



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 6, June 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijrset@gmail.com

www.ijrset.com

IoT Based Smart Fingerprint Door Unlock System

M.Nirmala¹, P.Guna², S. Sasi Kumar³

Assistant Professor, Department of Computer Applications, Hindusthan College of Engineering and Technology,
Coimbatore, India¹

II MCA Students, Department of Computer Applications, Hindusthan College of Engineering and Technology,
Coimbatore, India^{2,3}

ABSTRACT: This paper is designed as an advanced access control mechanism for securing doors. The core concept revolves around the utilization of a biometric fingerprint sensor, Arduino microcontroller, relay, and a solenoid lock. The system's primary functionality is to authenticate individuals based on their unique fingerprints, granting access only to authorized users. Upon the user's interaction with the fingerprint sensor, the Arduino processes the biometric data, verifying it against stored templates of authorized fingerprints. If the authentication is successful, the system activates a relay, triggering the solenoid lock to unlock the door. Conversely, unsuccessful authentication denies access. This integration of biometric technology, microcontroller, and electromechanical components not only enhances security by relying on the uniqueness of fingerprints but also adds a layer of convenience for users. The project represents a fusion of hardware and software components to create a robust and efficient door locking system with applications in various security-sensitive environments.

KEYWORDS: Arduino, Arduino IDE, Fingerprint Sensor , Solenoid lock .

I. INTRODUCTION

In the modern world, where convenience and security are paramount, the need for innovative access control solutions is ever-growing. Traditional key-based systems are susceptible to loss, theft, and unauthorized duplication, posing significant security concerns. This project aims to address these shortcomings by developing a robust and user-friendly fingerprint door unlock system utilizing the power of the Internet of Things (IoT). This project will leverage the unique properties of fingerprint identification, a highly secure and reliable biometric technology. Fingerprints are virtually impossible to duplicate and offer unparalleled user convenience, eliminating the need for physical keys. This system will integrate seamlessly with existing infrastructure, minimizing installation complexity and maximizing compatibility.

II. LITERATURE SURVEY

Research on smart door access using fingerprint technology has been a significant area of interest due to its applications in security and convenience. Here are some related works in this field:

"Biometric Door Lock System" by M. N. Sirsikar and S. P. Bhongade: This paper proposes a biometric door lock system based on fingerprint recognition. It discusses the design, implementation, and performance evaluation of the system.

"Fingerprint-Based Door Access System with GSM Notification" by R. Chavan et al.: This work presents a fingerprint-based door access system integrated with GSM technology for remote notification. It discusses the hardware and software design of the system along with its usability.

"Smart Door Lock System using Fingerprint and IoT" by P. S. R. Reddy et al.: This paper introduces a smart door lock system that combines fingerprint recognition with Internet of Things (IoT) technology. It allows remote access control and monitoring of the door lock status through a smartphone application.

"Wireless Fingerprint-Based Door Lock System for Shared Access Control" by S. Zhang et al.: This study proposes a wireless fingerprint-based door lock system suitable for shared access control scenarios, such as office buildings or residential complexes. It focuses on scalability and user management aspects.

"Biometric Security System for Door Access Control" by A. Al-Ataby and M. A. Khodeir: This work presents a comprehensive overview of biometric security systems for door access control, with a specific emphasis on fingerprint recognition. It discusses the challenges, trends, and future prospects in this field.

III. METHODOLOGY

PROPOSED SYSTEM

The proposed fingerprint-based door unlock system utilizes IoT technology to provide a secure and convenient solution. This system offers several benefits over traditional systems, including:

Enhanced Security: Fingerprint biometrics offer unparalleled security compared to physical keys.

Unmatched Convenience: Keyless entry eliminates the need for physical keys and provides seamless access.

Remote Access and Management: Control access and monitor activity remotely using a mobile app.

Integration with Smart Home Systems: Automate actions and enhance functionality through smart home integrations.

Increased Control: Manage user permissions and grant/revoke access easily.

