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Alert Cam Real Time Face Recognition and Alert System

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***Abstract*—The AlertCam system is a low-cost, IoT-based home security solution that uses the ESP32-CAM microcontroller to enable real-time facial recognition for automated door access control. The system captures images, compares them with a database of authorized individuals, and unlocks the door when a match is found. The system also offers a live video feed, providing real-time monitoring and enhancing security. This paper outlines the hardware and software design, implementation, and testing of the AlertCam system, demonstrating its effectiveness in improving home security.**

***Index Terms*— ESP32-CAM, IoT, Facial Recognition, Home Security, Automated Access Control, Real-Time Alerts.**

I. Introduction

AlertCam, is a smart home security system that aims to automate door access of domestic places using facial recognition technology capable of increasing the level of safety in homes. This system recognizes the individuals approaching your door with a camera and compares them with the database of authorized faces, build using ESP32-CAM module. In a scenario where the person is identified, the door automatically unlocks for them when they arrive. That way, the door stays locked if the face is not recognized [1]. The goal of this project is to provide an inexpensive and simple security system that can augment the traditional locks and keys. Homeowners are usually not at home to check every visitor one–by–one so this is where AlertCam comes in with its face recognition technology and automated control. The AlertCam includes a live video feed feature that streams real-time footage to the homeowner's mobile device whenever someone approaches the door. This allows the homeowner to monitor the situation remotely, providing instant access to live visuals. With this functionality, homeowners can make informed decisions, such as identifying visitors and taking appropriate action, even when they are not at home, ensuring enhanced security and peace of mind [1]. In conclusion, AlertCam is a good demonstration of how we can utilize current technology to create solutions for our everyday safety. Integration of facial recognition, door opening automation, and live video feed makes this project an intelligent, efficient and convenient way to prevent any unlocking of residential doors

II. Literature Review

A literature review is one of the most important and integral set-in creation of any project. It helps gain a clear perspective and a deeper understanding about the system currently at place.

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The main purpose of this review was to survey all existing system, do a feasibility study for our proposed project and allow us to form a streamlined course of action for the same.
According to the paper [1], it develops a home security system that uses Haar Cascade and CNN for face recognition, achieving 99% accuracy in identifying family members, and automating door access for enhanced security. Future scope of this paper is buzzer system that can be installed inside the residence with password to stop it else call police.
According to the paper [2], it research focuses on developing a smart home security system that uses CNN-based facial recognition to identify authorized individuals, offering a highly accurate alternative to traditional security methods. The system achieves 99.26% accuracy, enhancing the safety of modern residential environments. Future scope of this research paper is requirement for sufficient lighting conditions, more diverse dataset and Facial expressions, further enhance the system's ability to interpret human emotions.
According to the paper [3], the system enhances home security by automatically detecting and classifying objects using deep learning techniques. It sends real-time alerts to residents and their contacts, ensuring quick responses to potential threats. This solution is especially beneficial for the elderly and women living alone in urban areas. The integration of IoT and deep learning improves the effectiveness of traditional home surveillance systems. Future scope of this research paper is Improvement of Accuracy and Efficiency in face recognition, ensuring even better security and faster processing times.
According to the paper [4], the smartphone system has been developed to automate the locking of door it works as home automation systems to implement better security for homes with user interaction through their android smartphones but most innovative work is used here in this automated door lock. While lost keys and forgotten passwords are issues that have come to be accustomed with traditional locks, they call for an upgrade from the Stone-age era invention in need of a digital solution. This system is implemented for PIN entry via an android application and unlocking the door through voice commands and uses an Arduino board with Bluetooth. The paper listed several kinds of smart locking systems like Wi-Fi-based safety, NFC emulation and even hybrid encryption solutions, most of these leaning towards IoT.
According to the paper [5], this research work deals with designing a smartphone and GSM module of door locking system which is secure as well as user-friendly. The combined working of Arduino UNO board, HC-05 Bluetooth module, SIM900 GSM module, servo motor and LCD can be used to develop a more secured system. It also includes a password system that allows the users to lock the door as well unlock it using Bluetooth through smart-phone application developed in MIT App Inventor. This prevents unauthorized access, as the system sends an alert message to the authorized user face, in case of three invalid password attempts.
According to the research paper [6], in the proposed work, there is a two-password based authentication system, one for connecting through Bluetooth and other for unlocking the door. This is a project that takes an input from the Bluetooth 4.0 device, then you have to enter the password in it and if its verified then ATmega89c51 will drive the stepper motor using a driver circuit which then will change the lock of your door. This mechanism not only improves home security by stopping unwarranted access, but also allows the users to modify and reset the same if required.

III. METHODOLOGY

A. System Design

The system architecture consists of both hardware and software components working together to achieve reliable face recognition and door locking functionality. The major elements include the ESP32-CAM for face recognition, a relay module to control the door lock, and a solenoid lock for physical security. he ESP32-CAM captures and processes the face, comparing it to stored images. If a match is found, the relay module activates the solenoid lock, unlocking the door.

B. Hardware Design

Hardware design for face recognition and door lock system is described below. The ESP32-CAM Connection with FTDI Programmer is used to upload the code in Esp32 CAM module as shown in Fig. 1. First, the FTDI Programmer should be set to 5V mode by adjusting its jumper for stable operation with the ESP32-CAM. Then, connect the FTDI Programmer's VCC to the 5V pin on the ESP32-CAM, and the GND pin of the programmer to the GND pin on the ESP32-CAM. For communication, connect the TXD pin of the programmer to the RXD (U0R) pin of the ESP32-CAM, and the RXD pin of the programmer to the TXD (U0T) pin of the ESP32-CAM. To put the ESP32-CAM into bootloader mode, temporarily connect its IO0 pin to GND. Next, plug the FTDI Programmer into your computer via USB. Use the Arduino IDE or ESP-IDF to upload the code, ensuring you

select the correct COM port and ESP32 board type, such as the ESP32 Wrover Module. Click “Upload” in the Arduino IDE to flash the code onto the ESP32-CAM. Once the upload is complete, disconnect the IO0 pin from GND and press the Reset button on the ESP32-CAM to run the program.

ESP32-CAM Connections: -

To power the ESP32-CAM, connect the 5V output from the 7805-voltage regulator to the 5V pin on the ESP32-CAM. Ensure that the GND pin of the ESP32-CAM is connected to the common ground shared by all components for proper operation. For controlling the relay module, connect GPIO 12 of the ESP32-CAM to the input (IN) pin of the relay module. Additionally, when uploading code to the ESP32-CAM, connect GPIO 0 to GND to enable boot mode. Once the programming is complete, remember to disconnect GPIO 0 from GND before using the device.

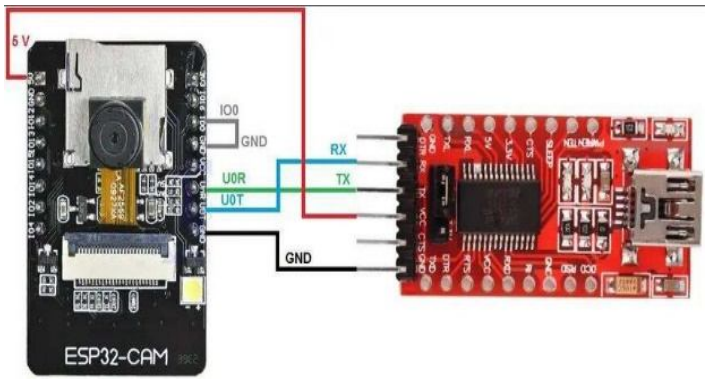

Figure 1. ESP32-CAM Module and FTDI Connections

Relay Module Connections and Solenoid Lock Connection: -

To set up the relay module, connect its VCC to the 5V output from the 7805 voltage regulator and its GND to the common ground. Link the IN pin to GPIO 12 of the ESP32-CAM for control. Connect the NO (Normally Open) pin to one terminal of the solenoid lock and the COM (Common) pin to the positive terminal of the 12V battery. For Selenoid Lock connet positive terminal to the NO terminal of the relay module and connect negative terminal to the common ground.

7805 Voltage Regulator Connections: -

Connect the VIN of the 7805-voltage regulator to the positive terminal of the 12V battery and its GND to the common ground. Then, connect the VOUT to the 5V pin of the ESP32-CAM and the relay module to provide power.

C. Circuit Design

The circuit diagram with all the connections is shown below in the Fig. 2.

