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FINGERPRINT-BASED SMART DOOR LOCKING SYSTEM FOR BANKS

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ABSTRACT

Traditional lock systems, despite their long history, have become inadequate in terms of security and convenience due to their susceptibility to various vulnerabilities. The advancement of technology has paved the way for more secure and convenient door lock systems, with biometric door locks emerging as a significant innovation. Fingerprint door lock systems, in particular, utilize a person's unique physical traits for authentication, capturing and storing biometric data to allow access only to recognized fingerprints. This project focuses on the implementation of a fingerprint-based door locking system, integrating electronic components and biometric technology to enhance security and streamline the access control process. Such a system is especially suitable for high-security environments like banks, demonstrating the practical application of the Internet of Things (IoT) in security solutions.

Keywords: Arduino Uno Board, Finger print sensor, LCD, Jumper Wires, Buzzer, Bread board, 12 Volt Power Adapter, 12 Volt Solenoid Lock, Relay Module.

I. INTRODUCTION

The fingerprint-based door locking system for banks is an advanced security solution that leverages biometric technology to ensure only authorized personnel can access restricted areas. This system is designed using an Arduino Uno board, a fingerprint sensor, an LCD display, jumper wires, a buzzer, a breadboard, a power adapter, a solenoid lock, and a relay module. The core component of this system is the fingerprint sensor, which captures and stores the unique fingerprints of authorized users. When a user places their finger on the sensor, the Arduino Uno processes the input and compares it with the stored data. If the fingerprint matches an authorized entry, the Arduino sends a signal to the relay module, activating the solenoid lock to unlock the door. The LCD display provides real-time feedback. The buzzer sounds an alert for unsuccessful access attempts, enhancing security by notifying personnel of potential unauthorized entry. The entire setup is powered by a reliable volts power adapter, ensuring consistent operation. This system not only enhances security but also offers efficient way to manage access control in bank environments.

II. LITERATURE REVIEW

It reveals a substantial body of research and technological advancements in the realm of biometric security. Fingerprint recognition technology has been extensively studied and proven to be a highly reliable and secure method for personal identification due to the uniqueness and permanence of fingerprints. Numerous studies have highlighted the advantages of biometric systems over traditional access control methods, citing their resistance to forgery and the difficulty of replicating biometric traits. Research indicates that integrating fingerprint sensors with microcontrollers like Arduino enhances system efficiency and user experience by providing quick and accurate access verification. Furthermore, advancements in sensor accuracy, algorithm development, and real-time processing capabilities have made biometric systems increasingly feasible for high-security applications, such as banking. Literature also points out the challenges associated with biometric systems, including environmental factors and sensor cleanliness, which can affect performance. However, continuous improvements and innovations are addressing these concerns, making fingerprint-based smart door locking systems a compelling choice for modernizing security infrastructure in banks.

III. METHODOLOGY

The functionality of system is divided into four levels. The block diagram for the Fingerprint-Based Smart Door Locking System is displayed in Figure 1.

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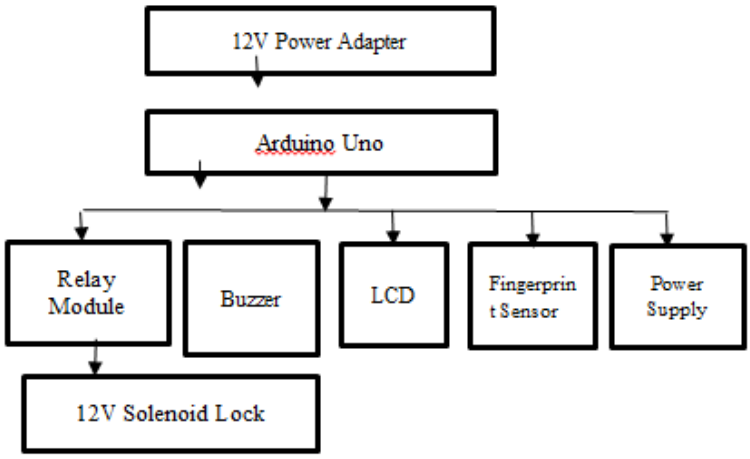

Fig 1. Block Diagram

In above block diagram of Fingerprint-Based Smart Door Locking System for Banks involves several key steps. First, the system components, including an Arduino Uno board, fingerprint sensor, LCD, buzzer, solenoid lock, relay module, breadboard, jumper wires, and power adapter, are selected and assembled according to a detailed schematic. The fingerprint sensor captures and verifies fingerprints, while the LCD displays system status and the buzzer provides audio feedback. The solenoid lock, controlled by the relay module, manages the door locking mechanism. Software development using the Arduino IDE involves coding for fingerprint enrollment, matching, and door control, integrating necessary libraries for sensor and component management. The system is then tested and calibrated to ensure accurate fingerprint recognition and reliable operation. Finally, the system is installed in the bank, with personnel trained on its use, and regular maintenance is scheduled to ensure ongoing security and functionality. This approach leverages biometric and IoT technologies to create a robust, reliable access control system, enhancing bank security.

