IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

3rd-International Conference on Muti-Disciplinary Application & Research Technologies (ICMART-2024)

Geetanjali Institute of Technical Studies

Vol. 11, Special Issue 2, May 2024

Implementation of a Fingerprint-Activated Door Lock Using Arduino UNO

Ravi Teli[1], Sunil Sharma[1], Rajveer Singh[2], Bhavya Ameta[2]

Assistant Professor, Department of ECE, GITS, Udaipur, India[1]

Undergraduate Student, Department of ECE, GITS, Udaipur, India[2]

Abstract: This paper explores the development of a fingerprint-based door lock system utilizing Arduino technology, aimed at enhancing security for residential and commercial environments. Traditional keys are vulnerable to duplication, loss, and theft, presenting significant security risks. Biometric security, notably fingerprint identification, offers a robust alternative due to its uniqueness to each individual and resistance to duplication. Biometric verification utilizes distinct biological traits for identity confirmation; among these, fingerprints are particularly reliable and accessible for integration into security systems. Our system employs a fingerprint sensor to capture and relay the user's print to an Arduino microcontroller, which then compares the input to its stored database. If the fingerprint matches an authorized user, the system either locks or unlocks the door, depending on its current state. Unauthorized access attempts result in no action, maintaining security until a recognized print is detected. This solution not only enhances security by reducing the likelihood of unauthorized access but also eliminates issues associated with physical keys, such as the inconvenience of loss or theft. By utilizing Arduino's capabilities, we aim to implement a user-friendly, efficient, and secure system that significantly mitigates the risks associated with traditional lock mechanisms.

Keywords: Biometric verification, Arduino, Fingerprint Sensor

I. INTRODUCTION

In the pursuit of advanced security solutions, the integration of biometric technology has become increasingly prevalent. The fingerprint-based door lock system described in this paper utilizes the Arduino UNO R3 V1.0, a popular microcontroller board known for its versatility and ease of use, which serves as the backbone of our design. This system is designed to offer a higher level of security compared to traditional mechanical locks, which are susceptible to various vulnerabilities such as key duplication and physical tampering. The core component of our system is a high-sensitivity fingerprint sensor, which captures the user's fingerprint details with high accuracy. This sensor is crucial for the system's ability to provide secure and personalized access control. Upon authentication of a registered fingerprint, the Arduino microcontroller processes the input and sends a signal to actuate a Solenoid Electric Door Lock. This lock is robust and designed for heavy-duty operation, ensuring that the door remains securely locked or unlocked based on the user's access rights. To drive the Solenoid Lock effectively, a MOSFET IRFZ44N is used due to its high current handling capability and efficiency in switching operations. This ensures that the lock operates reliably under varying electrical loads, thereby enhancing the system's overall durability and performance. The entire setup is powered by a 12 Volt Adapter, providing a stable and sufficient power supply to handle the demands of the continuous operation of the lock and sensor. This setup ensures that the system remains operational even in the event of power fluctuations, which is critical for maintaining security integrity. This paper will delve into the design, implementation, and operational aspects of this innovative security system, highlighting the seamless integration of these components to create a reliable and user-friendly solution that addresses modern security challenges.

II. LITERATURE REVIEW

Meenakshi et al. introduced an "Arduino Based Smart Fingerprint Authentication System" featuring a three-tier security protocol. This system utilizes a fingerprint sensor module operated by either an Arduino or a Raspberry Pi. To enhance security, a user must successfully pass through any two of the three security levels to gain access. Each authorized user's fingerprint is registered, linked with their mobile number, and associated with a unique image password via GSM. Unauthorized access attempts prompt the system to challenge the user with a random image selection task, failing which, the system resets to the initial screen [2].

Patil et al. proposed a "Smart Door Locking System Using IoT," employing Internet of Things technology to facilitate remote unlocking via a smartphone. This system integrates a servo library with a unique device ID recognized by an app developed for Android smartphones, enabling door unlocking from virtually anywhere [3].