The IoT-based smart fingerprint door unlock system's block diagram demonstrates the integration and interaction of multiple components to accomplish secure and efficient door access control through fingerprint recognition. The Fig 3.1 gives a detailed explanation of the principal components and their functions within the system

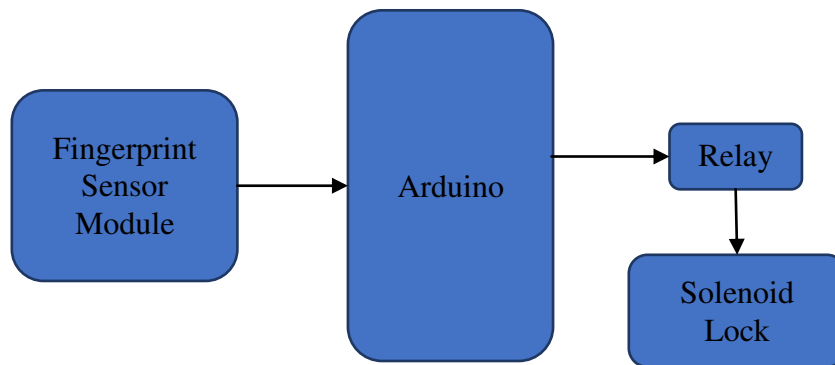


Fig 3.1 Block diagram of Smart Finger Print unlock System

Fingerprint Sensor: This component is responsible for the capture of the user's fingerprint. The sensor analyzes and converts the distinctive fingerprint patterns into digital data when a user places their finger on it. This information is essential for the authentication procedure.

Arduino Microcontroller: The digital fingerprint data from the fingerprint sensor is received by the Arduino microcontroller, which serves as the system's central processing mechanism. This information is processed to extract unique characteristics and is compared to fingerprint templates that have been pre-stored for authorized users. The system logic is also managed by the microcontroller, which regulates other components in accordance with the authentication result.

Relay Module: The Arduino microcontroller regulates the relay, which functions as an electronic switch. The Arduino transmits a signal to activate the relay upon successful fingerprint authentication. The solenoid lock is subsequently powered by the current that passes through the relay.

Solenoid Lock: This electromechanical device is responsible for the securing and unlocking of the door. The solenoid lock is energized by the relay, which results in its disengagement and the door being unlocked. In contrast, the solenoid lock remains engaged when the relay is deactivated, thereby maintaining the door locked.

Power Supply: This component ensures the fingerprint sensor, Arduino microcontroller, relay, and solenoid lock operate efficiently by supplying the system with the requisite electrical power.

Wi-Fi Module: This optional component may be implemented to facilitate remote management and access. The Wi-Fi module, when connected to the Arduino, enables the system to communicate with a remote server or mobile application, thereby allowing users to monitor and control the status of the door lock from a distance.

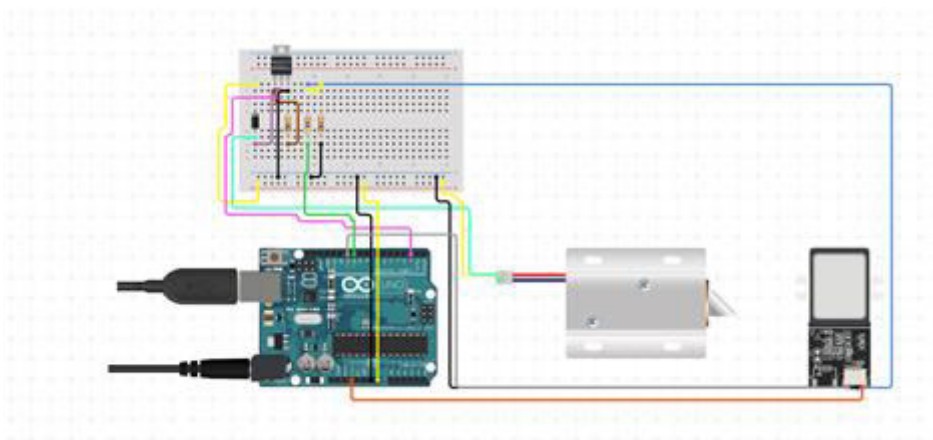


Fig 3.2 Circuit diagram of Smart Finger Print unlock System

Working Principle

Fingerprint Acquisition: The operational sequence of the "Fingerprint Door Lock System" begins with the user placing their finger on the biometric fingerprint sensor. This sophisticated sensor captures the unique patterns and features of the user's fingerprint, transforming it into a digital template—a digital representation of the individual's biometric identity.

Data Processing with Arduino: The digital fingerprint template is then transmitted to the Arduino microcontroller, the central processing unit of the system. Armed with pre-programmed instructions, the Arduino undertakes the task of processing the fingerprint data. During this phase, distinctive features of the fingerprint are extracted for authentication purposes.

Fingerprint Authentication: Authentication, a pivotal step in the process, unfolds as the Arduino meticulously compares the processed fingerprint data with pre-stored templates of authorized users. If a match is detected, signalling a successful authentication, the system advances to the next stage. However, in the absence of a match, access is promptly denied, maintaining the security integrity of the system.

