

Door Lock System Using Fingerprint and Esp32 cam

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Abstract—This project presents a smart door lock system that uses fingerprint recognition to improve home and office security and also a smart locking mechanism guided by a fingerprint scanner to raise the security of residences and workplaces. Because standard keys can be misplaced, appropriated, or duplicated, they offer fading protection. We addressed this gap by creating a system that releases the bolt only when a permitted fingerprint appears. Key parts consist of the AS608 module, responsible for both scanning and matching the print, and the ESP32-CAM controller, which handles logic and records photos of anyone seeking entry. An electromechanical lock controlled through a relay module carries out the actual locking. Continual mains supply means the setup avoids battery-replacement headaches. It is economical, easy for ordinary users to operate, and appropriate for private flats, student buildings, academic institutions, and business premises. Our project demonstrates that straightforward, low-cost electronics can enhance security and everyday convenience.

Index Terms—Smart Door Lock, Fingerprint Recognition, Biometric Security, ESP32-CAM, AS608 Fingerprint Sensor, Solenoid Lock, Relay Module, Home Security System, IoT-based Door Lock.

I. INTRODUCTION

Security plays the most crucial role in our everyday environments where we work, live, and conduct business. While most people still rely on the traditional arsenal of metal keys and basic locks, true safety is no longer guaranteed this way. Keys are prone to being dropped, forgotten, or altered by unauthorized copies, translating the act of daily locking into a vulnerability. By upgrading to biometric authentication, we outpace these limitations; a fingerprint is unmistakably unique and cannot be borrowed or set aside. This project aims to implement a fingerprint-driven smart locking device, removing the uncertainties associated with physical

keys. The user first places their fingertip on the unit's sensor. The system checks the database of authorized prints, and only if a match appears the latch is granted release; otherwise, the door remains secured. The core of our device is centered on two integrated modules: the AS608 fingerprint sensor that captures and verifies the biometric data under an energetic light, and the ESP32-CAM, a compact single-design board equipped with a camera and Wi-Fi. The ESP32-CAM controls the unlocking logic, connects to a network, and can photograph any person blocking to gain access, simultaneously sending an alert to the owner's smartphone if an unauthorized print is recorded. We chose a solenoid lock driven by an electric lock mechanism, with a relay module acting as the switch that engages the lock. A key advantage of our design is that the entire setup is powered directly from the household mains supply through an adapter. This eliminates the hassle of periodically recharging batteries. Although we have the option to add a battery backup, it would raise both the cost of components and the complexity of the circuit, so we decided to skip that for our base model. The final door lock system works intuitively, is budget-friendly and is architected for everyday authenticated use. Because of these traits, it is an excellent fit for any location where safety needs to be reinforced, such as private residences, dormitories, workplaces, and educational institutions. The project thus serves as a practical demonstration of how accessible components and straightforward circuitry can be melded to enhance personal security and everyday convenience.

II. LITRATURE REVIEW

Classic mechanical locks and keys, while ubiquitous, inherently possess vulnerabilities; keys can vanish or be surreptitiously duplicated at any moment. To bolster protection against these weaknesses, developers have turned to biometric identification

and identified fingerprint recognition as a leading approach. [1] This technology stands out for its precision and dependability, qualities that stem from the intrinsic uniqueness of each person's fingerprint. [2]

The AS608 fingerprint sensor is the go-to choice for hobby projects: it's inexpensive, compact, and works perfectly within limited budgets. When monitoring and locking tasks is the goal, the ESP32-CAM board proves ideal. [3] Thanks to the built-in camera and dual-band Wi-Fi, it can snap a photo and beam real-time data to the cloud in a heartbeat. Guiding the locking action are solenoid locks paired with inexpensive relay modules, proven and battle-tested in countless home and small business setups. [4] Add-to that the research advisory to always include a reliable wall-powered circuit and, if possible, a small UPS battery, and the system's uptime climbs to new highs. The combined research and field results reinforce that a fingerprint- controlled gateway using an ESP32-CAM is a safe, sensible, and low-cost method for making everyday environments more secure. [5]

Our project discusses about the smart door lock system which is authenticated with the multiple biometric access. The door is accessed with both the fingerprint and face recognition. [6] The outsiders are detected with the ESP32 Camera and blink helps to send the notification to the mobile. This system is to develop an application for the Smart Automation System playing a major role which helps in reducing a work done manually by using some embedded hardware and technologies that come with it. [7] The anticipated effort is to send a signal to locker door from a Tablet or mobile devices by using wireless system through the web page we can see the details of locker status. This permits the user to lock and unlock a locker through fingerprint and WIFI authentication. [6] The idyllic resolution of the work is that, if the locker is not locked and its status, the user will have the authenticated entry through the locker door from fingerprint or Laptop via webpage authentication and entry times are noted in the database located in the secured cloud. [8] Digital door locks have grown quite prevalent in recent years as technology has advanced and the use of IoT has increased. A digital lock does not require a physical key to operate, instead relying on Radio Frequency Identification (RFID), fingerprint, Face ID, pins,

passwords, and other methods to do so. [9] Using these diverse technologies, we have previously built several digital door lock applications. In this article, we will use the Camera (ESP32 CAM) to create an IoT-based Wi-Fi Door Lock system. [2] The creation of a door lock system is accomplished using facial recognition in conjunction with the ESP32 CAM for more accurate face detection. The ESP32 CAM is powered by battery that acts because it is the system's backbone, and it controls the door locks and unlocks systems. [10] This door lock system works on facial recognition. Here, the door lock system is controlled by face recognition of a private. A door is one of the defense features to take care of physical security of the house. [3]

The fingerprint recognition is unique, reasonably stable over time, and supported by sophisticated sensing and matching pipelines (acquisition → enhancement → feature extraction → matching), it continues to be a top biometric for access control. Current surveys compare optical, capacitive, and ultrasonic sensing, pointing out trade-offs in cost, energy, spoof resistance, and integration for IoT devices. While ultrasonic and advanced capacitive options improve anti-spoofing and wet-finger performance at a higher cost, optical sensors continue to be popular in low-cost embedded access systems.

III. METHODOLOGY

In this project, a fingerprint-based smart door lock system was developed using the AS608 fingerprint sensor, ESP32-CAM module, solenoid lock, and relay module. The main aim is to allow access only to authorized users by verifying fingerprints and enhancing security by capturing images of unauthorized access attempts.

The system was designed with the following steps:

1. System Planning and Design: The overall structure of the system was planned by selecting key components— AS608 for fingerprint recognition, ESP32-CAM for control and image capture, a solenoid lock for the locking mechanism, and a relay module to control the lock using electrical signals. Power was supplied using a 5V adapter.
2. Fingerprint Enrollment: Initially, fingerprints of authorized users were registered using the AS608 sensor. These fingerprints are stored in the sensor's

internal memory and are used for future matching.

3. **Fingerprint Verification:** When a person tries to access the door, the fingerprint sensor scans their finger and compares it with the stored templates. If the fingerprint matches, it sends a signal to the ESP32- CAM to unlock the door.

4. **Door Unlocking Mechanism:** The relay module receives a HIGH signal from the ESP32-CAM following verification. After that, the relay turns on the solenoid lock, briefly unlocking the door. After a brief pause, the relay is turned off, causing the door to automatically lock once more.

5. **Image Capture:** The ESP32-CAM takes a picture of the individual attempting to enter if their fingerprints do not match. For future use, you can save this image locally or send it to an email server or cloud.

6. **Power Supply Configuration:** A 5V regulated power adapter that is connected to the main power supply powers the system. This eliminates the requirement for frequent charging. If a battery backup is required for power outages, it can be added, but the cost and complexity go up.

The project methodology is to combine fingerprint verification with real-time monitoring for secure access. The initial step is enrolling and storing fingerprints of registered users in the fingerprint sensor module. When an individual tries to unlock the system, the sensor reads the input and checks with the stored information. Upon matching the fingerprint, Arduino Uno reads the signal and energizes the relay to unlock the solenoid lock. But in the event of unsuccessful fingerprint attempts, the ESP32-CAM takes photograph of the individual and sends it to the registered user through a Telegram bot, along with the remote viewing link for real-time monitoring. Thus, even unauthorized attempts are caught in time and reported. The system functions perfectly through a constant power supply, rendering it reliable, automated, and perfect for contemporary smart security systems.

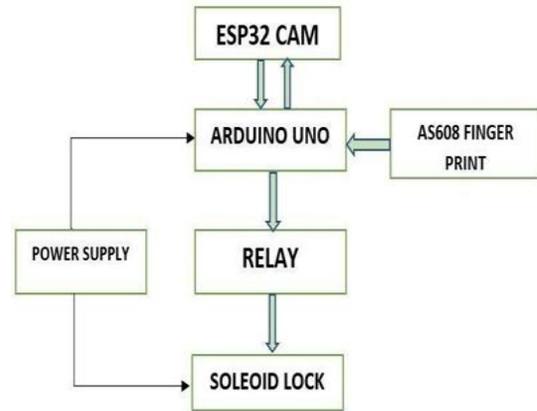


Fig.1 Block Diagram

The fig.1 shows the system is a biometric door lock with built-in surveillance. It is meant to make security better and monitoring smarter. The system works by scanning the user's fingerprint and comparing it to pre- stored templates. When a successful match is found, the controller turns on the relay circuit, which powers the solenoid lock and lets people in. At the same time, the ESP32-CAM is used to take pictures or stream video of the access event, which adds another layer of security to the system. This integration makes sure that every access attempt, whether it was allowed or not, can be watched and recorded for security reasons.

IV. EXPERIMENTS AND RESULTS

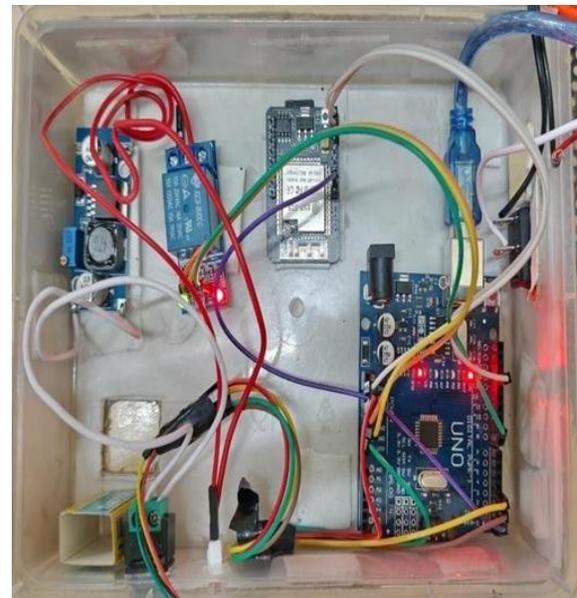


Fig.2. Connections

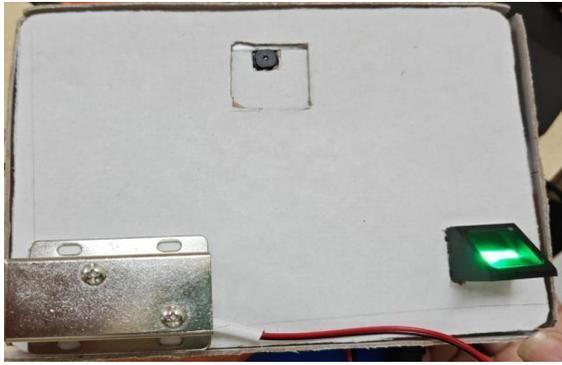


Fig.3 Actual Veiw

the fig.2 and fig.3 shows the hardware setup of a smart fingerprint-based door lock system well organized within an enclosure. The Arduino Uno acts as the controller unit, interpreting the input from the fingerprint sensor and deciding whether to unlock the door. The ESP32-CAM is added for monitoring, with the system taking photos or even offering live monitoring whenever an attempt is made to open the lock. A relay module is used to drive the solenoid lock as an electronic switch which powers the lock solely after authenticating successfully.

The power supply guarantees reliable functioning of all the components, and the wiring illustrates the connection between the controller, camera, relay, and lock mechanism. The enclosure shields the circuit against external destruction and keeps the setup small and secure. All in all, the system integrates biometric security with real-time monitoring, offering a low-cost, automated, and effective solution to smart access control in residences and workplaces.

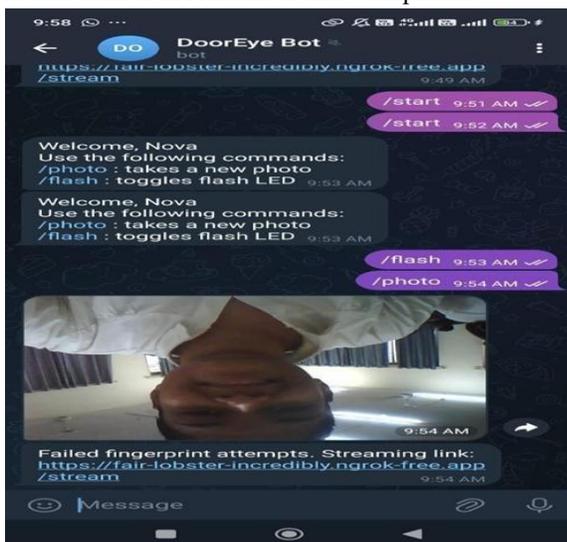


Fig.4 Live Streaming

This photograph (Fig. 4) indicates the interface of the Telegram bot (Door Eye Bot) employed for remote monitoring and control of the smart fingerprint door lock system. The bot provides the users with interfaces to interact with ESP32-CAM using commands like

/Photo to take a photo and /flash to switch the camera's flash LED. In the above example, on unsuccessful attempts of fingerprint authentication, the system takes a self-portrait of the individual and forwards it to the registered Telegram channel. It also offers a live video stream link generated using ngrok, allowing real-time surveillance of the access point.

The feature promotes overall security within the system in that it offers real-time alerts and pictorial evidence of unauthorized access attempts. Although the fingerprint authentication fails, the owner is instantly notified via Telegram with both image and live stream features. This combination of IoT messaging and biometric access therefore not only provides security and automation but also remote control and monitoring, which is essential for contemporary smart home and office security systems.

V. CONCLUSION AND FUTURE WORK

This project effectively uses fingerprint recognition and the ESP32-CAM module to demonstrate a low-cost, dependable, and secure smart door lock system. The system lowers the possibility of duplicate keys, lost keys, and unwanted access by substituting biometric authentication for conventional keys. By adding a layer of monitoring and taking pictures of unsuccessful access attempts, the integration of a camera module further improves security. Electronically controlling door access is made efficient with the use of a relay module and solenoid lock. All things considered, the system is useful, simple to operate, and appropriate for settings where safety is a concern, such as homes, workplaces, hostels, and educational institutions.

1. Mobile App Integration: A mobile app can be developed to control and monitor the door lock remotely, receive alerts, and view captured images in real-time.

2. Voice Alerts and Logs: Audio alerts and logging of access events can be added to further improve user interaction and tracking.
3. Integration with Home Automation: The door lock system can be linked with other smart home devices like alarms, lights, or CCTV systems for a complete smart security solution.

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