

Development of a Fingerprint Door Lock System Using Arduino Uno Microcontroller

Dr. Jayapradha V¹, Nivethitha Sivakumar²

¹Assistant Professor, Department of ECE, SCSVMV,

²ME Embedded System Technology, Department of ECE, SCSVMV

ABSTRACT:

This paper presents the design and implementation of a fingerprint door lock system using Arduino Uno microcontroller. The fingerprint sensor module SEN0188 is a versatile and reliable sensor module that can be used in a variety of biometric projects. It is designed for various applications that require secure access control. It can be adapted for use in commercial settings such as offices, hotels, or high-security facilities. The system can be integrated into various applications such as secure storage lockers, personal safes, vehicle access systems, or even mobile devices for biometric authentication.

Keywords— Microcontroller, Arduino, authenticate, relay.

I. Introduction

Lock systems have been around for centuries, and traditional lock systems are still being used today. However, these systems are no longer considered secure and convenient as they are prone to various vulnerabilities. The rise of technology has led to the development of advanced door lock systems that are more secure and convenient than traditional lock systems. Biometric door lock systems are one such technology that uses a person's unique physical traits for authentication purposes. Fingerprint door lock systems are becoming increasingly popular due to their security and convenience. This thesis presents the design and implementation of a fingerprint door lock system using Arduino Uno microcontroller.

II. METHODOLOGY

Description of the design and implementation of fingerprint door locks using the Arduino Uno microcontroller. The system consists of hardware and software components. The system was designed and implemented using the Arduino IDE software and using C++ programming languages.

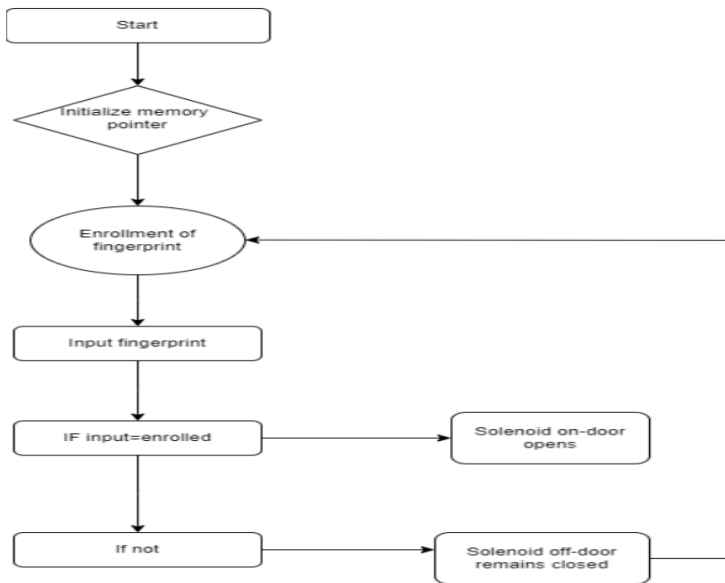


Fig1: FLOW CHART

III. HARDWARE COMPONENTS

BLOCK DIAGRAM

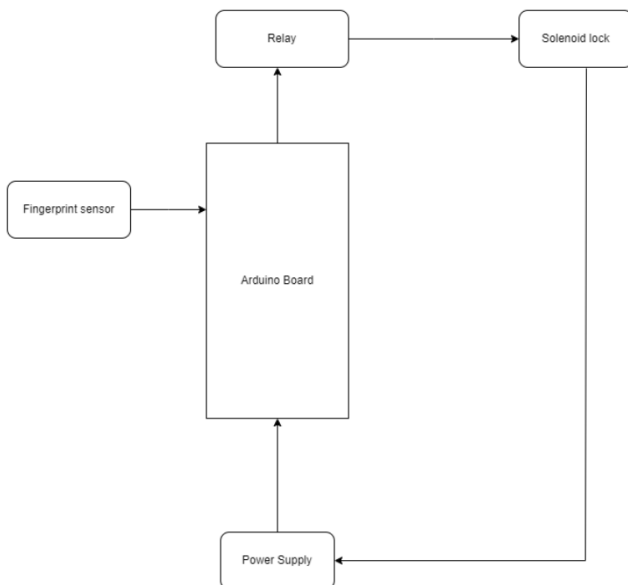


Fig2: Block Diagram

A. ARDUINO UNO

- The Arduino UNO is the best board to get started with electronics and coding. In the beginning with the platform, this UNO is the most robust board that can be started playing with. The UNO is the most used and documented board of the whole Arduino family.

