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# Smart Door Lock System using Finger Print and Facial Recognation

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ABSTRACT

With the rapid advancement of the Internet of Things (IoT) and smart home technologies, traditional mechanical locking mechanisms are becoming increasingly obsolete due to vulnerabilities associated with physical keys and password-based systems. This paper proposes a secure and convenient Smart Door Lock System that utilizes dual- biometric authentication, integrating both fingerprint recognition and facial recognition to ensure robust access control.

The system is built around a microcontroller (e.g., Arduino or ESP32) interfaced with an R305/FPM10A fingerprint sensor and a Raspberry Pi Camera or OV7670 module for facial detection. The software architecture employs image processing algorithms (such as Haar Cascades or LBPH for face recognition) and minutiae point matching for fingerprint verification. The door remains locked until the system simultaneously or sequentially verifies the identity of the occupant against a pre-enrolled database.

This dual-modal approach significantly reduces the false acceptance rate and enhances security by ensuring that access requires unique biological traits that cannot be easily replicated or stolen. Furthermore, the system eliminates the need for physical keys, thereby providing keyless entry and mitigating the risks associated with key loss or unauthorized duplication. The proposed design offers a scalable, user-friendly solution for modern residential and commercial security applications.

Keywords: Biometric Authentication, Facial Recognition, Fingerprint Sensor, Smart Lock, Embedded Systems, IoT Security.

## I INTRODUCTION

Security has been a fundamental concern for humanity throughout history, and the evolution of locking mechanisms reflects our continuous efforts to protect property and ensure personal safety. From ancient mechanical locks to modern electronic access control systems, the quest for more secure and convenient solutions has driven significant technological innovation. In recent years, the emergence of the Internet of Things (IoT) and smart home technologies has revolutionized the way we interact with our living spaces, making traditional security systems increasingly inadequate for meeting the demands of modern lifestyles.

In today's rapidly advancing world, security has become a major concern for homes, offices, and organizations.

Traditional locking systems based on keys or passwords are increasingly vulnerable to theft, duplication, and unauthorized access. To overcome these limitations, smart security systems have been developed using advanced biometric technologies.

A smart door lock system using fingerprint and facial recognition provides a highly secure and convenient solution for access control. This system uses unique biological features—such as fingerprints and facial patterns—to authenticate users. Since these features are difficult to duplicate or forge, the system ensures a higher level of security compared to conventional methods.

The integration of fingerprint sensors and facial recognition technology allows dual-layer authentication, enhancing reliability and accuracy. It eliminates the need for physical keys and reduces the risk of unauthorized entry. Additionally, such systems can be integrated with IoT for remote monitoring and control, making them suitable for modern smart homes and automated environments.

Overall, this smart door lock system offers improved security, ease of use, and advanced functionality, making it an essential component of modern access control systems. the modern era, security has become a top priority due to the increasing risks of theft, intrusion, and unauthorized access. Conventional locking systems that rely on physical keys or passwords are no longer sufficient, as they can be easily lost, stolen, or duplicated. This has led to the development of advanced security solutions that provide higher reliability and protection. Among these, smart door lock systems based on biometric authentication have gained significant popularity.

A smart door lock system using fingerprint and facial recognition is an advanced access control system that uses unique biological characteristics of individuals for identification and verification. Fingerprint recognition works by scanning and matching the unique patterns of ridges and valleys on a person's finger, while facial recognition analyzes facial features such as the distance between eyes, nose shape, and jaw structure. These biometric traits are highly distinctive, making the system secure and difficult to bypass.

## II LITERATURE REVIEW

1) The evolution of door locking systems has progressed from traditional mechanical locks to advanced electronic and biometric-based security systems. Early systems mainly relied on keys and passwords, which were prone to loss, theft, and hacking. Researchers have highlighted that password-based systems are vulnerable to security breaches and inefficiencies, leading to the need for more reliable authentication methods. As a result, biometric technologies such as fingerprint and facial recognition have emerged as effective solutions for improving access control and security.