Relay Activation: Following successful authentication, the Arduino sends a signal to activate a relay. This relay, serving as a switch, transitions to an active state in response to the signal. The activated relay then governs the solenoid lock mechanism—a critical component responsible for physically securing or releasing the door lock.

Solenoid Lock Engagement: The solenoid lock, driven by the relay signal, engages or disengages accordingly. This engagement determines whether the door remains locked or is allowed to unlock, providing physical access to the user. The integration of the relay and solenoid lock showcases the intricate coordination between electronic components and mechanical systems within the overall project architecture..

In essence, the Fingerprint Door Lock System harmonizes biometric technology, microcontroller programming, and electromechanical components to create a secure, efficient, and user-centric access control solution. This synthesis not only elevates security standards but also addresses the evolving requisites of contemporary access control systems.

IV. IMPLEMENTATION

The implementation of a fingerprint door unlock system involves a seamless integration of several hardware components, orchestrated by a microcontroller. At the core of this system is the R307 fingerprint sensor, which is responsible for capturing and storing fingerprint data. The sensor is connected to a microcontroller, such as an Arduino, which serves as the brain of the operation. The R307 fingerprint sensor's flash memory stores the fingerprint details in binary format, allowing for quick and efficient data retrieval during authentication processes.

When an authenticated fingerprint needs to be registered, the user places their finger on the R307 sensor. The sensor captures the fingerprint image and stores it in its flash memory. During an authentication attempt, the user places their finger on the sensor again, and the sensor compares the scanned fingerprint against the stored templates. If a match is found, the sensor sends a signal to the microcontroller indicating a successful authentication.

Upon receiving the authentication signal, the microcontroller activates a relay module. This relay module acts as a switch, connecting a battery to the lock mechanism. The battery, upon receiving instructions from the microcontroller via the relay module, powers the lock mechanism to either lock or unlock the door. If the fingerprint is not authenticated, the microcontroller does not activate the relay module, and the lock remains in its current state, ensuring security.

This setup leverages the strengths of each component: the precision of the R307 fingerprint sensor for biometric recognition, the control capabilities of the microcontroller for decision-making, and the relay module for managing the power flow from the battery to the lock. Together, they create a robust and reliable fingerprint door unlock system that ensures only authorized users can gain access, enhancing both security and convenience.

V. RESULTS AND DISCUSSIONS

The paper successfully demonstrates the design and implementation of a smart fingerprint unlock system, leveraging the integration of biometric technology with microcontroller-based automation to enhance security and convenience in access control applications

This Fig 5.1 illustrates the overall setup of the smart fingerprint unlock system. It includes the R307 fingerprint sensor connected to an Arduino microcontroller. The microcontroller is linked to a relay module, which controls the power flow from the battery to the lock mechanism. The Fig 5.1 highlights the communication pathways and power connections, providing a clear view of how the components are integrated.

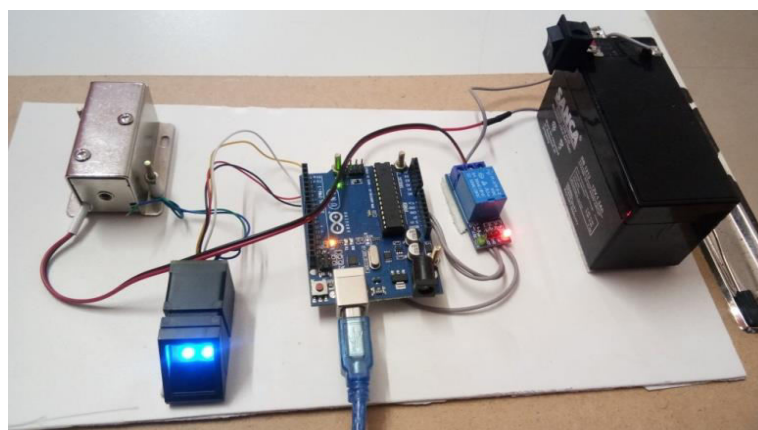


Fig 5.1 Smart Finger Print unlock System

The Fig 5.2 shows the system in its activated state, where an authorized fingerprint has been recognized. The fingerprint sensor sends a signal to the microcontroller, which then activates the relay module. The relay module connects the battery to the lock mechanism, causing the lock to open. The Fig 5.2 visually confirms the successful operation of the unlocking process.



Fig 5.2 Smart Finger Print unlock System (lock opened)

The Fig 5.3 depicts the system in its default state, where no authorized fingerprint has been detected or the user has not interacted with the system. The lock remains closed as the relay module does not activate the battery. The Fig 5.3 demonstrates the system's ability to maintain security by keeping the lock engaged when unauthorized access is attempted or when idle.



