Electronic Door Locker: Using fingerprint and keypad

Abstract— This document describes the construction of a door lock using fingerprint and keypad which unlocks or locks the door. This project report contains minor details of the materials used and methodology along with future plans and discussions.

Keywords— *Arduino IDE Development, Arduino UNO*

I.INTRODUCTION

This project introduces a groundbreaking solution that integrates automated door lock technology. This revolutionary system enhances the way of our security in our day-to-day life, security management, and improved theft security. Explore our, electronic door lock which combines Arduino interfacing.

The system utilizes a **fingerprint sensor module** to authenticate users based on their unique biometric data and a **4x4 matrix keypad** to accept passcodes. An authorized user can unlock the door either by scanning a registered fingerprint or by entering the correct passcode. The combination of these two access methods ensures higher security and convenience, providing an alternative means of entry in case of sensor malfunction or unavailability.

II.PROBLEM DEFINITION

Electronic door locks, especially systems that combine biometric authentication with keypad access, offer a modern, secure, and convenient solution for protecting homes, offices, and restricted areas. Their ability to provide keyless entry, enhanced access control, and activity monitoring has made them increasingly popular in both residential and commercial security systems.

III.LITERATURE REVIEW

In recent years, the development of electronic door locking systems has gained significant attention due to growing concerns regarding security and privacy. Several studies and projects have explored various technologies such as biometric authentication, RFID, smart card systems, and keypad-based access control to enhance door security solutions.

Singh and Sharma (2019) implemented a dual authentication door locking system using both a 4x4 matrix keypad and fingerprint scanner. Their system was capable of operating in dual mode — either by biometric verification or

password entry — offering users an alternative access method in case of fingerprint sensor failure

The studies also highlight existing challenges, such as power dependency, limited fingerprint storage, and environmental factors affecting biometric performance. These findings emphasize the importance of designing systems with alternative access options, power backup mechanisms, and secure data handling protocols.
This project builds upon these concepts by integrating both a fingerprint sensor and a keypad into a compact and affordable door locking system suitable for personal, residential, and small office applications.

A comprehensive list of all the electronic components and devices used in this project is provided below, along with a brief description of their specific functions and purposes within the system.

COMPONENT	**REMARK**
Arduino Uno	Microcontroller board based on the ATmega328P, provides digital and analog I/O pins, operates at 5V. Serves as the central control unit.
Fingerprint Sensor (R307)	Biometric module for capturing and verifying fingerprints. Interfaces with Arduino through serial communication.
4x4 Matrix Keypad	User input device for entering numeric passwords. Connects to Arduino via digital I/O pins.
1-Channel 5V Relay Module	Electrically operated switch used to control the 12V solenoid lock using the 5V Arduino output.
12V Solenoid Lock	Electromechanical locking device that opens upon receiving a 12V supply via the relay module.
Male to Male Jumper Wires	Connect various male header pins on modules to the Arduino board and breadboard connections.
Female to Male Jumper Wires	Used to connect female header modules (like the fingerprint sensor) to the Arduino’s male header pins.

COMPONENT	REMARK
Female to Female Jumper Wires	Enables connections between modules with male header pins or breadboard terminals.
Breadboard	A solderless device for prototyping the circuit connections and integrating various components.
12V DC Power Supply	External power source for driving the solenoid lock and providing system power through a regulated connection.

IV.ASSEMBLY AND WORKING

A. Methodology

The construction and implementation of the project involved several systematic steps:

Component Assembly and Circuit Connections:

The Arduino Uno was connected to a fingerprint sensor module via serial communication (TX, RX, GND, and VCC connections).

A 4x4 matrix keypad was interfaced with Arduino using eight digital I/O pins to capture numeric password inputs.

A 5V relay module was connected to a digital output pin of the Arduino. The relay's normally open (NO) terminal was wired to a 12V solenoid lock, controlling its actuation.

All components were connected using male-to-male, male-to-female, and female-to-female jumper wires on a breadboard for easy prototyping and troubleshooting.

Programming and System Logic Development:

The Arduino was programmed using the Arduino IDE. Libraries for the fingerprint sensor and keypad were imported to simplify integration.

The system logic was designed such that it first prompts the user to scan a fingerprint. If the fingerprint is recognized, access is granted, and the relay is triggered to open the lock.

If the fingerprint scan fails or is skipped, the user is prompted to enter a numeric password using the keypad. A correct password similarly triggers the relay to open the lock.