2) Fingerprint recognition is one of the most widely used biometric techniques in smart door lock systems due to its uniqueness and reliability. Various studies have focused on fingerprint-based systems, explaining how minutiae points (ridge endings and bifurcations) are used for identification. Researchers have also compared different fingerprint sensing technologies such as optical, capacitive, and contactless systems. These studies conclude that fingerprint recognition offers high accuracy and security, although performance may be affected by environmental conditions or poor-quality fingerprints. □

3) Facial recognition technology has also gained significant attention in recent years, especially with advancements in machine learning and image processing. Research papers demonstrate that facial recognition systems use algorithms such as Principal Component Analysis (PCA) and Eigenfaces for feature extraction and classification. Many implementations using platforms like Raspberry Pi have achieved accuracy levels of around 90%, making them suitable for real-time smart security applications. However, challenges such as lighting conditions, facial expressions, and pose variations can impact system performance.

4) Recent studies emphasize the integration of biometric systems with Internet of Things (IoT) technology to create smart home environments. IoT-enabled smart door locks allow remote monitoring, real-time alerts, and control through mobile applications. Researchers suggest that combining multiple authentication methods—such as fingerprint and facial recognition—enhances system reliability and reduces the chances of unauthorized access. Multifactor authentication systems are therefore considered more secure and efficient than single-method systems. □

5) Overall, the literature indicates that smart door lock systems using fingerprint and facial recognition provide a robust, secure, and user-friendly solution for modern access control. While fingerprint systems offer high precision and maturity, facial recognition adds contactless convenience and flexibility. The integration of these technologies, along with IoT, represents the future of smart security systems. However, ongoing research is still focused on improving accuracy, reducing environmental limitations, and enhancing system efficiency for real-world applications.

## **III** EXISTING SYSTEM

The existing door lock systems can be broadly classified into traditional, electronic, and biometric-based systems. Traditional lock systems mainly use mechanical keys for access control. Although widely used, these systems suffer from major drawbacks such as key duplication, loss of keys, and lack of monitoring capabilities. Due to these limitations, researchers and developers have shifted towards electronic and smart locking systems to improve security and convenience. □
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Electronic door lock systems were introduced as an improvement over conventional lock. These systems use keypads, passwords, or RFID cards for authentication. A microcontroller-based password system allows users to unlock doors using a predefined code, and it can trigger alarms in case of incorrect attempts. However, these systems are still vulnerable to password hacking, shoulder surfing, and card loss, which reduces their reliability in high- security applications.

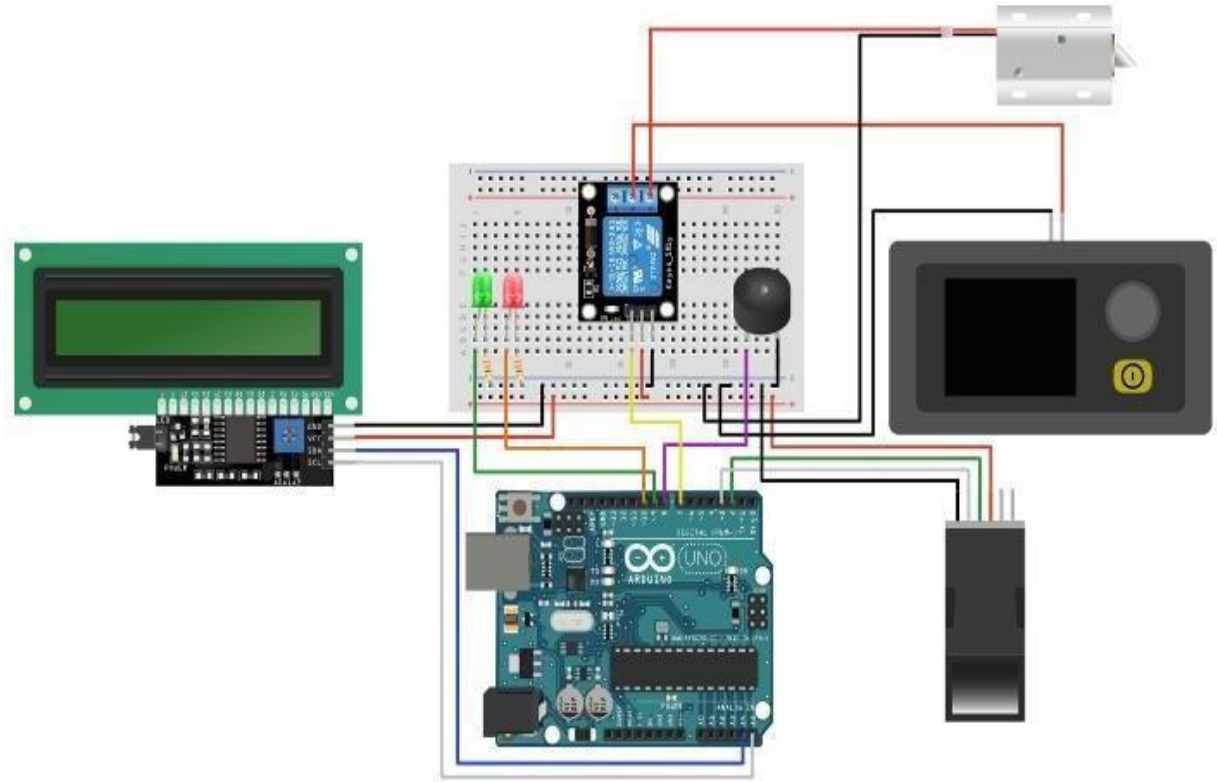
## **IV** PROPOSED SYSTEM

The proposed system is an advanced smart door lock system that integrates both fingerprint and facial recognition technologies to provide a highly secure and efficient access control mechanism. Unlike existing systems that rely on a single authentication method, this system uses dual biometric verification to enhance security and reduce the chances of unauthorized access. The system is designed using a microcontroller or embedded platform (such as Arduino or Raspberry Pi), along with biometric sensors, a camera module, and electronic locking mechanisms.

In the proposed system, the authentication process begins when a user attempts to access the door. The system first captures the fingerprint using a fingerprint sensor and compares it with the stored database. If the fingerprint is successfully verified, the system proceeds to the second level of authentication, where the camera captures the user's face and processes it using facial recognition algorithms. Only when both biometric verifications are successful, the system sends a signal to unlock the door through a relay or motor mechanism.

The system also incorporates IoT capabilities to improve functionality and user convenience. By connecting the system to the internet, users can monitor and control the door lock remotely using a mobile application. The system can send real-time notifications or alerts in case of unauthorized access attempts. Additionally, administrators can add or remove users, update biometric data, and view access logs through the application interface. recognition camera captures high-quality facial images, while the fingerprint scanner scans and recognizes authorized fingerprints. The microcontroller processes facial and fingerprint data, controlling the door lock mechanism. The Wi-Fi/Bluetooth module enables IoT connectivity for remote monitoring and control. The system uses face recognition and fingerprint matching algorithms to authenticate users, providing enhanced security and convenience. Users can register their facial and fingerprint data, and the system will authenticate them using these modalities. The system also provides remote monitoring and control capabilities through a mobile app, enabling users to receive real-time notifications and updates. Overall, the proposed system provides a secure, convenient, and efficient solution for smart door locking.

Hardware Architecture



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BLOCK DIAGRAM OF PROPOSED SYSTEM

