of people in the room as well as their body temperatures while the face mask detector identifies individuals without a mask. The door does not open if a person's body temperature is very high; else, it proceeds to the next level, i.e., face mask detection. The accuracy for the intended purpose of face mask detection and body temperature measurement was measured to be around 97 percent.

[6] Contactless Body Temperature Monitoring of In Patient Department (IPD)

Wasana Boonsong, Narongrit Senajit, Piya Prasongchan

This research paper mentions an IoT network-based Contactless Body Temperature Monitoring of Inpatient Department (IPD). The device intends to track the body temperature of IPD automatically using a wireless infrared sensor embedded IoT-Microcontroller module. The overall system is designed and developed as an embedded system. The system uses an infrared temperature sensor that works with an IoT-WIFI controller on the NodeMCU ESP32 board. The detected data about a patient's temperature is transferred to the patient via the internet network. The NodeMCU ESP32 is a

controller unit that processes and transfers data through a router to store on a cloud network. Data is stored in real-time. The DCI90614ESP infrared sensor is a non-contact thermometer for use with any microcontroller which can communicate with it through its I2C interface. ESP32 is a single 2.4 GHz Wi-Fi and Bluetooth combo chip designed to achieve the best TSMC ultra-low power consumption and RF performance with robustness, versatility, and reliability. The IR sensor used provides high precision non-contact temperature measurements with a range of around 50 cm. An organic light-emitting diode (OLED) was adopted to create digital displays in the temperature monitoring device. The embedded program can detect the human's body temperature according to the user's design. When the monitored temperature value is recorded equal to or higher than the reference value, the alarm function notifies the user and the user's device of it. The wireless IoT-body temperature monitoring device was found to have a reliability rating of almost 50% and can be calibrated a few times to improve the same.

[7] Smart Door Lock System

Shashidhar Rudregowda

This smart door lock system is mainly targeted to provide high security at a low cost. The fingerprint of the user is stored in the microcontroller. If a user scans his fingerprint and is detected as authorized, an OTP is sent on his/her mobile number using GSM. And in other scenarios where the fingerprint is not matched, OTP will not be sent to his mobile number. Instead, the buzzer will turn on, indicating that someone is trying to access the door.
This can be implemented in the places where security plays a major role, that is, in banks, offices, etc.

[8] Smart and real-time door lock system for an elderly user based on face recognition

Rezki Saputra, Nico Surantha

This project is designed especially for older people who are unfamiliar with modern marking technology, smartphones, or other ways of interacting with users. This smart door is based on a face recognition algorithm with an architectural system design. Automatic facial recognition key locks activate by detecting movement in the environment using the PIR sensor. After finding someone, Arduino will turn on the light and, at the same time, send a message to the Raspberry Pi to see the face. If the found person is identified as the owner in relation to the site, if the face is matched, the Raspberry Pi will activate the solenoid to open the door, then the owner can open the door and enter the house. As soon as the door is opened, the magnetic field will change. When the door closes, the magnetic field can rise, and the Raspberry Pi will stop the solenoid from blowing to lock the door.

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3. BACKGROUND

Security of homes is one of the main concerns for people nowadays. The constant uptick in theft and robbery cases is pushing people to look for some alternative, more secure locking mechanisms than the current manual locks in use, as they are increasingly being compromised. Every house generally comprises one or more entrances. The main door is the most vital security component to consider, especially in houses where entry is possible only through the main door, such as flats. The main Doors and their associated locking mechanisms are the most important components to consider while looking for the security of homes. Different door locks are present in the market for installation, such as mechanical ones or electronic locks. But every lock has a weak point of its own, and the thieves and robbers are able to get access to the homes by breaking or disabling the locks.

According to a National Crime Records Bureau report, a case of theft, robbery, or dacoity is reported every 3rd minute. In 2017, the value of property stolen from residential premises was in excess of Rs. 2065 crores which is a 40% jump from Rs. 1,475 crores were stolen the previous year, i.e., in 2016. As many as 33% of cases (2,20,772 out of 6,68,061 cases, to be precise) were registered under theft under the IPC cases. Around 90% of cases registered under Offences against Property were of theft and burglary. Theft and dacoity are among the most common and most feared crimes in India. Theft is also the second most common crime against senior citizens of the country.