Reddy et al. developed a "Security System Based on Knock Pattern Using Arduino and GSM Communication," which relies on a secret knock pattern recognized only by the property owner.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

3rd-International Conference on Muti-Disciplinary Application & Research Technologies (ICMART-2024)

Geetanjali Institute of Technical Studies

Vol. 11, Special Issue 2, May 2024

This system, built with an Arduino and GSM module, unlocks only when the correct knocking pattern is applied at a designated spot, providing a keyless security solution that avoids duplication risks [4].

Areed and Marwa F. devised a "Keyless Entry System Based on Arduino Board with Wi-Fi Technology." Their system uses an Arduino Uno board equipped with a Wi-Fi shield, allowing door unlocking via a PHP-based application from any location with internet access, significantly expanding operational flexibility compared to conventional systems [5].

Jayasree Baidya et al. from North South University discussed the "Design and Implementation of a Fingerprint-Based Lock System for Shared Access" in their term paper. They explored the use of smartphone-based fingerprint technology, suggesting that door locks could be integrated with smartphones to utilize built-in fingerprint sensors for access control. This connection could be established via Bluetooth or Wi-Fi, proposing that the ubiquity of fingerprint-enabled smartphones could make this system increasingly relevant. [15]

III. IMPLEMENTATION

Architectural Design:

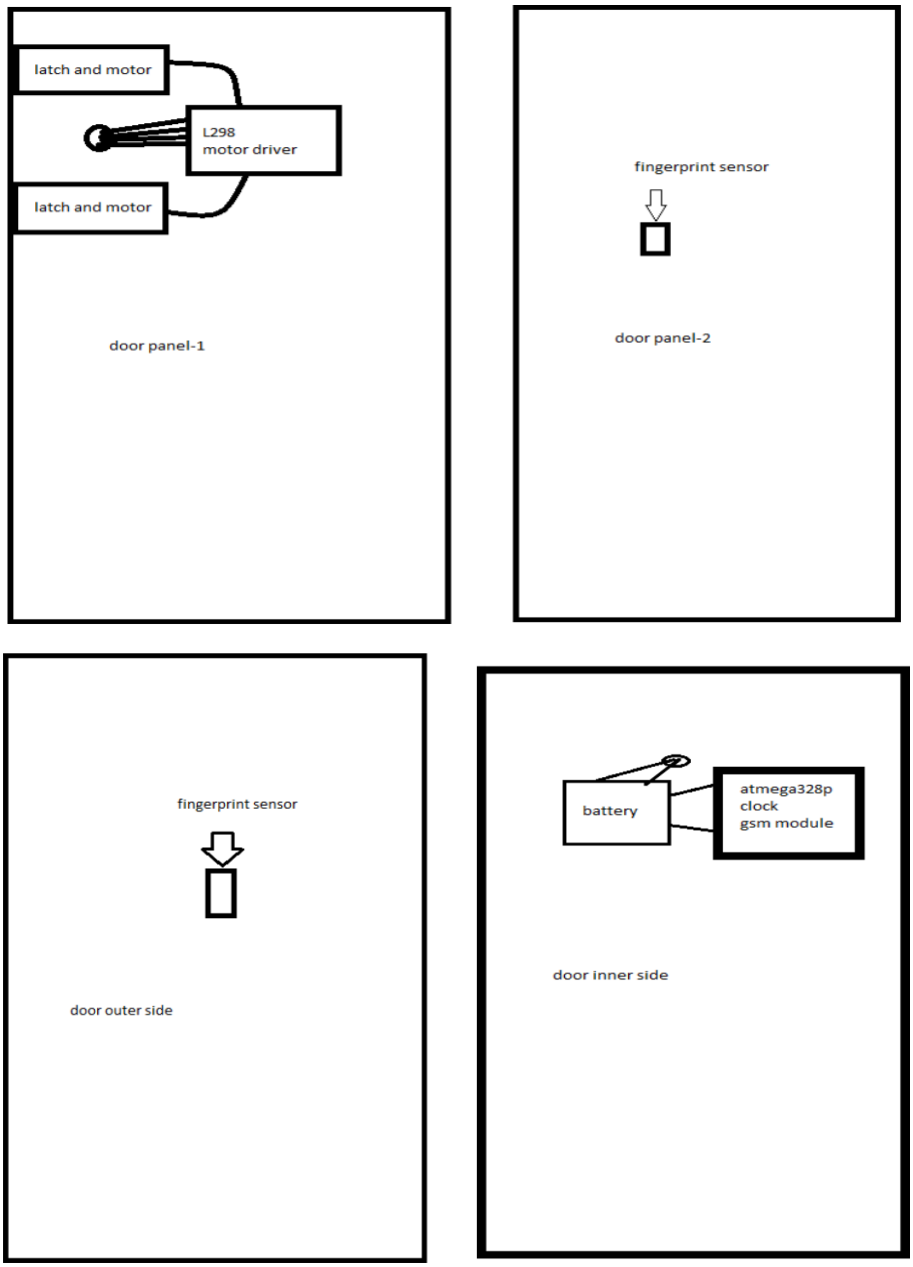

Figure 1: Architectural Design

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

3rd-International Conference on Muti-Disciplinary Application & Research Technologies (ICMART-2024)

Geetanjali Institute of Technical Studies

Vol. 11, Special Issue 2, May 2024

Flow Chart

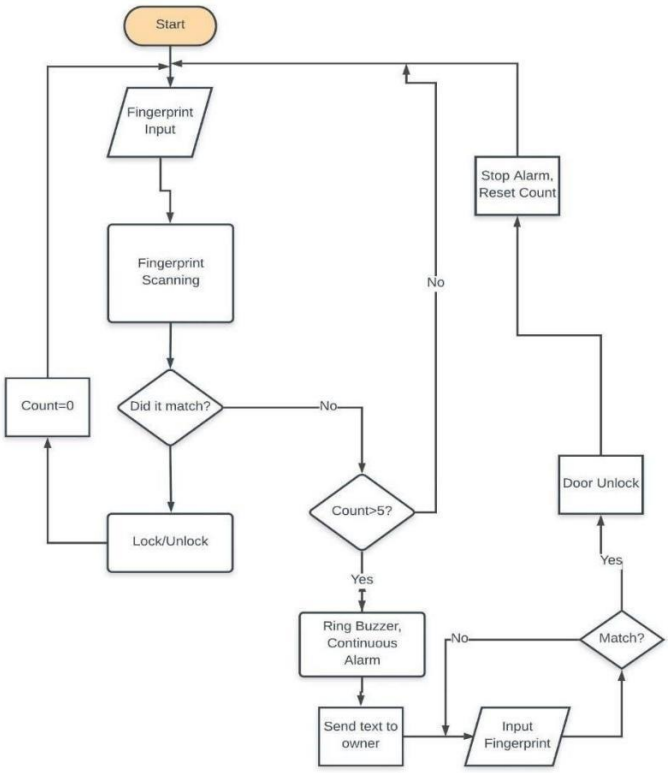

Figure 2: Flow Chart

System Setup

The system's hardware assembly began with setting up the Arduino UNO R3 V1.0 as the central processing unit. This board was chosen for its reliability and ample digital and analog I/O pins which are essential for managing multiple components including sensors and actuators. The Arduino was programmed using the Arduino Integrated Development Environment (IDE) software, which allows for the writing, compiling, and uploading of code directly to the board. The fingerprint sensor module R305 was connected to the Arduino using UART communication lines. Pins TX and RX of the R305 were linked to digital pins 2 and 3 of the Arduino, respectively. This setup enabled serial communication between the Arduino and the fingerprint sensor, crucial for sending and receiving fingerprint data.

Power Supply Configuration

A 12-volt DC adapter was used to power the entire system. Despite the Arduino UNO requiring only 5V, the solenoid lock's requirement for a higher voltage necessitated a common 12V supply. The Arduino's onboard 5V voltage regulator was employed to step down the voltage for the Arduino, while the solenoid lock directly utilized the 12V input.

Integration of the Solenoid Lock

The solenoid electric door lock was integrated into the system to actuate the locking mechanism. It was driven by the Arduino through a MOSFET IRFZ44N, which handled the high current needed to activate the solenoid. The connection was established using Jumper Wires from the MOSFET to the solenoid, ensuring that the door lock could operate effectively with the fluctuating power demands.

Programming and Operation

The Arduino program was written to initiate a fingerprint scanning process whenever an attempt to access the door was made. The system worked on a simple operational logic: if the scanned fingerprint matched any of the stored fingerprints in the database, the Arduino sent a signal through the MOSFET to activate the solenoid lock, thereby unlocking the door. If no match was found, the system would deny access, keeping the door locked.

The user interface was straightforward, allowing users to register or delete fingerprints using serial commands from a connected PC or a directly attached keypad. This flexibility ensured that managing access permissions was both user-friendly and secure.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

3rd-International Conference on Muti-Disciplinary Application & Research Technologies (ICMART-2024)

Geetanjali Institute of Technical Studies

Vol. 11, Special Issue 2, May 2024

Testing and Debugging

Once assembled, the system underwent rigorous testing to ensure reliability. The fingerprint registration process was refined to reduce errors, and multiple user scenarios were simulated to verify the system's responsiveness and accuracy. Debugging was primarily done through the serial monitor in the Arduino IDE, where messages regarding system status and errors could be directly read and addressed.

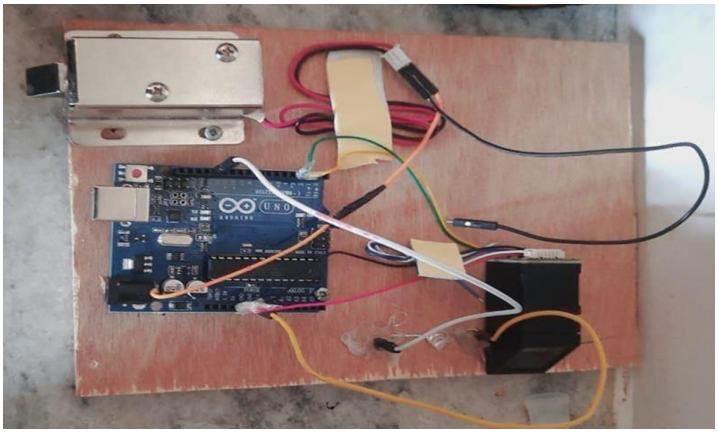

Figure 3: Implemented System

The implementation of this system demonstrated a successful integration of biometric authentication into a door security system, leveraging Arduino's versatile platform and the precise recognition capabilities of the fingerprint sensor. This setup not only enhanced security but also offered a modern solution to access management without the need for physical keys.

IV. RESULT AND DISCUSSION

In implementing the Fingerprint Door Lock System using Arduino, we successfully integrated and configured all necessary components with the power supply. The system's primary goal is to enhance security by utilizing a fingerprint sensor to register and recognize the owner's fingerprints. The Arduino is powered with a 5V supply, facilitated through the USB connection used for code uploading. Upon successful registration, when an authorized user places their thumb on the fingerprint sensor, the system promptly unlocks. Repeating the process locks the door again. Both locking and unlocking actions are completed in less than one second, showcasing the efficiency of the solenoid lock employed in this project.

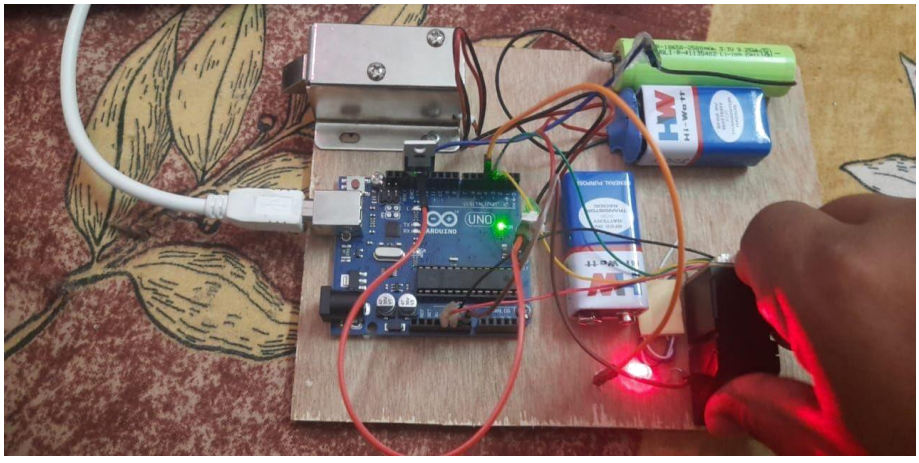

Figure 4: Working Model

Compared to a traditional secure system, our fingerprint door lock system is advanced, efficient and more secure. A normal security system is comprised of locks, which, in contact with the appropriate keys, get unlocked. In our system, an authorized and correct fingerprint is the only key to unlocking the secure lock system. Lock systems are very necessary in our day-to-day life. In order to secure important and personal belongings as well as one’s privacy, there is no alternative to lock and key. But the type of the system implemented tells a lot about the extent to which something can be and will be secured. Fingerprint door lock system is a biometric lock in which fingerprint interface is used as the keyto unlock.

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

3rd-International Conference on Muti-Disciplinary Application & Research Technologies (ICMART-2024)

Geetanjali Institute of Technical Studies

Vol. 11, Special Issue 2, May 2024

It is safer and more secure as fingerprints are unique and cannot be copied. There are some basic differences between locking systems of many kinds. Traditional lock and key systems, fingerprint lock systems, password/pin code systems, biometric lock systems are some of the security systems one can simply implement for security purposes. The pros and cons of each system make them efficient, secure, differentiable and hard to break. Some basic differences in performance and system structure between these security systems are as follows:

Table 1: Performance Evaluation

Types of differences	Lock & key	Biometric Lock	Fingerprint Lock
Composition	Composed of simply lock and its key	Fingerprint scanner and /or retina scanner.	Fingerprint scanner
Interfaces	Key	Fingerprint and/or retina	Fingerprint
Function	Unlocks by key only	Unlocks by fingerprint and/or retina scan	Unlocks by fingerprint
Performance	Low	Very high	High
Strength	Moderate	Very high	High
Efficiency & vulnerability	Less effective and highly vulnerable	Very effective and less vulnerable	Highly effective and less vulnerable

V. CONCLUSION

The Fingerprint-Based Door Lock System utilizing Arduino technology represents a significant advancement in secure access control. Through the implementation of biometric verification, this system offers a more reliable and secure alternative to traditional mechanical locks. The unique nature of fingerprints ensures that access is granted only to authorized individuals, effectively eliminating the risks associated with key duplication and loss. Our evaluation has demonstrated that the system performs with high efficiency and robust security. It quickly recognizes authorized fingerprints to unlock, and equally swiftly denies access when unrecognized fingerprints are presented. The system's reliance on simple, yet advanced technological components like the Arduino UNO and fingerprint sensors ensures both reliability and cost-effectiveness.

This project not only highlights the practical applications of combining hardware engineering with biometric technology but also sets a precedent for future developments in security systems. As biometric technology continues to evolve, it holds the potential to become the standard method for securing not only doors but also a broader range of sensitive interfaces in both personal and commercial spaces. In conclusion, the Fingerprint-Based Door Lock System illustrates a successful integration of traditional security mechanisms with modern technology to create a safer, more secure environment. This innovation offers a promising direction for future research and development in the field of security systems.

REFERENCES

[1]. Password Based Door Lock System Using Arduino," Research Gate. https://www.researchgate.net/publication/330998913_ Password Based Door Lock System Using Arduino (accessed Aug. 08, 2021).
[2]. Meenakshi, N, M Monish, K J Dikshit, and S Bharath. "Arduino Based Smart Fingerprint Authentication System." In 2019 1st International Conference on Innovations in Information and Communication Technology (ICIICT), 1–7. CHENNAI, India: IEEE, 2019.
[3]. Patil, Karthik A, Niteen Vittalkar, Pavan Hiremath, and Manoj A Murthy. "Smart Door
[4]. Locking System Using IoT" 07, no. 05 (2020): 5.
[5]. Reddy, R Sai Charan, P Vamsi Krishna, M Krishna Chaitanya, M Neeharika, and K Prabhakara
[6]. Rao. "Security System Based on Knock Pattern Using Arduino and GSM Communication" 4, no. 1 (2018): 5.
[7]. Areed, Marwa F. "A Keyless Entry System Based on Arduino Board with Wi-Fi Technology." Measurement 139 (June 2019): 34–39. https://doi.org/10.1016/j.measurement.2019.02.028.

[8]. Kishwar Shafin, Md., Kazi Lutful Kabir, Nazmul Hasan, Israt Jahan Mouri, Samina Tasnia
[9]. Islam, Lazima Ansari, Md. Mahboob Karim, and Md. Afzal Hossain. "Development of an RFID Based Access Control System in the Context of Bangladesh." In 2015 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), 1–5. Coimbatore, India: IEEE, 2015.
[10]. Anil K. Jain, Arun Ross and Salil Prabhakar. An Introduction to Biometric Recognition. IEEE Transactions on Circuits and Systems for Video Technology, Special Issue on Image and Video Based Biometrics, Vol. 14(1), January, 2004.
[11]. Anil K. Jain, Jianjiang Feng and Karthik Nandakumar. Matching Fingerprints. IEEE Computer, 43(2), pp. 36-44, February, 2010.
[12]. Mary Lourde R and Dushyant Khosla. Fingerprint Identification in Biometric Security Systems. International Journal of Computer and Electrical Engineering, 2(5), October, 2010.
[13]. Ankita, S., Mayank, P. & Manish, T. (2019). A comparative study to detect fraud financial statement using data mining and machine learning algorithms. International Research Journal of Engineering and Technology (IRJET), 6(8), 1492-1495.
[14]. Malabika Sarma has presented the Fingerprint Based Door Acess using Arduino.
[15]. Sai K Yashwant has presented the iLock: State-of-the-art Sophisticated Door Lock for Wireless Devices.
[16]. Jayasree Baidya has presented the Design and implementation of a fingerprint -based lock system for shared access.
[17]. Karma Toshomo has presented Dual Door Lock System Using Radio-Frequency Identification and Fingerptint Recognition.
[18]. Meenakshi N, Monish M, Dikshit KJ, Bharath S. Arduino Based Smart Fingerprint Authentication System. In year 2019 the 1st International Conference on Innovations in Information and Communication Technology (ICIICT) 2019 Apr 25 (pp. 1-7). IEEE.
[19]. Baidya J, Saha T, Moyashir R, Palit R. Design and implementation of a fingerprint based lock system for shared access. In year 2017 the IEEE 7th Annual Computing and Communication Workshop and Conference (CCWC) 2017 Jan 9 (pp. 1-6). IEEE.
[20]. Anu, Bhatia D. A smart door access system using finger print biometric system. International Journal of Medical Engineering and Informatics 2. 2014 Jan 1;6(3):274-80.
[21]. Tiwari, K., Patel, M. (2020). Facial Expression Recognition Using Random Forest Classifier. In: Mathur, G., Sharma, H., Bundele, M., Dey, N., Paprzycki, M. (eds) International Conference on Artificial Intelligence: Advances and Applications 2019. Algorithms for Intelligent Systems. Springer, Singapore. https://doi.org/10.1007/978-981-15-1059-5_15
[22]. Taunk, D., Patel, M. (2021). Hybrid Restricted Boltzmann Algorithm for Audio Genre Classification. In: Sheth, A., Sinhal, A., Shrivastava, A., Pandey, A.K. (eds) Intelligent Systems. Algorithms for Intelligent Systems. Springer, Singapore. https://doi.org/10.1007/978-981-16-2248-9_11
[23]. The International Conference on Advances in Computing, Communication Control and Networking (ICACCCN) 2018 Oct 12 (pp. 80-85). IEEE.
[24]. Anu, Bhatia D. A smart door access system using finger print biometric system. International Journal of Medical Engineering and Informatics 2. 2014 Jan 1;6(3):274-80
[25]. Folabi A, Alice O. On Securing a door with finger print biometric technique. Transactions on Machine Learning and Artificial Intelligence. 2014 Apr 11; 2:8696.

