International Journal of Scientific Research and Engineering Development-– Volume 9 Issue 2, Mar-Apr 2026
Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Smart Door Lock Using RFID, Fingerprint Sensor and Bluetooth Module

Sonawane Mayuresh[*1], Sonawane Darshan[*2], Pimparkar Yuvraj[*3], Prof. R. S.Arora*[4]
[*1234](Department of Electrical Engineering, M. S. B. T. E., Sanjivani K .B. P. Polytechnic, Kopargaoan, Maharashtra, India
Email: mayureshsonawane8993@gmail.com, sonawanedarshan8855@gmail.com, Yuvrajpimparkar2031@gmail.com, arorarsee@sanjivani.org.in)

----------**********----------

Abstract:
Security is one of the major concerns in residential and commercial buildings. Traditional locking systems are vulnerable to duplication and unauthorized access. This paper presents the design and implementation of a Smart Door Lock System using RFID, Fingerprint Sensor, and Bluetooth Module. The system provides multi-level authentication to enhance security. RFID technology allows authorized users to unlock the door using a registered RFID card. The fingerprint sensor ensures biometric verification for higher security. Additionally, the Bluetooth module enables wireless access control through a smartphone. The proposed system improves safety, reliability, and user convenience while reducing the risk of unauthorized entry. The system is cost-effective and suitable for homes, offices, and institutions.

Keywords— Smart Door Lock, RFID, Fingerprint Sensor, Bluetooth Module, Arduino, Security System.

----------**********----------

INTRODUCTION

Electrical line workers do very dangerous work every day. They work near high voltage wires, electric poles, transformers, and substations. There is always a risk of electric shock, high temperature, fire, and harmful gases. Many accidents happen because workers cannot detect these dangers in advance. A normal safety helmet only protects the head from physical injury. It cannot detect electrical or environmental dangers. So, there is a need for a smart safety system that can monitor the surroundings and give warning alerts.

The smart helmet for electrical line workers is designed to improve worker safety. It uses sensors to detect voltage, temperature, and harmful gases. If any unsafe condition is found, the system gives a sound and visual alert. In serious situations, it can also send an emergency message to the supervisor. This project helps in reducing accidents, improving safety, and protecting the lives of electrical workers. It is simple, low cost, and easy to use.

METHODOLOGY

The methodology of this project is based on designing and integrating multiple authentication technologies with a microcontroller-based control system. The first step in the methodology is system design and planning. In this stage, all required components such as ESP32, RFID reader, fingerprint sensor, relay module, solenoid lock, LEDs, and power supply are selected according to their specifications and compatibility.

After component selection, hardware integration is carried out. The RFID reader is connected to the ESP32 using SPI communication. The fingerprint sensor is connected through UART (serial communication). The relay module is connected to one of the digital output pins of ESP32. The solenoid lock is connected through the relay and powered using a separate 12V battery. Proper wiring and grounding are ensured to avoid short circuits and voltage fluctuations.

The next step is software development. Programming is done using Embedded C / Arduino IDE platform. The code is written to read RFID card data, capture fingerprint data, and process Bluetooth commands. The microcontroller compares received authentication data with stored data. If the data matches, the relay is activated for a few seconds to unlock the door. If the authentication fails, the system denies access and shows a red LED indication.

Testing and debugging are important parts of the methodology. Each module is tested individually before integrating into the complete system. After integration, the full system is tested under different conditions to ensure reliable performance. The final system is then assembled into a prototype model for demonstration.

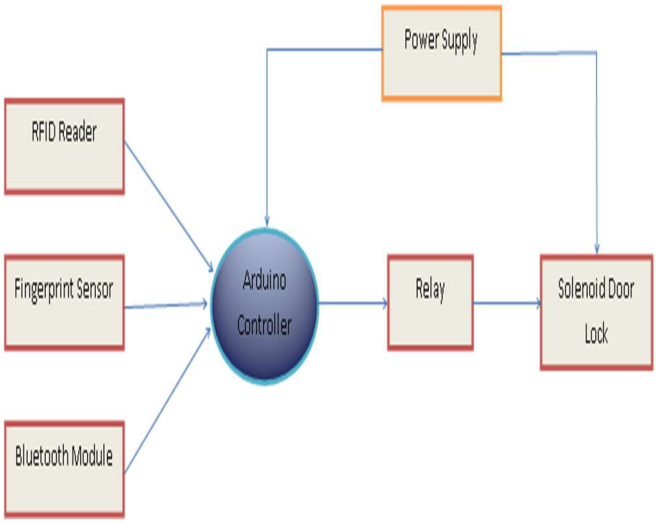
BLOCK DIAGRAM

Figure illustrates the overall architecture of the proposed smart door lock system. The system consists of three input modules: RFID reader, fingerprint sensor, and Bluetooth module. These modules are connected to the Arduino microcontroller, which acts as the central processing unit.