B. FINGER PRINT SENSOR MODULE

EN0188 fingerprint sensor was used in this thesis project. It can be easily integrated into various biometric projects. It is compatible with Arduino development boards and can be used to implement secure access control systems, attendance management systems, and other biometric applications. The sensor module is equipped with a high-resolution optical scanner that can capture fingerprints with high accuracy and speed. The SEN0188 fingerprint sensor module has a compact design and is easy to install. It communicates with Arduino boards via a serial interface and can store up to 1000 fingerprint templates in its internal memory. The module also features a 13 built-in LED indicator and buzzer that provide real-time feedback during fingerprint scanning. Overall, SEN0188 is a versatile and reliable fingerprint sensor module that can be used in a variety of biometric projects. Its ease of use and compatibility with Arduino boards make it an ideal choice for hobbyists and professionals alike.

C. SOLENOID DOOR LOCK

The MP001161 Solenoid Lock is a compact and powerful locking mechanism designed for various applications that require secure access control. It operates at 12V DC and consumes 18W of power, making it suitable for a range of electronic locking systems. This solenoid lock is known for its reliability, durability, and efficient performance. It features a solenoid coil that, when energized, generates a magnetic field, allowing the lock to engage or disengage. The lock mechanism is designed to securely hold or release a latch or bolt, providing a reliable locking and unlocking mechanism.

D. RELAY MODULE

The module is used to control the electronic door lock. It is activated by the Arduino Uno if the fingerprint data matches one in the database. The 103020010 latching relay module is an electronic module that uses a latching relay to control the switching of an electrical circuit. The module is compact and easy to use, making it a popular choice for various applications that require remote control of electrical circuits. The module typically consists of a latching relay, a control circuit, and an interface for connecting to an external control device, such as a microcontroller or a switch. It operates on a low input voltage and provides a high output voltage, making it ideal for use in battery-operated devices.

This module is based on 2-Coil Latching Relay. In contrast to the ordinary relay, this latching relay does not need continuous power to keep the state, only a rising/falling pulse is needed to change the work state. Even the power can be removed when the work state does not need to change, making this module especially suitable for low power projects.

IV. SOFTWARE COMPONENTS

The fingerprint sensor interface program is used to interface the fingerprint sensor with Arduino Uno. It captures the fingerprint data and sends it to the Arduino Uno for processing. The user interface program provides a graphical user interface (GUI) for managing the system. It allows users to add, delete, and modify fingerprints in the database, view system status, and control the electronic door lock.

V. Methodology

Prior to connecting the parts, the datasheets were carefully examined to gather information about each component. The fingerprints were saved and uploaded to an Arduino board before to component connections. Using a USB cable, the Arduino board was linked to a PC. Adafruit fingerprint sensor library was then set up. Following the upload of the enrollment program, the serial monitor was turned on. Then, COM8 software was applied. Three fingers were then inserted. Two finger placements were made for verification. An Arduino board was updated using the program. A program to operate the electronic lock was then built and included in the main program. The program included the functionalities that are required to run the full system.

System testing:

The university laboratory's testing station was used to power the system once all connections had been made. The system was supplied with 12V power. The green light then began to illuminate via the fingerprint scanner. The door is shut. The system was tested by placing a finger on the scanner, whose fingerprint was already stored there. The lock was unlocked since the fingerprints matched. When a different finger was scanned whose fingerprint had not previously been saved, the lock stayed locked. Thus, the system's functionality was examined.

Advantages

Fingerprint door lock systems provide a high level of security compared to traditional lock systems. Each person has a unique fingerprint, making it extremely difficult for unauthorized individuals to gain access. It eliminates the risks associated with lost or stolen keys and the potential for unauthorized key duplication. With a fingerprint door lock system, there is no need to carry keys or remember complex passwords or PINs. Your fingerprint is always with you, making it a convenient and quick method of access. It eliminates the troubles of searching for keys or fumbling with locks.

Fingerprint door lock systems come in various designs and styles, offering aesthetic appeal to complement the overall look of your door or property. They can be sleek, modern, and discreet, enhancing the visual appeal of your entryway. These advantages make fingerprint door lock systems an attractive choice for those seeking a secure, convenient, and technologically advanced method of access control.

Disadvantages

While fingerprint recognition technology has improved significantly, there is still a possibility of false rejection. Factors such as dirt, moisture, or changes in finger condition can impact the accuracy of fingerprint recognition, leading to occasional instances of legitimate users being denied access. Fingerprint door lock systems can be more expensive compared to traditional lock systems. The technology involved, including the fingerprint sensor and associated hardware, adds to the overall cost of installation and maintenance. This cost may be a deterrent for those on a tight budget.

VI. CONCLUSION

In future, the project can be expanded to incorporate advanced security features such as multi-factor authentication, combining fingerprint recognition with other biometric modalities such as facial recognition or iris scanning.

The fingerprint door lock system can be integrated into broader smart home systems, allowing users to control access and monitor their doors remotely using mobile apps or voice assistants. Integration with other smart devices such as surveillance cameras or alarm systems can create a comprehensive home security ecosystem.

By connecting the fingerprint door lock system to the cloud, users can remotely manage access permissions, monitor activity logs, and receive real-time notifications.

The fingerprint door lock system can be adapted for use in commercial settings such as offices, hotels, or high-security facilities.

It can provide secure access control, attendance tracking, and customizable access privileges for employees or authorized personnel. The fingerprint sensor technology used in the project can be applied beyond door locks. It can be integrated into various applications such as secure storage lockers, personal safes, vehicle access systems, or even mobile devices for biometric authentication.

As fingerprint recognition technology continues to advance, future iterations of the project can incorporate improved algorithms and sensors to enhance accuracy, speed, and reliability. This would result in faster and more accurate fingerprint recognition, reducing false accept and reject rates.

VII. FUTURE SCOPE

AI can also help detect anomalies or potential security threats, adding an extra layer of intelligence to the system. Collaboration with security systems providers can open opportunities for partnerships, allowing for the integration of the fingerprint door lock system into existing security infrastructure or providing it as a bundled solution with other security products. These future potentialities highlight the versatility and scalability of the fingerprint door lock system project, with opportunities to expand its functionality, enhance security features, and integrate it into broader technological ecosystems.

The advancements made in this project contribute to the growing field of biometrics and highlight the potential for further innovation in this area.

REFERENCES

- [1] Fingerprint Sensor Accessed 11.05.2023. <https://www.farnell.com/datasheets/3216194.pdf>
- [2] Wikipedia
- [3] A. K. Jain, Y. Chen and M. Demirkus, "Pores and Ridges: High-Resolution Fingerprints Matching Using Level 3 Features," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 29, no. 1, pp. 15-27, Jan. 2007, Accessed 11.05.2023. doi: 10.1109/TPAMI.2007.250596.
- [4] Martin, M., Štefan, K., & Ľubor, F. (2018). Biometrics Authentication of Fingerprint with Using Fingerprint Reader and Microcontroller Arduino. TELKOMNIKA (Telecommunication Computing Electronics and Control), 16(2), 755. Accessed 12.05.2023. <https://doi.org/10.12928/TELKOMNIKA.V16I2.7572>
- [5] T. Chugh, K. Cao and A. K. Jain, "Fingerprint spoof detection using minutiaebased local patches," 2017 IEEE International Joint Conference on Biometrics (IJCB), Denver, CO, USA, 2017, pp. 581-589, accessed 12.05.2023. doi: 10.1109/BTAS.2017.8272745.
- [6] Arduino Uno Accessed 11.05.2023. <https://store.arduino.cc/products/arduino-uno-rev3>
- [7] Video tutorial
https://www.google.com/search?q=SEN0188+Fingerprint+Sensor+connection+image&tbm=isch&ved=2ahUKEwiJhMrikvP-AhVOwioKHTjYAVwQ2-cCegQIABAA&oq=SEN0188+Fingerprint+Sensor+connection+image&gs_lcp=CgNpbWcQAzoECCMQJ1C-KFjDggFgkloBaABwAHgAgAF7iAGbGZIBBDY4LjGYAQcGAAQgAQtd3Mtd2l6LWltZ8ABAQ&scli=ent=img&ei=v_RfZMmoLM6EqwG4sIfgBQ&bih=904&biw=1920#imgrc=iLrV2uDhVorqCM
- [8] Relay Module Embedded Computers, Education & Maker Boards> Arduino> Embedded Development Kit Accessories – Arduino Accessed 13.05.2023. <https://www.farnell.com/datasheets/3752244.pdf>
- [9] Adapter Accessed 13.05.2023. <https://www.farnell.com/datasheets/3752244.pdf>