So, there is a need to invent such locks which cannot be easily broken or compromised, and whenever an unauthorized person, possibly an intruder, is standing in front of the smart lock enabled door, an alert, possibly with a photo of the person is sent to the owner of the house. An automatic door locking system that can ensure that only authorized persons are allowed entry to the home or premises where it is installed and instantly alerts the owner of an unauthorized person standing outside or trying to break into the house is the need of the hour. The unauthorized person alert becomes a necessity because if all the house occupants are out for some reason, then the thieves could easily break in and

steal the precious hard-earned items, money, or jewellery from the house. Also, a huge bonus would be to provide a live stream of the house to its owner, which can be accessed via a mobile or laptop.

This project aims to utilize the Internet of Things (IoT) technology for providing the people concerned about the safety of their homes or flats with an efficient, reliable, and cost-effective door which has been named "COVSTOP: The Door with a brain." IoT utilizes the ability of sensors to collect data and the ability of microcontrollers to control the devices connected. The 5 components of IoT, namely Thing, Controller, Sensor, Actuator, and Communicator, are effectively used to provide the enhanced and unbreakable security mechanism enabled smart door.

The main functionalities which people search for in smart door locks include ease to use, durability, automation, enhanced security, and alert mechanism, to name a few. All the needs and requirements of people have been kept in mind while designing the product, and they have been well taken care of. Our focus has been on a completely contactless system to lend a helping hand in the fight of the world against the unprecedented COVID pandemic. Therefore, the proposed product makes use of the RFID authentication and face detection technology as its two levels of authentication for providing entry to the house and a contactless MLX temperature sensor for measuring temperature. RFID is a very fast, fundamental, and inexpensive technology for authentication. The face detection is performed through the ESP32 cam module, which is again a very small and inexpensive device. This product deals with all the needs and requirements of city residents and people residing in theft-prone areas, and it could prove to be a gamechanger in the home security domain.

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4. METHODOLOGY

ESP32 CAM

ESP32 CAM (in fig 4.1) is a small microcontroller or module with an ESP32 S chip, which offers both Wi-Fi and Bluetooth connectivity. It has several GPIO pins, a flash with an OV2640 camera, and a microSD card slot that supports a maximum 4GB memory card in which we can store captured images or videos. It is a separate microcontroller that needs to be coded by either an FTDI programmer or an Arduino.

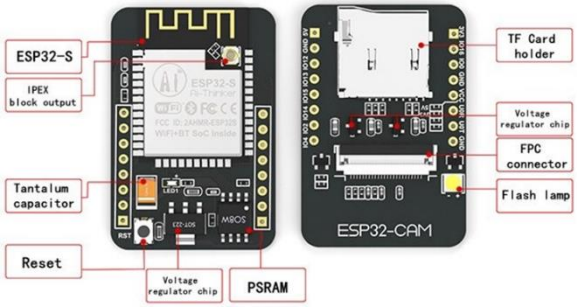

Fig. 4.1: ESP32 Cam

MLX90614

Fig. 4.2: MLX Temperature Sensor

MLX90614 is an infrared thermometer used for contactless thermal scanning. It is small with a pretty good accuracy which gives a temperature with the minimal error of ± 0.5 o C. IR sensitive Thermopile detector chip and the signal conditioning ASIC are integrated together. It can measure the temperature ranging between -20 to 120°C.

RFID RC

Radio **F**requency **Id**entification (in fig. 4.3). The RC522 RFID Reader creates a 13.56MHz electromagnetic field that it uses to communicate with the RFID tags. It consists of two things: reader and tag. A reader sends electromagnetic waves; when the tag comes in close contact, it captures energy from waves and sends a response to the reader.