The RFID reader scans authorized cards and sends the unique ID to the controller. The fingerprint sensor captures biometric data and compares it with stored templates. The Bluetooth module enables wireless authentication through a smartphone application.

If any authentication method is verified successfully, the Arduino sends a signal to the relay module, which activates the solenoid lock mechanism to unlock the door. If authentication fails, the system denies access.

This multi-layer authentication improves overall system security and reliability.



Block Diagram

APPLICATIONS

- The Smart Door Lock system has many practical applications in modern security systems.
- It can be used in residential houses to improve home security. Instead of traditional keys, users can access their homes using RFID cards or fingerprints.
- In offices and companies, this system can be used to restrict unauthorized entry into cabins, server rooms, or confidential areas. Only registered employees can gain access.
- In educational institutions such as colleges and laboratories, it can be used to secure restricted rooms and equipment storage areas.
- Banks and financial institutions can use this system for locker rooms and record rooms where high security is required.
- It can also be used in hostels, apartments, hospitals, and government offices where controlled access is important.
- Because of Bluetooth connectivity, the system can be further upgraded into IoT-based smart home applications.

ADVANTAGES

- The Smart Door Lock system offers several advantages over traditional locking systems.

- It provides higher security because it uses biometric fingerprint authentication, which is unique for every person.
- RFID technology allows quick and contactless access.
- Bluetooth feature adds convenience by enabling wireless control.
- The system reduces the risk of losing physical keys.
- It supports multiple users, and new users can be added easily.
- The relay module ensures safe isolation between low voltage and high voltage circuits.
- The system is low cost compared to commercial biometric locks.
- It consumes less power and operates efficiently.
- The use of multiple authentication methods increases overall reliability and security.

CONCLUSIONS

The Smart Door Lock System using RFID, Fingerprint, and Bluetooth is a modern and reliable security solution. This project successfully replaces the traditional key-based locking system with a smarter electronic access control system. By combining multiple authentication methods, the system increases security and reduces the chances of unauthorized access.

The ESP32 microcontroller controls the entire system and processes data from the RFID reader and fingerprint sensor. If the authentication is successful, it activates the relay to unlock the solenoid door lock. The use of a separate 12V supply for the solenoid ensures safe and stable operation. LED indicators provide clear status information to the user.

This system is secure, cost-effective, and easy to use. It reduces the risk of losing physical keys and allows easy management of authorized users. The project also helps in understanding embedded systems, microcontrollers, and security technologies. With further improvements, it can be upgraded into a complete smart home security system.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the Department of Electrical Engineering, M.S.B.T.E., Sanjivani K.B.P. Polytechnic, Kopargaon, Maharashtra, India, for providing the necessary facilities, laboratory support, and technical guidance required for the successful completion of this research work.

The authors are especially thankful to the project guide and faculty members for their valuable suggestions, continuous encouragement, and constructive feedback throughout the development of the Smart Door Lock System. Their support and motivation played a vital role in improving the quality of this research paper.

The authors also extend their appreciation to their friends and classmates for their cooperation and assistance during the testing and implementation phase of the project.

REFERENCES

[1] K. Finkenzeller, RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identification, 3rd ed. New York, USA: Wiley, 2010.

[2] R. Want, "An Introduction to RFID Technology," IEEE Pervasive Computing, vol. 5, no. 1, pp. 25–33, Jan.–Mar. 2006.

[3] S. Prabhakar, S. Pankanti, and A. K. Jain, "Biometric Recognition: Security and Privacy Concerns," IEEE Security & Privacy, vol. 1, no. 2, pp. 33–42, Mar.–Apr. 2003.

[4] A. K. Jain, A. Ross, and S. Prabhakar, "An Introduction to Biometric Recognition," IEEE Transactions on Circuits and Systems for Video Technology, vol. 14, no. 1, pp. 4–20, Jan. 2004.

[5] M. A. Hannan, M. S. Hossain, and A. Mohamed, "Smart Door Lock System Using Biometric and RFID Technology," in Proc. International Conference on Electrical Engineering and Informatics, 2012, pp. 45–50.

[6] Arduino, "Arduino Uno Rev3 Datasheet," Arduino Official Documentation, 2018.

[7] H. Liu and H. Darabi, "Survey of Wireless Indoor Positioning Techniques and Systems," IEEE Transactions on Systems, Man, and

Cybernetics, vol. 37, no. 6, pp. 1067–1080, Nov. 2007.

[8] A. Juels, "RFID Security and Privacy: A Research Survey," IEEE Journal on Selected Areas in Communications, vol. 24, no. 2, pp. 381–394, Feb. 2006.