3.1 Tools and Components

3.1.1 Arduino UNO

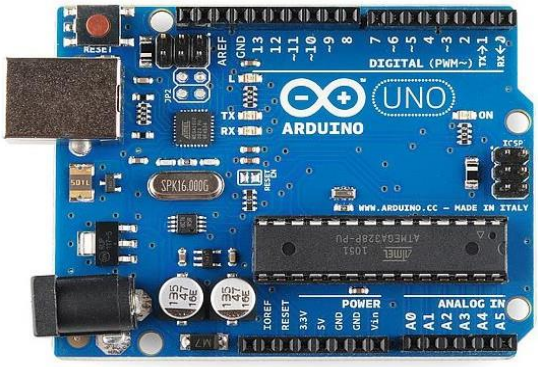

Fig 2. Arduino UNO

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board.

3.1.2 Fingerprint Sensor

Fig 3. Fingerprint sensor

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Fingerprint recognition systems work by examining a finger pressed against a smooth surface. The finger's ridges and valleys are scanned, and a series of distinct points, where ridges and valleys end or meet, are called minutiae. These minutiae are the points the fingerprint recognition system uses for comparison.

3.1.3 LCD

Fig 4. LCD

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smart phones , televisions, computer monitors and instrument panels. LCDs were a big leap in terms of the technology they replaced, which include light-emitting diode (LED) and gas-plasma displays. LCDs allowed displays to be much thinner than cathode ray tube (CRT) technology.

3.1.4 Jumper wires

Fig 5. Jumper wires

A jump wire(also known as jumper, jumper wire, DuPont wire)is an electrical wire, or group of them in a cable, with a connector or pin at each end which is normally used to interconnect the components of a bread board or other prototype or test circuit, internally or with other equipment or components, without soldering.

3.1.5 Buzzer

Fig 6. Buzzer

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & sire.

3.1.6 Bread board

Fig 7. Bread board

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A Bread board is simply a board for prototyping or building circuits on. It allows you to place components and connections on the board to make circuits without soldering.A bread board, solder less bread board, orpro to board is a construction base used to build semi-permanent proto types of electronic circuits .Unlike apery or strip board, breadboards do not require soldering or destruction of tracks and are hence reusable. For this reason, breadboards are also popular with students and in technological education.

3.1.7 12Volt Power Adapter

Fig 8. 12Volt Power Adapter

The primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters.

3.1.8 12Volt Solenoid Lock

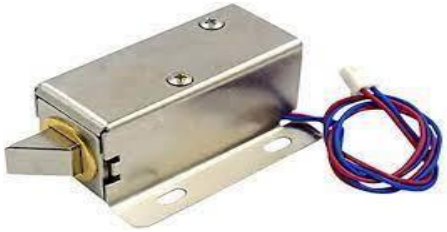

Fig 9. 12 Volt Solenoid Lock

The solenoid lock denotes a latch for electrical locking and unlocking. It is available in unlocking in the power-on mode type, and locking and keeping in the power-on mode type, which can be used selectively for situations.

3.1.9 Relay Module

Fig 10. Relay Module

A power relay module is an electrical switch that is operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a micro controller. When activated, the electromagnet pulls to either open or close an electrical circuit.

IV. WORKING

The proposed fingerprint-based smart door locking mechanism, designed for enhanced security and streamlined access control in banks, utilizes the Arduino Uno microcontroller and a high-precision fingerprint sensor to capture and store authorized personnel's unique fingerprints. When a fingerprint is placed on the sensor, the Arduino processes the input, matches it against the stored database, and if successful, triggers the relay module to activate the solenoid lock, unlocking the door. An LCD display provides real-time access status, while unsuccessful attempts prompt an audible alert from a buzzer, notifying security personnel of potential unauthorized access. Powered by a reliable adapter, this system replaces traditional keys and access cards with biometric authentication, offering a secure, efficient, and user-friendly solution for managing access in bank

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environments.

V. RESULT ANALYSIS

Fig 11. Hardware Model of the Project

The fingerprint-based smart door locking mechanism significantly enhances security and streamlines access control within banks by replacing traditional keys and access cards with biometric authentication. During testing, the system reliably captured and matched fingerprints, with successful matches triggering the solenoid lock and providing real-time feedback via the LCD display. Unsuccessful attempts activated the buzzer, effectively alerting security personnel to potential unauthorized access. Powered by a consistent adapter, the system demonstrated robust performance and user-friendly operation, offering a secure, efficient, and reliable solution for high-security environments.

VI. CONCLUSION

The fingerprint-based door locking system for banks, leveraging biometric technology and IoT components, offers a significant advancement in security and access control. The system ensures that only authorized personnel can access restricted areas. This innovative approach addresses the vulnerabilities of traditional keys and access cards, providing a secure, efficient, and user-friendly solution. The system's reliability is bolstered by continuous power from a stable adapter, while real-time feedback and alerts enhance security monitoring. The literature review underscores the proven reliability and security of biometric systems, reinforcing the system's viability for high-security applications. Methodologically, the system's design, assembly, coding, testing, and deployment demonstrate a comprehensive approach to modernizing bank security infrastructure. This fingerprint-based smart door locking mechanism stands out as a compelling solution for enhancing security, improving operational efficiency, and modernizing access control in banking environments.

VII. FUTURE SCOPE

The future scope of the fingerprint-based door locking system for banks includes potential enhancements such as integrating advanced biometric algorithms for improved accuracy and security. Implementing wireless communication protocols like Bluetooth or Wi-Fi could enable remote monitoring and access management capabilities. Additionally, incorporating cloud-based storage for fingerprint data could enhance scalability and facilitate centralized management across multiple bank branches. Integration with smart building systems for seamless access control integration and enhanced user experience represents another promising avenue for future development. These advancements aim to further strengthen security measures while offering increased convenience and efficiency in access management for bank environments.

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