Fig. 4.3: RFID

HC-SR04 Ultrasonic sensor

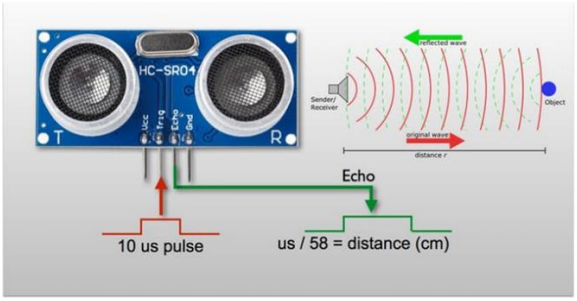

Fig. 4.4: HC-SR04

It is a low power, inexpensive, easy to interface distance detector which works on the principle of calculating distance using the time gap between original and reflective wave and the speed of sound. It provides detection between 2cm to 400 cm. It uses ultrasound (high frequency sound, inaudible to humans). Ultrasonic distance sensor consists of two ultrasonic transducers. The purpose of one transducer is to transmit ultrasonic waves and other is to capture the reflected sound.

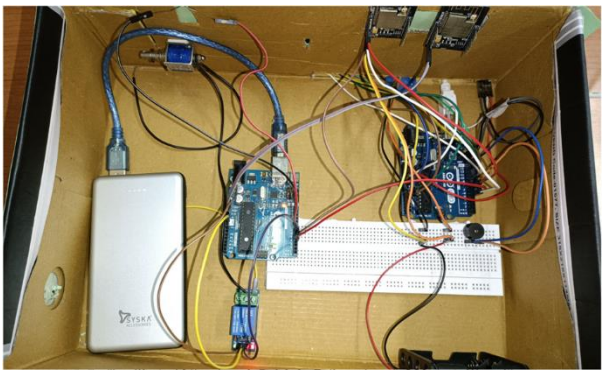

Fig. 4.5 Internal circuitry

In this project (in Fig. 4.5) we have used two ESP32 CAM modules, one for face recognition which tells whether the person standing in front of the door is authenticated i.e., whether his/her face is enrolled in the database or not. The other ESP32 CAM is used to capture the image and communicate with telegram. ESP32 CAM livestream the captured video on the Wi-Fi server. On that we are performing operations such as detecting if there is any face in camera range, verifying the face with the enrolled images, capturing a still photo and sharing it to telegram.

HC-SR04 Ultrasonic sensor sends ultrasonic sound, and captures the time between the transmitted and reflected sound. Using the formula:

Distance=duration*0.034/2,

Distance can be calculated using the above formula. If the distance lies between the desired range, our gate captures the temperature to identify if the entity in radius is a human or an object.

If the temperature lies between human range, users have to scan an RFID card, and the door matches the RFID value to the authorized ids. If RFID matches, one output pin of Arduino going to ESP32 CAM to do face recognition turns high. That ESP32 CAM has 2 output pins, and 1 input pin. One output pin turns high only in the case if the face is matched and this pin is going to the Arduino which in turn opens the gate. In the case if there is any face detected but is not registered, the intruder pin turns on which goes to the second ESP32 CAM.

Second ESP32 CAM has 1 output pin and 2 input pins, one coming from Arduino which is HIGH if there was no RFID with person or RFID scanned was wrong and the other from first ESP32 CAM implying there is someone unregistered standing at the door. If any of the pins turns HIGH, that ESP32 CAM communicates with telegram using telegram bot and sends a photo to the owner of the house. Owner can further communicate with the door using a second ESP32 CAM either by requesting another photo, or turn on/off flash, unlock or lock the door remotely if he wants from anywhere. ESP32 CAM searches for any new message every second. If the command is to lock or unlock the door, ESP32

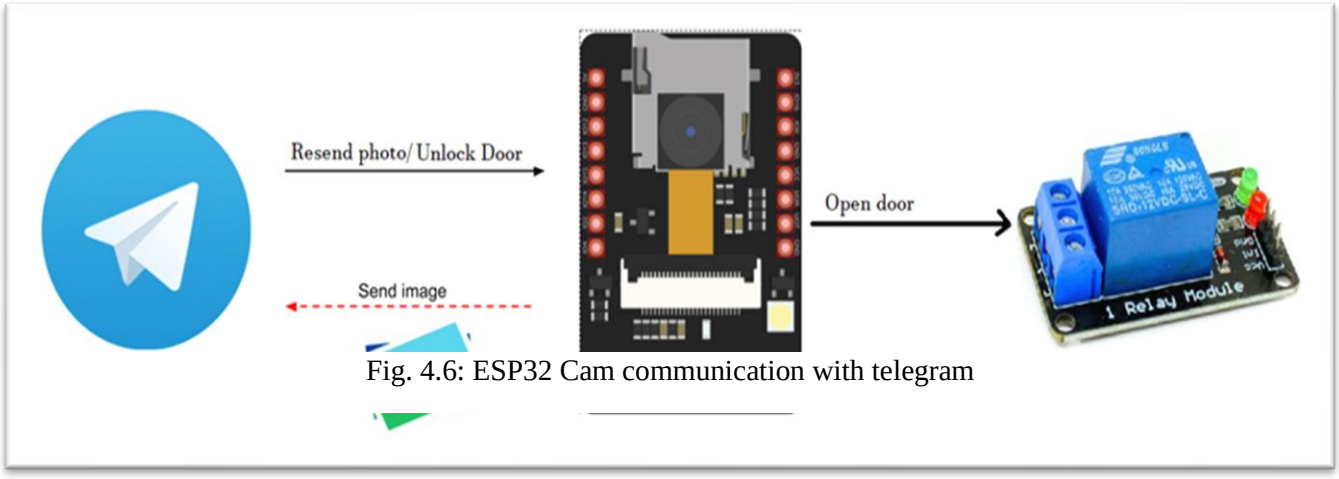

Fig. 4.6: ESP32 Cam communication with telegram

CAM communicates with the relay through one output pin.

Relay then activates the solenoid lock in every case the door unlock pin is turned on. This whole system is contactless and prevents any unauthorized access. Members inside the house are also alerted through a buzzer sound if any person has fever through the buzzer. We can access the livestream to check the outside view of the door anytime we want, which also gives insiders access to live surveillance cameras. We have also given a feature to add/remove any face from the registered faces anytime the customer wants

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5. WORKING OF COVSTOP

We have deployed an **ultrasonic distance sensor HC-SR04** at the door which is used as a distance detector to detect if someone is standing near the door and if someone is found standing near to the door it triggers temperature check along with our two-level security checks in order to check for his/her authentication to enter the premises or not. Here in this project, we have set our lower limit of proximity range as 10 centimetres and upper limit for the same being 30 centimetres. This range can be easily altered as per customer's requirements. If the ultrasonic sensor HC-SR04 detects that someone is standing in close proximity to the door, it activates our **MLX IR contactless temperature sensor** which measures the temperature of the object in front of the door. If the temperature measured does not fall in the human range, in that case we abort the security checks and the control is given back to the ultrasonic sensor. But if the measured temperature is in human range, then two different cases will arise. One being that the temperature is normal. Second being that the temperature is high which signifies that the person standing outside could be a potential covid patient. In the second case we alert the insiders of the premises by sounding the buzzer so that they can take all the precautionary measures and follow covid appropriate behaviour with the person. After this temperature check, we proceed to the security checks needed to grant access for entering the premises to the person. Here we have implemented a two-level security check by incorporating **Radio Frequency Identification (RFID)** verification as the first and primary level security check along with **ESP32 Cam based face recognition** as the second and secondary level security check.

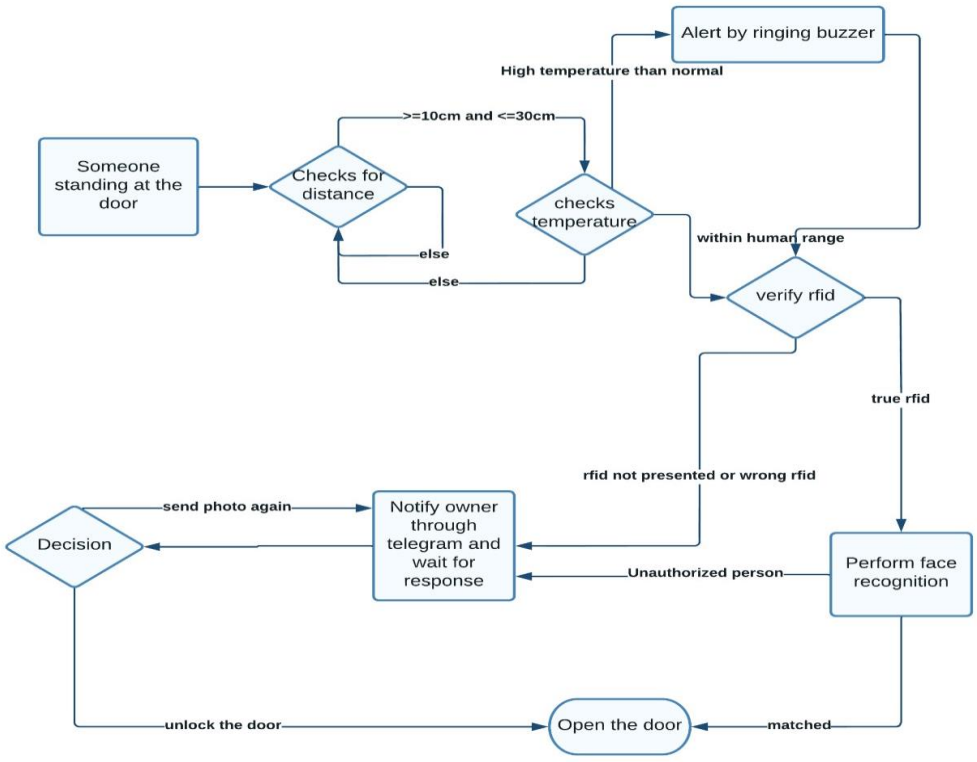

Fig. 5.1: Workflow of the project

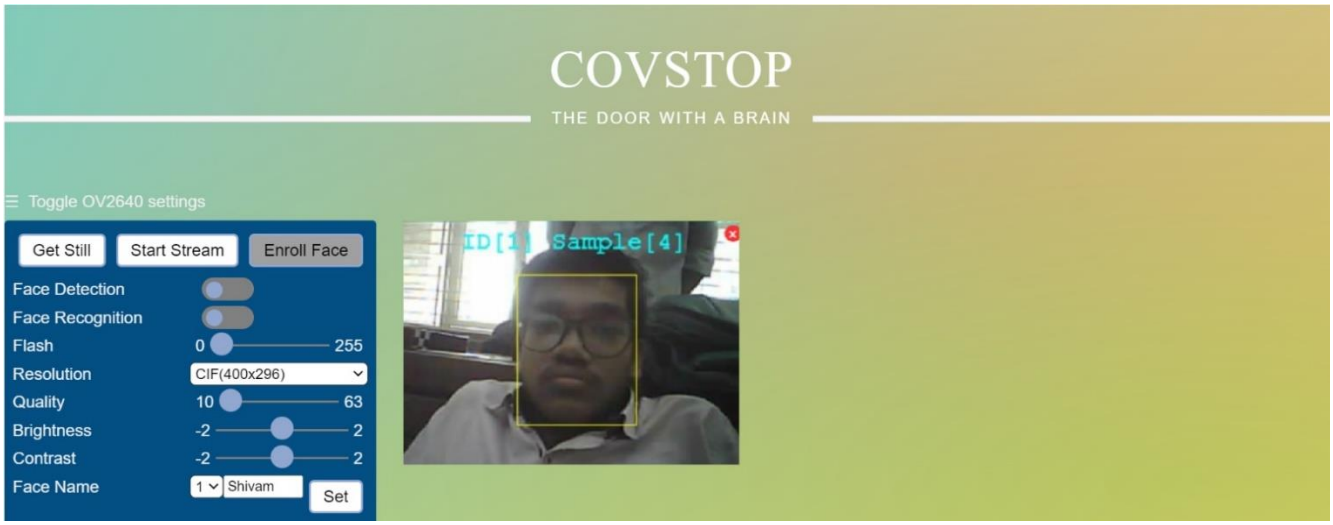

Fig. 5.2: Website with enroll face feature

THE MOTIVATION/ REASON BEHIND OPTING FOR A TWO-LEVEL AUTHENTICATION AGAINST A SINGLE LEVEL AUTHENTICATION.