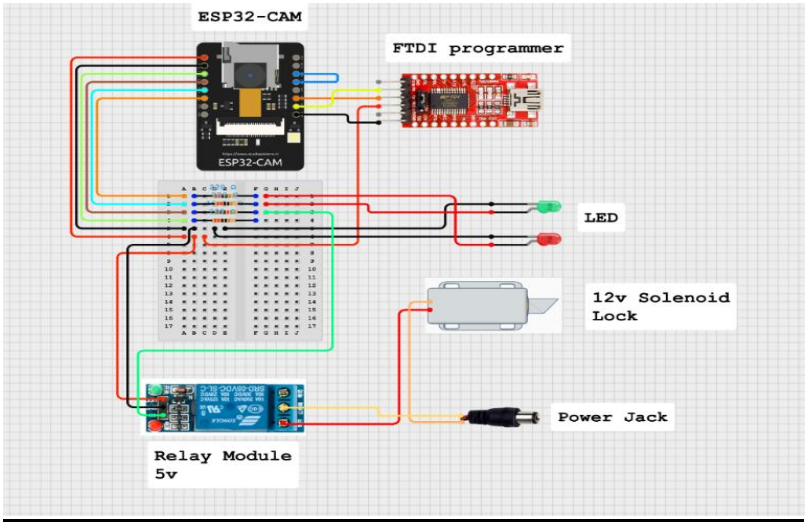

Figure 2. Circuit Design

D. Software Design

For software design, the coding for the ESP32-CAM is performed using the Arduino IDE, a versatile platform for writing and uploading code to microcontrollers. To program the ESP32-CAM, first we set up the Arduino IDE and install the necessary libraries.

Development Environment Setup

To set up the development environment, start by installing the Arduino IDE on your laptop. Open the Arduino IDE, go to File > Preferences, and add this URL to the Additional Board Manager URLs field: https://dl.espressif.com/dl/package_esp32_index.json. Next, navigate to Tools > Board > Boards Manager, search for "ESP32," and install the required package.

E. Implementation

In the implementation phase, the proposed system was developed by integrating both hardware and software components. The hardware setup as shown in Fig. 4 involved connecting the ESP32-CAM with peripherals such as a relay module, power supply, and FTDI programmer for programming. The software as shown in Fig. 3 was developed using the Arduino IDE, where libraries like ESP camera and Wi-Fi were utilized to enable face detection, recognition, and system control.

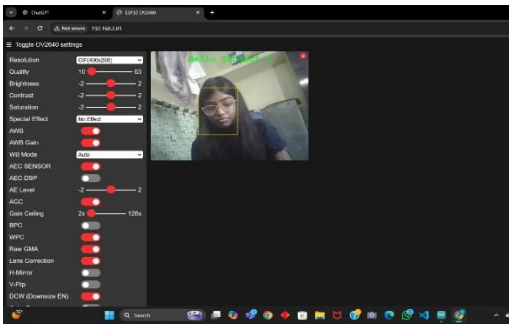

Figure 3. Face Recognition 2

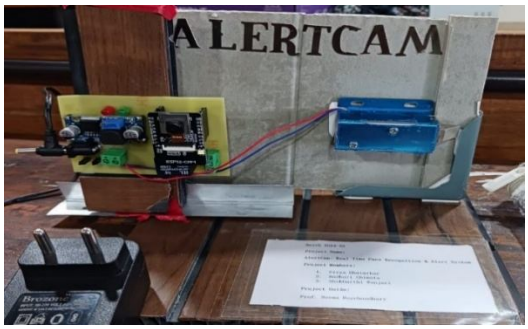

Figure 4. Hardware Setup

F. Data Flow

The data flow diagram shown below illustrates the process of face recognition using an ESP32 camera. First, the ESP32 camera captures a face. Then, it checks the face against the database. If the face matches, the door unlocks. If it doesn't match, the door stays locked. This process ensures only authorized people can enter.

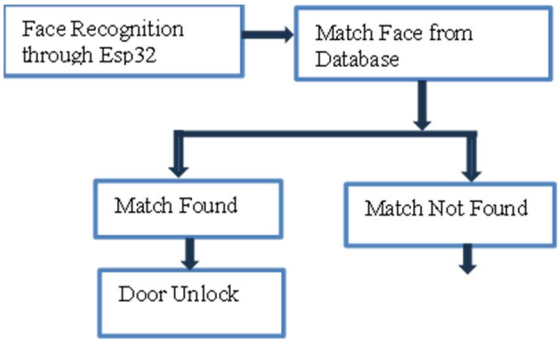

Figure 4. Data Flow

IV. RESULT

The system successfully recognized authorized individuals with high accuracy, unlocking the door promptly and reliably. For unrecognized faces, the system maintained the door in a locked state and sent real-time notifications via WhatsApp to alert the homeowner. The live video feed feature worked seamlessly, providing clear and consistent visuals under various lighting conditions, including low light and direct sunlight. The system demonstrated reliable performance during multiple tests, ensuring quick responses and accurate detection. This combination of automated door access, instant alerts, and real-time monitoring enhances overall home security and provides homeowners with peace of mind.

V. Conclusion

In conclusion, AlertCam provides a user-friendly, responsive, and accessible solution to home security challenges. Its combination of facial recognition, door control, and instant live video feed represents a step forward in smart home security technology. As a project, it illustrates the potential of IoT devices like the ESP32-CAM to deliver reliable, cost-effective, and easily scalable security solutions that can be adapted to various residential and commercial settings. This project lays the groundwork for future enhancements and integrations, such as additional alert options or integration with other smart home devices, to create an even more robust security ecosystem.

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