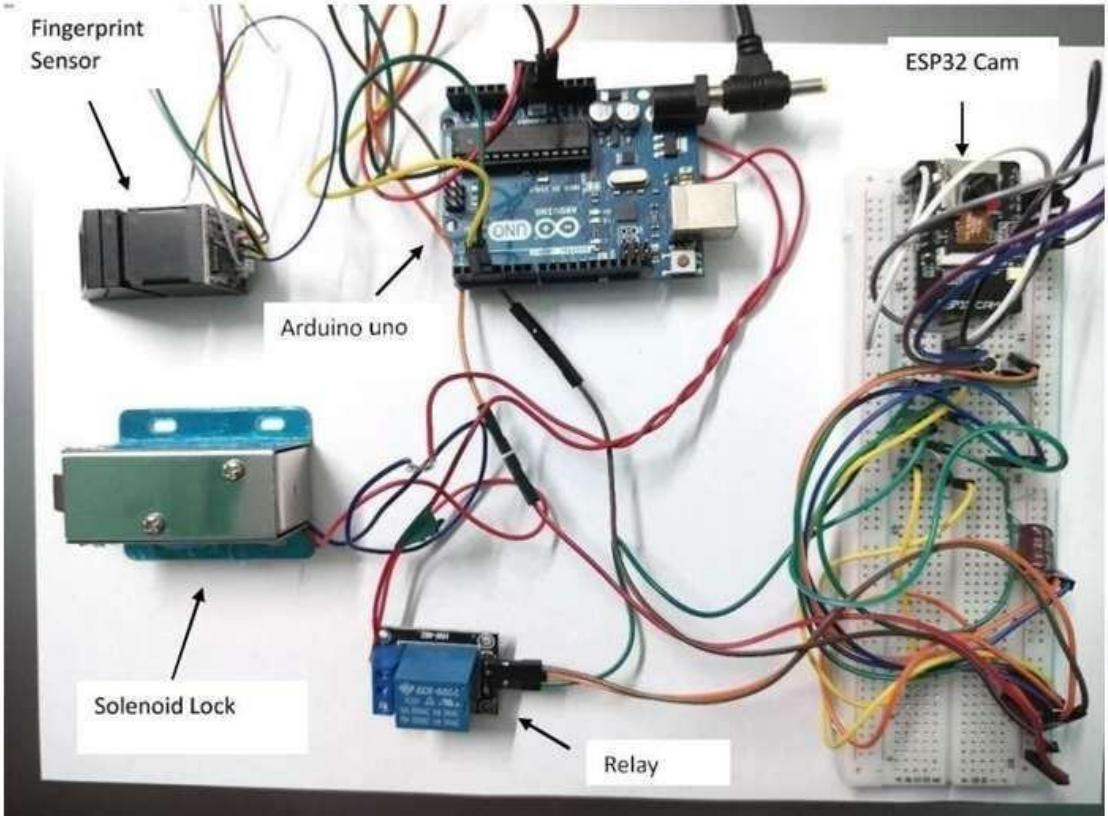


Fig 2: Block Diagram of Proposed System

**V** RESULTS

The circuit consists of an ESP32-CAM module, fingerprint sensor, relay module, solenoid door lock, I2C LCD display, buzzer, LEDs, and power supply connections.
The ESP32-CAM acts as the main controller and performs face recognition using its onboard camera, while the fingerprint sensor provides biometric authentication.

When the user places their finger on the sensor, the fingerprint module sends the scanned data to the controller through UART serial communication. At the same time, the ESP32-CAM captures the face image and compares it with stored face data. If both fingerprint and face match successfully, the controller activates the relay module, which switches ON the solenoid door lock and unlocks the door.

The I2C LCD display is connected to the controller using SDA and SCL lines and shows messages like “Place Finger”, “Face Matched”, “Access Granted”, or “Access Denied”.
The green LED glows when authentication is successful, while the red LED glows for invalid access. A buzzer is connected as an alarm indicator, which beeps during unauthorized access or wrong attempts.

The relay module is used as an interface between the low-power controller and the high-power electromagnetic door lock/solenoid lock. Since the lock requires more current, the relay safely switches the external supply to the lock. The whole system works on 5V supply for relay, LCD, and fingerprint sensor, while the ESP32-CAM uses
3.3V regulated supply.

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## VI CONCLUSIONS

The Smart Door Lock System using Fingerprint Sensor and Facial Recognition is an advanced and reliable security system designed to provide safe and keyless access. It uses dual biometric authentication, which increases the level of protection by allowing entry only to authorized users. This makes it highly useful for homes, offices, laboratories, and other restricted areas where security is important.

The system offers fast response, easy operation, and improved convenience compared to traditional lock systems. It reduces the risk of losing physical keys and helps prevent unauthorized entry. By combining fingerprint sensing with facial recognition, the project ensures better accuracy and modern smart security features, making it suitable for today's digital world.

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