Smart Lock Using Image Recognition

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***Abstract*— In this age of technology, smart lock system technology has have become vital and indispensable in current times. The software program of image recognition systems can be implemented to surveillance at home, workplaces, and campuses, accordingly. Image processing system is extensively used for human identification because of its potential to measure the facial factors and recognize the identification in an unobtrusive way. In this paper, the design and development of smart lock system using image recognition, the authentication module and the design of real-time face recognition smart lock system embedded. The registered user's image is saved in the device as a dataset to train the lock. The system recognizes the registered faces very fast and controls the hardware part to be unlocked. This project will modifies a standard shelf to have a security system that unlocks the use of Face Verification. Then it will assembled a Windows Forms Application which can store, verify, and unlock trusted faces. It will build a Face ID controlled Digital Door lock system using ESP32-CAM, which transmits the live pictures of the visitors via email along with an SMS notification.**

Keywords—face recognition, smart lock, face verification, SMS notification.

I. INTRODUCTION

In today's modern technology everything has to be a little bit easier. In that era, facial recognition opened the door to a new way of security. Firstly, it will detect the face of the person on the door. If the face is already registered, then it will open otherwise the alert message will be sent to the owner and buzzer will start to buzz. The camera will record the video data and that recorded data can be stored by using cloud-computing. We can capture live video with our HD camera, and it is connected with the microprocessor and the captured video can be saved in the cloud. And then when we need it, the captured face can be processed by the app, and it will detect and send it to Microsoft FACE API for detecting whether to open the door or not.

Fig 1: Smart Door Lock System using Face Recognition

These kinds of technologies make life much easier and smarter. We can be even more convenient with automatic door opening. Day by day everything became automatic, so in near future almost every home and office will become automated. We just have to take it to the industry level and make it less expensive so that mass people can buy it.

If we focus on the past few years, most of the industries are working in the fields of machine learning, artificial intelligence, big data analytics, etc. IoT based projects are the major motto of all these companies, which will eventually make things easier and smarter. For these reasons, it became a vital need to digitalize our daily life locks with loT security tools. As a result, industries introduced the locks movable with stepper motors with digital number pad to get input from the user, and it needed to add infrared or Bluetooth modules to operate all these devices. A major difference in face recognition door lock with these locks is that there is no need to use a stepper motor, the application detects the face with stored images in the application program in our application. We have eliminated unwanted components like stepper motors and drivers which are used in existing models. We are using newer and unparalleled features of facial detection as an access point to open or close the door. Where it is the combination of relay module and solenoid lock for opening the door, so it became unique and user friendly. This new facial recognition door model allows people to get more interested in it because of its features and advantages and also due to its functionality.

We live in a time where lots of robbery and thefts are going on, as a result having good door security becomes a significant issue for all. Even if we have normal analog locks to the door, unwanted guests can enter inside by getting a key or cloning a key. Else if we use password locks, there is also a chance that they can open it by stealing the password or using modern technology. Facial recognition locks ultimately solve this problem. By using the facial recognition door lock, our homes and offices will become more secure and safe. In this new era, face recognition door locks will play an important role for security and privacy purposes. These face recognition locks will identify people, who the person is, and if the face is matched with stored data from the database, then it will automatically open the door otherwise it will be sent an alert message to the owner.

Right now, IoT based face recognition applications such as smart classrooms, all home security systems, refrigerators, smart surveillance, smart vehicles, and many other applications are popular worldwide. This normal door to smart door converting idea actually started in 1950 but was first implemented in 1970. Then it went through lots of modifications and following this trend we are proposing this

high featured door lock with facial recognition. For every smart application they have their own drawbacks and advantages. But people tend to choose the one which is safer and smarter than other door locks. Our proposed smart door lock with face recognition will have all the features that people need. [1]

II. TOPOLOGY

The ESP32-CAM module can be programmed with an ESP-IDF or with Arduino IDE. ESP32-CAM component also has several GPIO pins to connect the external hardware. We need an FTDI board to program the module as the ESP32-CAM doesn't have a USB connector.
For our proposed lock system, we can use the following connections so that our system can be connected to our laptop or pc for coding purposes.

ESP32-CAM	**FTDI Board**
5V	VCC
GND	GND
UOR	TX
UOT	RX
ESP32-CAM	**Relay Module**
5V	VCC
GND	GND
IO4	IN

We are going to code from a laptop using Arduino IDE by first installing the ESP32 add-on. But before we code, our circuit should look akin to the following:

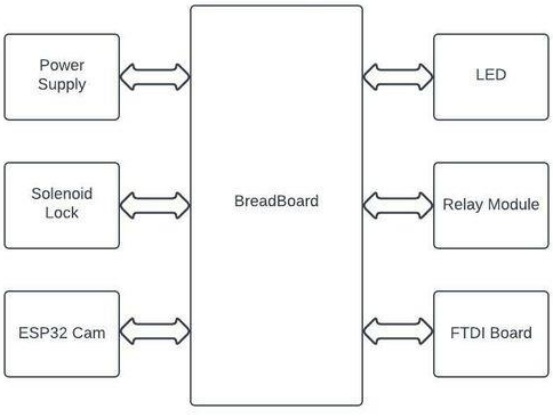

Fig 2: block diagram of the proposed topology of smart door unlock system
As depicted by the block diagram, we connect a +12v power supply to the bread board, the ESP32-CAM module around which we connect using jumping wires the Relay Module, the Solenoid Lock, the LEDs, and two wires into an FTDI Board through which we can program the CAM module to receive input and output instructions visually and work with the connected apparatus accordingly. Below we also shown the flow chart of the proposed topology of smart door unlock system.

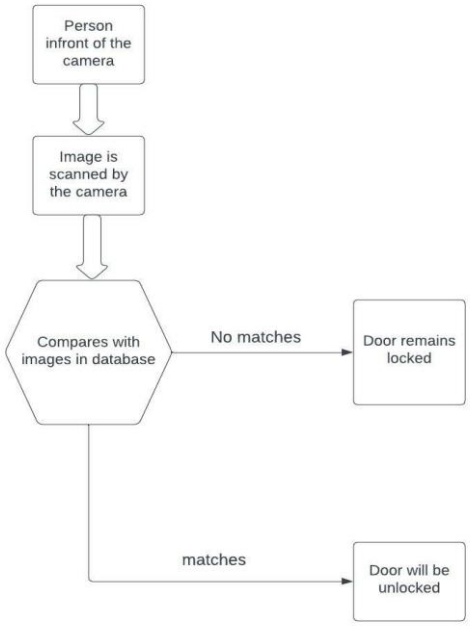

Fig 3: Flow chart of the proposed topology of smart door unlock system

III. PROPOSED SYSTEM DESIGN AND SIMULATION

For developing face recognition door we need a set of instruments like ESP32 CAM (for capturing face id), FTDI Board, Relay module, Solenoid lock, LED(red and green), Breadboard (for connections) , 12v power supply or battery and jumping wires for all the connections.

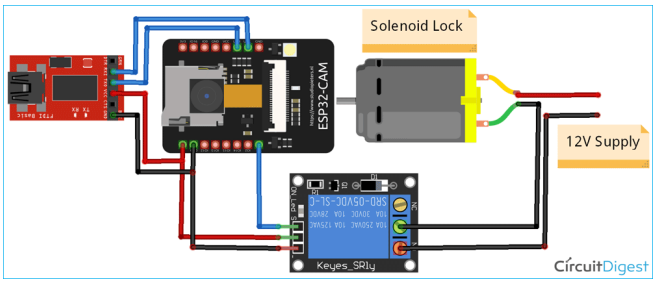

FIG 4: ELECTROMAGNETICS CONNECTIONS ON BREADBOARD [2]

The electrical circuit above combines an FTDI board, Relay Module, and Solenoid Lock. The FTDI board is utilized to flash the code into ESP32-CAM as it doesn't have a USB connector while the relay module is used to switch the Solenoid lock on or off. TX and RX of the FTDI board are connected to RX and TX of ESP32 and the IN pin of the relay module is connected to IO4 of ESP32-CAM. VCC and GND pins of the FTDI board and Relay module is connected to the Vcc and GND pin of ESP32-CAM.

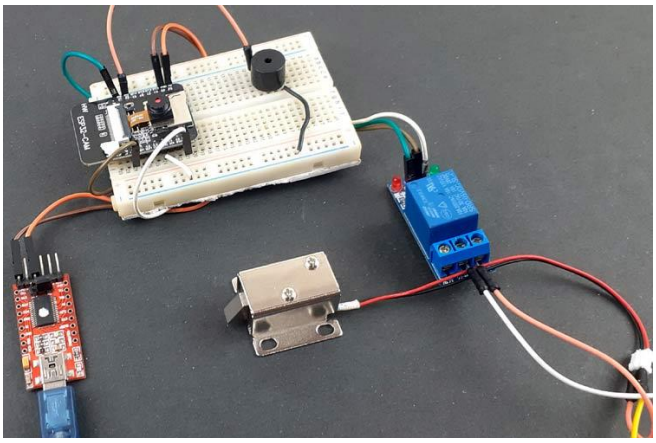

FIG 5: DESIGN OF A CIRCUIT FOR OUR SYSTEM [2]

IV. HARDWARE DEVELOPMENT AND TESTING

A. *Hardware Development of the proposed Lock*

ESP32-CAM: The ESP32-CAM module is a low-cost development board with a very small size OV2640 camera and a micro-SD card slot. It has an ESP32 S chip with built-in Wi-Fi and Bluetooth connectivity, with 2 high-performance 32-bit LX6 CPUs, 7-stage pipeline architecture.

FTDI Board: FTDI Board develops, manufactures, and supports devices and their related cables and software drivers for converting RS-232 or TTL serial transmissions to and from USB signals, in order to provide support for legacy devices with modern computers.

Relay Module: A power relay module is an electrical switch that is operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a micro controller. When activated, the electromagnet pulls to either open or close an electrical circuit.

Solenoid Lock: A solenoid lock works on the electronic-mechanical locking mechanism. This type of lock has a slug with a slanted cut and a good mounting bracket. When the power is applied, DC creates a magnetic field that moves the slug inside and keeps the door in the unlocked position.

Jumper Wires: A jumper is a tiny metal connector that is used to close or open part of an electrical circuit. It may be used as an alternative to a dual in-line package (DIP) switch.

Hardware Procedure:
This part covered the essential settings including the ESP32 Camera board manager installation. The system is powered by ESP 32 CAM circuit. The Circuit Diagram for ESP32-CAM Faces Recognition Door Lock System is combined with an FTDI board, Relay Module, and Solenoid Lock. The FTDI board is employed to flash the code into ESP32-CAM because it doesn't have a USB connector while the relay module is employed to modify the Solenoid lock on or off. The circuit diagram is shown below. Here Arduino IDE is employed to program ESP32-CAM. The entire code is split into four parts. One is that the main code for the camera and relay module were the ESP32 locks or unlocks the door consistent with face recognition, and therefore the other three codes are for website, camera index, and camera pins. After completing the code, insert the network credentials. To acknowledge the faces with ESP32-CAM, first, we've to enroll the faces. For that, activate the Face recognition and detection features from settings then click on the Enroll Face button. It takes several attempts to save lots of faces. After enrolling the faces, if a face is recognized within the video feed, ESP32 will make the relay module unlock the door. Whenever the person comes ahead of the door, it recognizes the face and if it's registered then it opens the door.

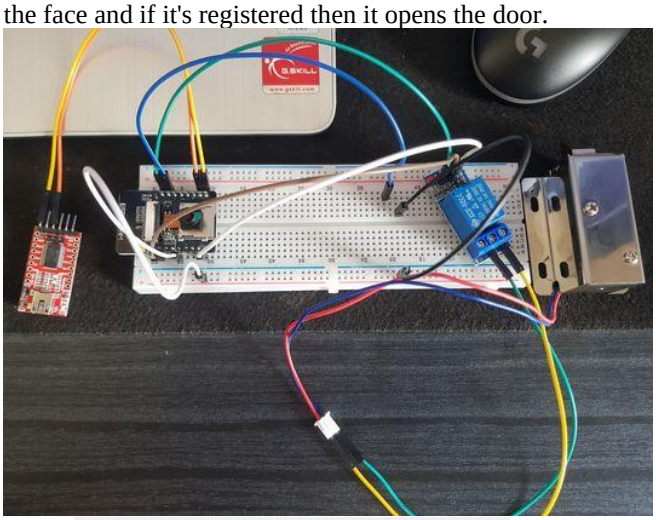

Fig 6: ESP32-CAM Face Recognition Door Lock System

Install ESP32 Board on Arduino IDE:

Here Arduino IDE is used to program ESP32-CAM. For that, first, install the ESP32 add-on on Arduino IDE. To install the ESP32 board in your Arduino IDE, go to ***File> Preferences.*** Now copy the below link and paste it into the "Additional Board Manager URLs" field as shown in the figure below. Then, click the "OK" button:

https://dl.espressif.com/dl/package_esp32_index.json

Now go to *Tools* > *Board* > *Boards Manager*. In Board Manager, search for ESP32 and install the "ESP32 by Espressif Systems".

B. *Experimental Testing of the proposed Face Lock System:*

Finally to upload the code, connect the FDTI board to your laptop, and select the 'ESP32 Wrover Module' as your board. Also, change the other settings as shown in the below picture:

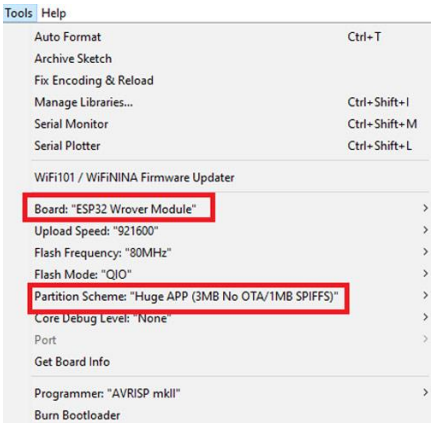

Fig 7: ESP32 Wrover Module'

Don't overlook to attach the IO0 pin to GND earlier than importing the code and additionally press the ESP32 reset button after which click on at the add button.
Note: If you get errors while uploading the code, check that IO0 is connected to GND, and you selected the right settings in the Tools menu.

After importing the code, do away with the IO0 and GND pin. Then open the serial display and extrade the baud price to 115200. After that, press the ESP32 reset button, it'll print the ESP IP cope with and port no. at the serial display.

Now navigate to the browser and input the ESP IP address this is copied from the Serial monitor to get entry to the camera streaming. It will take you to the streaming page. To begin the video streaming, click on on the 'Start Stream' button at the lowest of the page.

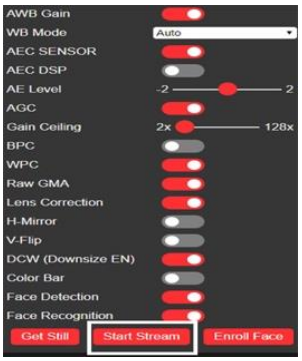

Fig 8: The streaming page

To recognize the faces with ESP32-CAM, first, we should enroll the faces. For that, activate the Face recognition and detection functions from settings after which click on at the Enroll Face button. It takes numerous attempts to keep the face. After saving the face, it detects the face as subject zero in which 0 is the face number. After enrolling the faces, if a face is identified withinside the video feed, ESP32 will make the relay module high to unlock the door.

V. Results and Discussions

Face recognition will test on both tested image and untested image. We stored some tested images in database (those people only have access to enter), if those images match to the real time image, then only the door will open otherwise the alert message will be sent to the owner. When someone enters in front of the camera then it will scan the face and try to check the images with stored images in database whether both matches or not, if it matches then the door will open otherwise the owner gets alert message.

These projects help in case of unknown person tries to enter then the system sends alert message to the authorized person and at the same time buzzer beeps for the security purpose.

VI. Conclusion

As a conclusion, the security system of face recognition has been successfully leading in IoT field. It is user friendly. Even the growth of the technology also increasing day by day. This face recognition can be used mostly where high security is needed for confidential information to keep more secure. It helps to reduce problems of frauds and thefts. The major advantage is nothing but if any known or unknown persons enters, we can get notification. These recognition technique makes life more safer and privacy. But it is somewhat expensive and work depends on the connections, we can even loose security sometimes. Nowadays slowly everything comes under IoT based, in future everything depends on these sensors and remote controllers. Most of the industries slowly growing in these IoT field.

RERENCES

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