The reason for opting for a two-level authentication was to provide people with an enhanced security cover regarding the authentication of the person trying to enter the house. The RFID card, as we all know, could be misplaced, and a person with bad intentions could get access to it. Moreover, the ESP32 cam-based face recognition is also not 100% accurate, and a person with a similar face to some authenticated person could be recognized as known by the camera. Because of these reasons, it was decided to go with two levels of authentication. Nevertheless, the product is totally flexible, and if a customer wants the door to be opened on passing any single authentication level, the smart door can be easily modified according to the same.

As mentioned above through RFID verification we check for the first level of authentication. Again, two cases will arise:

CASE-5.1: RFID MATCHED

CASE-5.2: INVALID RFID/RFID NOT MATCHED/NO RFID AVAILABLE

In case 1 when the RFID match was successful we proceed to our second level security check i.e. face recognition which is performed by the ESP-32 CAM attached on the door. There will again be two subcases to this particular case:

CASE-5.1.1: FACE MATCHED WITH THE ENROLLED FACES

CASE-5.1.2: FACE RECOGNITION UNSUCCESSFUL

In **CASE 5.1.1** i.e., after successful RFID match along with successful face recognition as the person has passed both the primary as well as secondary security checks so he/she is granted access to enter the premises and ultimately the gate opens.

Whereas in **CASE 5.1.2,** where secondary security criterion is not met, we notify the owner of the house via telegram app by sending the photo of the person standing outside and letting the owner at his/her end decide whether to grant access to the person or not. There are various commands which the owner can send as a response message in order to control the door remotely. These commands are:

1. **/UNLOCK** Command sent as a response message by the user to unlock and open the door remotely.

2. **/LOCK** Command as response message to lock the door remotely.

3. **/PHOTO** To demand for a new photo

4. **/FLASH** To toggle the flashlight.

In **CASE 5.2** where the RFID scan is unsuccessful or if the RFID is not available, then also we notify the owner of the house via telegram app by sending the photo of the person standing outside and letting the owner at his/her end decide whether to grant access to the person or not by sending the any of the above discussed commands as the response message to the photo sent via the app.

6. RESULT ANALYSIS AND PERFORMANCE EVALUATION

COVSTOP is a completely contactless smart door lock system with an inbuilt feature to detect the potential covid patients along with the RFID verification and Face Detection authorization. To check the working of the complete project and to analyse its performance in various scenarios possible, it was tested for face detection accuracy along with its RFID verification capability and whether it sends the images to telegram in case of an unauthorized person trying to enter the house.

To analyse the working of the project, we have tested all the possible scenarios discussed below:

1. RFID verified and Face Matched
2. RFID verified but Face not found in database
3. RFID not verified

Results Obtained:

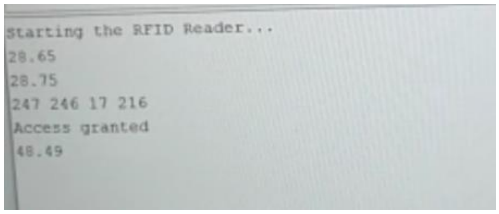

Fig. 6.1 Case-1

Here, first of all, the ultrasonic sensor detects whether someone is near the door and is within a range of 10-30 cm. Only then the RFID scanner activates and reads the card ID from the RFID tag; if the user is unable to provide the RFID card within 3 seconds, then we assume that the person does not have the card and proceed with the 3rd scenario. According to the above image, we can see that when a person is 28.75 cm away from the door, the card ID of the RFID tag presented is read, and as the face is matched, access is granted. Along with this, the temperature of the person is also displayed so as to detect whether he/she is a potential covid patient or not.

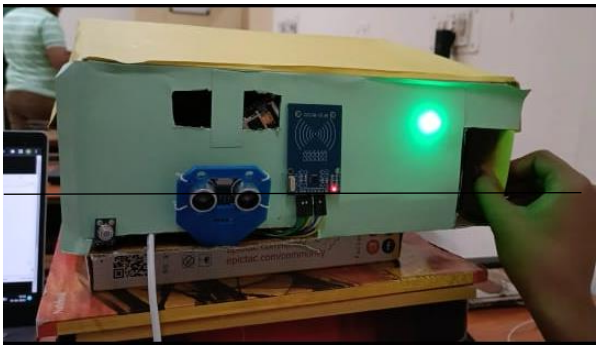

Fig. 6.2: Gate opens

The door gets opened successfully when both the authentication levels are passed.