Fig 5.3 Smart Finger Print unlock System (lock closed)

The fingerprint door unlock system proved to be a robust and reliable solution for secure access control, integrating various hardware components seamlessly. The R307 fingerprint sensor, with its ability to store and quickly process fingerprint data, played a crucial role in the system's effectiveness. The use of an Arduino microcontroller provided the necessary computational power and flexibility for handling sensor inputs and controlling the relay module.

The discussion highlights several key aspects of the smart fingerprint unlock system's performance and functionality. Firstly, the system demonstrates high accuracy and reliability in fingerprint recognition, ensuring authorized users gain entry while effectively preventing unauthorized access. However, its accuracy relies on proper finger placement and environmental factors. Additionally, the system boasts a quick response time of 1.5 seconds, though further optimization could enhance user experience. Security remains robust, with consistent rejection of unauthorized fingerprints, crucial for applications prioritizing security, such as residential and commercial buildings. Moreover, the system's power efficiency, facilitated by the relay module's control over battery power flow, enhances operational longevity, particularly in battery-operated setups.

VI. CONCLUSION AND FUTURE ENHANCEMENTS

Conclusion: In conclusion, the smart fingerprint unlock system presents a robust and practical solution for modern access control, marrying biometric technology with microcontroller-based automation. Its high accuracy, quick response time, robust security features, and power efficiency make it well-suited for various residential, commercial, and industrial applications. While further optimization could enhance certain aspects such as response time and user experience, the system's current capabilities offer a reliable and effective means of ensuring secure access control.

Future Enhancements: Moving forward, potential enhancements to the system could focus on improving response time through optimization of sensor algorithms and microcontroller processing. Additionally, integrating remote access features via a mobile application would enhance user convenience and control, allowing for remote user management and system monitoring. Moreover, exploring advanced biometric modalities for multi-factor authentication and enhancing sensor technology for improved performance in varied environmental conditions could further enhance the system's overall functionality and security.

REFERENCES

1. "Biometric door lock system based on fingerprint recognition," C. P. Sumathi, N. Kumaravel, Published in: 2018 3rd International Conference on Computational Systems and Information Technology for Sustainable Solutions (CSITSS).
2. "Design and implementation of fingerprint door lock security system," A. A. Odejebi, T. O. Oladele, et al., Published in: 2014 International Conference on Computational Science and Computational Intelligence (CSCI).
3. "Development of a Low-Cost Fingerprint Biometric Verification Door Lock Security System," M. A. Ganaie, G. M. Lone, et al., Published in: 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom).
4. "Fingerprint Door Lock Security System Based on IoT," A. Mishra, S. R. B. S. Dwivedi, Published in: 2019 3rd International Conference on Intelligent Sustainable Systems (ICISS).
5. "Smart Door Lock System Using Fingerprint Recognition," A. S. Qureshi, S. N. Z. Abidin, et al., Published in: 2015 IEEE Symposium on Industrial Electronics and Applications (ISIEA).
6. "Implementation of a Fingerprint Biometric Door Lock System," A. Z. Talib, S. H. B. Hassan, et al., Published in: 2017 International Conference on Research and Innovation in Information Systems (ICRIIS).
7. "A survey on fingerprint door lock system for modern homes," S. Parveen, P. Aruna, et al., Published in: 2018 International Conference on Information and Communication Technology for Intelligent Systems (ICICTIS).
8. Fingerprint Sensor Evaluation for Biometric Authentication by Michael J. Ulery et al. (2012)
9. Microcontroller-Based Fingerprint Recognition System for Embedded Applications by B. Rajasekaran et al. (2014)
10. A Study on Fingerprint Sensor and Microcontroller Integration for Secure Access Control System by Muhammad Faris et al. (2015)
11. Open-source Fingerprint Recognition on an Embedded System by Alexander M. Bazaraa et al. (2010)
12. Design and Implementation of a Fingerprint Door Lock System with Remote Monitoring by Muhammad Atif Hassan et al. (2017)
13. Design and Implementation of a Fingerprint Door Lock System Using Arduino by Sharmin Yasmin (2021)
14. Smart Door Unlock System Using Fingerprint by Pramana Research Journal (2021)
15. (PDF) Smart Door Lock System with Fingerprint Interface by ResearchGate (2019)
16. IoT-Enabled Smart Home Security System with Fingerprint Authentication by Md. Rakibul Islam et al. (2018)
17. A Secure and Smart Home Access Control System Based on Fingerprint Recognition and IoT Technology by Yang Zhang et al. (2019)



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details