Testing and Validation:

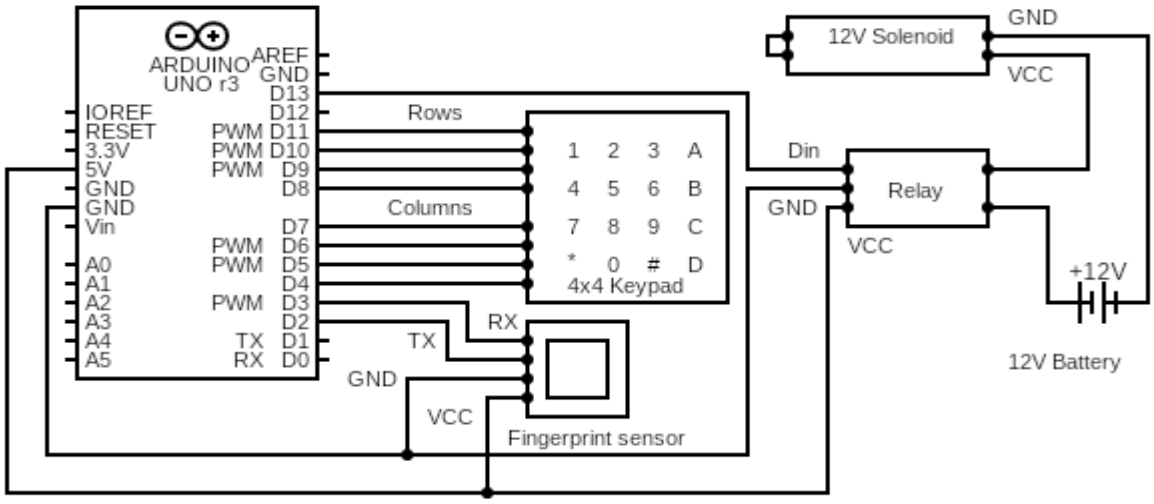
Individual components such as the fingerprint sensor, keypad, relay, and solenoid lock were tested separately to ensure proper functionality.

The complete system was then tested by registering fingerprints, entering passwords, and observing the door lock operation in various scenarios including correct access, incorrect inputs, and system reset conditions.

Power Management: The system was powered through a 12V DC supply connected to the Arduino's VIN pin and the solenoid lock via the relay.

This methodology ensured a structured and efficient approach to building a secure, dual-authentication electronic door lock system, integrating both biometric and passcode-based access controls.

B. Circuit Diagram and Connections



This circuit diagram shows a security system using an Arduino Uno, a 4x4 keypad, a fingerprint sensor, a relay module, and a 12V solenoid lock powered by a 12V battery. The Arduino Uno is at the center of the system.

- The 4x4 keypad is connected to digital pins D4 to D11 on the Arduino: the top four keypad pins (rows) connect to D8 through D11, and the bottom four pins (columns) connect to D4 through D7.

- The fingerprint sensor connects with its TX pin going to Arduino RX (D2), and its RX pin going to Arduino TX (D3). It shares a common GND with the Arduino and gets power from the 5V (VCC) pin of the Arduino.

- The relay module, which controls the solenoid lock, has its Din (signal) pin connected to D12 of the Arduino. The relay is powered from the 5V (VCC) and GND of the Arduino.

- The 12V solenoid is connected to the normally open (NO) contact of the relay, and its other end goes to the GND. The relay's VCC and the solenoid's VCC are both connected to the positive terminal of the 12V battery, while their GNDs connect to the battery's negative terminal, which is also connected to the Arduino's GND for common grounding.

This setup allows the solenoid to be activated via relay control when correct input is detected from either the keypad or fingerprint sensor.

C. Workflow

Workflow of the Arduino-Based Security System

1. **System Initialization**
    - When power is applied, the **Arduino Uno boots up**.
    - The Arduino initializes the **keypad**, **fingerprint sensor**, and **relay module**.
    - The fingerprint sensor and keypad are ready to receive input.
2. **User Authentication Begins**
    - The user is prompted to either:

- Enter a password using the 4x4 keypad, or
- Place their finger on the fingerprint sensor after pressing #.