Fig. 6.3(a): Case-2

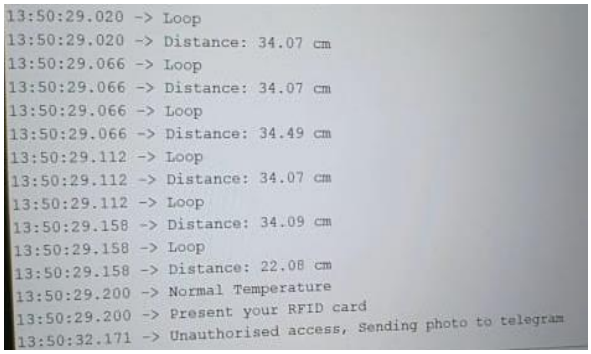

Fig. 6.3(b): Case-2

In case the person is able to present an authentic RFID card, but his/her face is not recognized, then the door automatically sends his/her photo to the telegram, and the control is provided to the owner whether to unlock the door, let the door to be in lock state or get another photo of the person at the door.

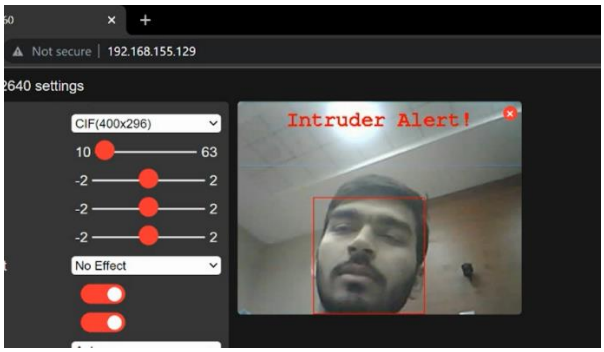

Fig. 6.4: No face matched

So, in this scenario, when a person comes in the range of 10-30 cm, the RFID scanner reads the card ID of the RFID tag, and the RFID card is matched, but the face of the person is not recognized, then a photo of the person is sent to the telegram, and this may be a case of a thief trying to gain entry into the house.
The owner gets notified about the person standing at the door and can remotely give commands to unlock or lock the door. There is also a command provided to ask for another photo of the unrecognized person. As shown in the image above, the owner gets another photo of the person standing at the door.

When the user gives the command '/unlock,' the door gets unlocked, and the green led gets switched on, depicting that the door is opening, as you can see in the image below.

Another case is that no RFID card is presented by the person to the door when the user is in the range of 10-30 cm as detected by the ultrasonic sensor, then the door automatically assumes that the person may be an intruder and sends his/her photo to telegram of the owner same as in the 2nd scenario discussed above and the further working remains the same as in the 2nd case.

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7. CONCLUSION AND FUTURE WORK

Through this project, a new smart door locking mechanism was devised, which is more efficient, secure, and user-friendly than the other door locks currently in use. The use of RFID provides a very affordable and convenient way to check for authentication. The ESP32 cam-based face detection works in real-time and requires absolutely no action from the person willing to enter apart from standing in front of it to capture his/her face. The primary aim to provide a cost-effective, reliable, and secure door locking system is met through this project. The smart door allows a person entry into the house if both the security clearances are met and immediately notifies the owner through telegram if any of the authentication levels is not cleared. Moreover, the product can be modified according to the user's needs; for example, if someone wants the door to allow entry on either RFID authentication or face matching, that could be easily implemented. In a nutshell, it is a viable alternative to most of the door locks currently in use.

While working on this project, some potential future routes have been identified if this project is to be scaled to an industry-standard product, some of which are described below:

- In an industry-standard product, to minimize the hardware size and to maximize processing capability, more powerful camera modules can be used.
- Iris recognition can be incorporated with face recognition if the domain area is more sensitive and requires enhanced security like military bases.
- Image Classification can also be incorporated into an industry-standard product so that if an animal is present in front of the door, then the hardware does not unnecessarily alert the owner through mobile notification.

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