3. **Input Verification**
   - **If the user enters a password via the keypad**:
     - The Arduino reads the key presses.
     - It compares the entered password with a **predefined password stored in the code**.
     - If the password matches, it proceeds to activate the solenoid.
     - If the password is incorrect, access is denied.
   - **If the user uses the fingerprint sensor by pressing #**:
     - The sensor captures the fingerprint.
     - It sends data to the Arduino through the serial communication pins (TX → D2, RX → D3).
     - The Arduino checks if the fingerprint matches any **pre-enrolled fingerprints**.
     - If matched, access is granted; otherwise, denied.
4. **Relay Activation**
   - Upon successful authentication (via keypad or fingerprint):
     - Arduino sends a **HIGH signal to pin D12**.
     - This activates the **relay module**.
     - The relay switches ON and allows **current from the 12V battery** to flow to the **12V solenoid lock**.
5. **Solenoid Unlocks**
   - When powered, the **12V solenoid** pulls or pushes (depending on type), unlocking the system.
   - It remains unlocked for a set duration 5 seconds, which is controlled by a delay in the Arduino code.

6. **Relay Deactivation**
    - After the delay, Arduino sets **pin D12 LOW**.
    - The relay turns OFF, cutting power to the solenoid.
    - The solenoid returns to its locked state (usually spring-loaded).

V. RESULTS AND DISCUSSIONS

Incorporating the learnings and feedback gathered during the development stages, we successfully built a reliable Fingerprint and Keypad-based Door Lock System. The system was meticulously assembled, tested, and refined, with all components performing as expected. The final results were highly satisfactory, clearly demonstrating that the initial objectives outlined for this project were effectively achieved.

One of our primary objectives was to understand and implement biometric authentication technology in conjunction with numeric keypad input for real-life applications in access control systems. The secure door lock system, powered by an Arduino Uno microcontroller, interfaced seamlessly with both the fingerprint sensor and keypad, ensuring that only authorized individuals could unlock the door.

The fingerprint system effectively identified registered users, granting access by activating a 12V solenoid lock via a 5V relay module. Likewise, the numeric keypad provided a reliable backup authentication method, allowing users to input a secure passcode for access when needed. The dual-authentication approach enhanced system flexibility and security, fulfilling our goal of creating a secure, dual-method access system.

In addition to the hardware implementation, careful attention was given to the system logic and software programming, ensuring that user interactions were efficient and intuitive. The Arduino-based program successfully handled fingerprint enrolment, scanning, and verification, as well as passcode management, relay control, and system status indications.

Using a breadboard for initial prototyping offered flexibility and ease of modification during the development and testing phases. Stable and secure connections were established using male-to-male, male-to-female, and female-

to-female jumper wires, enabling seamless integration of various modules and components.

The final system underwent extensive testing under various operational scenarios:

- Correct fingerprint authentication.
- Incorrect fingerprint attempts.
- Correct passcode entry.
- Incorrect passcode handling.
- Simulated power failure and system reset conditions.

In all cases, the system performed reliably, with quick response times and accurate authentication results.

The successful implementation of this project demonstrates the feasibility and practicality of using biometric and keypad-based electronic door locks in real-world applications. The project met all its objectives, including:

- Integrating biometric authentication for enhanced security.
- Providing an alternative numeric passcode access method.
- Ensuring stable control of a solenoid locking mechanism via a relay.

Developing a reliable, low-cost, and efficient access control solution for personal and office security applications.

This work highlights the potential of combining simple, cost-effective electronic components with Arduino-based programming to create secure and scalable access control systems

VI. CONCLUSION

The implementation of the Fingerprint and Keypad-based Door Lock System using the Arduino Uno microcontroller has proven to be an efficient, cost-effective, and reliable solution for enhancing security in personal and office environments. The simplicity of Arduino's design environment allowed for rapid development and integration of multiple hardware components including a fingerprint sensor, 4x4 keypad, relay module, and 12V solenoid lock.

The system effectively achieved dual-method access control, combining biometric verification with passcode entry. This redundancy ensures authorized access even

in cases where one method may temporarily fail, thereby increasing system reliability and user convenience. Additionally, the use of a relay-controlled solenoid lock demonstrated safe and stable locking and unlocking operations.

The project successfully met its primary objectives, offering a secure, easy-to-use, and scalable access control system. With accurate fingerprint recognition, effective keypad input handling, and seamless hardware integration, this project highlights the potential of combining biometric and electronic technologies for modern security applications.

Future enhancements could include integrating a real-time clock (RTC) for logging access times, GSM modules for remote alerts, or Wi-Fi modules for IoT connectivity, expanding the system's functionality further and also adding a camara to enhance security.

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VII.VISUALS: