Project Report

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Branch: MCA AI/ML **Section/Group:-24MAM 3(A)**
Semester:3 **Date of Performance:**
Subject Name: IOT **Subject Code:24CAH-723**

Aim:- RFID-Based Smart Door Lock System Using Arduino

(Times New Roman-14)

Objectives: (Min. 3) (Times New Roman-14)

1. **To design and implement** a secure door locking system using an **Arduino UNO microcontroller** and **RFID technology** for contactless user authentication.
2. **To control the locking mechanism** using a **solenoid lock**, which automatically unlocks when a valid RFID tag is detected and locks again after a predefined time.
3. **To interface the RFID reader** with the Arduino UNO for reading unique tag IDs and verifying them against stored authorized IDs.
4. **To provide visual and audio feedback** using and a **buzzer** to notify the user about different system states such as access granted, access denied, and system ready.
5. **To ensure system reliability and safety** by using proper driver circuitry, power supply management, and fail-safe operation for the solenoid lock.
6. **To develop a cost-effective and user-friendly security system** that can be easily installed and expanded for future smart home or office automation.
7. **To display real-time system status and messages** such as “Scan Your Card,” “Access Granted,” and “Access Denied” on a 16x2 LCD module for better user interaction and monitoring.
8. **To test and evaluate the performance of the system** under various conditions to ensure accurate RFID detection, quick response time, and consistent operation for enhanced security and reliability.

Components Required: (Times New Roman-14)

Sno	Name of Component	Qty
1.	Arduino Uno)	1
2.	RC522 RFID Module	1
3.	RFID TAGS	1
4.	Buzzer	1
5.	16*2 LCD MODULE	1
6.	Breadboard	15+
7.	Jumper Wires	1
8.	Solenoid Door lock	1
9.	Relay Module(5v)	1

Details of Components: (Times New Roman-14)

1. **Arduino Uno**

The Arduino Uno is the central controller of the entire system. It is an open-source microcontroller board based on the ATmega328P microchip and operates at a voltage of 5V. The Uno board is equipped with 14 digital input/output pins, 6 analog inputs, and a 16 MHz quartz crystal that ensures precise timing. It serves as the brain of the project, processing the input received from the keypad and generating output signals for the servo motor, LED, and buzzer. The Arduino is programmed using the Arduino IDE, making it beginner-friendly and easy to use. Its versatility and reliability make it an ideal choice for embedded system applications such as password-based security systems.

2. **RC522 RFID Module/RFID Tags**

The RC522 RFID Module is a low-cost and efficient RFID reader that operates at 13.56 MHz frequency. It is based on the MFRC522 IC and is used for contactless identification applications. The module communicates with the Arduino UNO through the SPI (Serial Peripheral Interface) protocol for fast data exchange. It can read unique identification data stored in RFID tags or cards placed within a range of 2–5 cm. The RC522 operates at 3.3V and includes an onboard antenna for signal transmission and reception. In this project, the RC522 module is used to read the unique ID of the RFID tag and send it to the Arduino for authentication. If the scanned ID matches the stored authorized ID, the Arduino activates the solenoid lock to unlock the door. It is compact, reliable, and ideal for secure access control applications.
RFID Tags are small electronic devices that contain a microchip and an antenna

used for wireless communication with an RFID reader. Each tag has a unique identification number (UID) that can be read when it comes near the RFID reader. The tags used in this project are passive RFID tags, which do not have an internal power source and are powered by the electromagnetic field generated by the reader. These tags are lightweight, durable, and inexpensive, making them suitable for security systems. In this project, authorized RFID tags unlock the door when presented near the reader, while unauthorized tags are denied access.

3. 16*2 LCD MODULE

The 16x2 LCD module is a widely used display device in embedded systems for showing text-based information. It consists of 16 columns and 2 rows, allowing it to display up to 32 characters at a time. The LCD operates on a voltage range of 4.7V to 5.3V and communicates with the Arduino using either 4-bit or 8-bit parallel interface mode. It is controlled by the HD44780 controller, which is compatible with the Arduino LiquidCrystal library for easy programming. In this project, the 16x2 LCD module is used to display system messages such as “Access Granted,” “Access Denied,” “Scan Your Card,” and “Door Locked.” This provides real-time feedback to the user during operation. Due to its low cost, low power consumption, and clear visibility, the 16x2 LCD is ideal for displaying status information

4.Buzzer

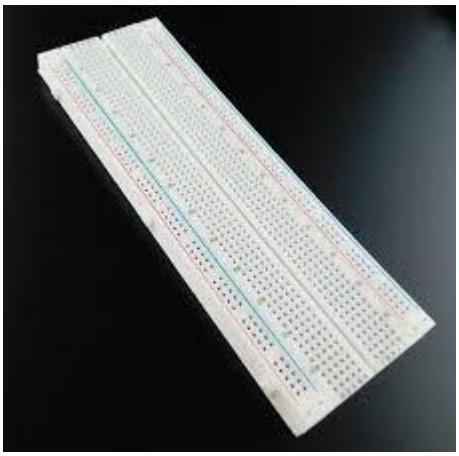
A buzzer is an electronic audio signaling device that produces sound when an electric signal is applied. It is used in this project to provide audio feedback during operation. When the user enters the correct password, the buzzer emits a short beep indicating access granted, while multiple quick beeps indicate an incorrect password. The buzzer operates at 3V to 5V and can be either active (self-oscillating) or passive (requiring tone signals from Arduino). It serves as an important user interface component, giving real-time sound alerts that enhance the usability and feedback system of the smart door lock.

5.Solenoid Door lock

The solenoid door lock is an electromechanical locking device used to control access in security systems. It operates on a voltage range of 9V to 12V and consists of a coil that generates a magnetic field when energized, causing the metal bolt to retract or extend. The lock remains engaged (locked) when no current is applied and disengages (unlocks) when powered. In this project, the solenoid door lock is controlled by the Arduino through a relay or transistor driver circuit. When a valid RFID tag is detected, the Arduino sends a signal to activate the solenoid, unlocking the door for a short duration before automatically locking again. The solenoid lock is reliable, durable, and suitable for applications requiring automatic and secure door control.

1. Breadboard

The breadboard is a solderless prototyping board used to connect electronic components temporarily for testing and experimentation. It allows easy circuit modification without soldering, making it ideal for prototyping embedded systems like this one. The breadboard has interconnected rows and columns that allow power and signals to flow between components such as the Arduino, keypad, buzzer, and servo motor. In this project, the breadboard serves as the main platform for assembling and testing the circuit before final implementation. It helps students and developers make changes quickly and identify connection errors easily.



2. Jumper Wires

Jumper wires are essential for establishing connections between the Arduino, breadboard, and other components. They come in various types, such as male-to-male, male-to-female, and female-to-female. These wires are flexible, reusable, and ideal for prototyping. In this project, jumper wires are used to carry electrical signals and power between modules such as the keypad, servo motor, LED, and buzzer. Good quality jumper wires ensure stable electrical connections and minimize voltage drops or loose contacts that could affect circuit performance.

3. Relay Module(5v)

The 5V relay module is an electromechanical switch that allows the Arduino to control high-voltage devices safely. It operates on a 5V signal and uses an electromagnetic coil to open or close the circuit. In this project, the relay module controls the solenoid door lock, enabling the Arduino to lock or unlock the door securely when a valid RFID tag is detected.

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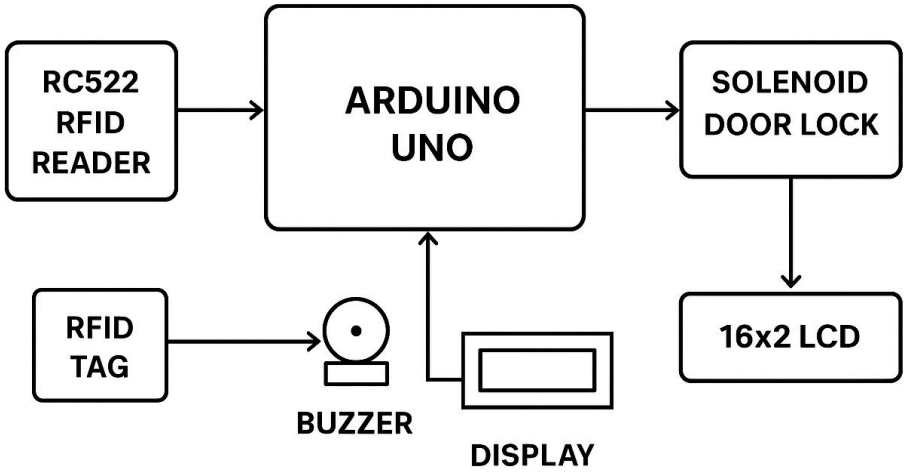
Block Diagram of Designed Model:

Block Diagram-(Times New Roman -12)



Working of Designed Model:

- The working of the designed model is based on the principle of **RFID authentication using a microcontroller**. When the system is powered on, the Arduino UNO initializes all the connected components including the RC522 RFID reader, solenoid lock, buzzer, and 16x2 LCD display. The LCD shows a welcome message such as “Scan Your Card,” indicating that the system is ready for operation. When a user places an RFID tag near the RC522 reader, the module reads the unique identification number (UID) stored in the tag and sends it to the Arduino UNO via the SPI communication interface. The Arduino then compares the scanned UID with the list of pre-stored authorized IDs saved in its memory.
  If the scanned UID matches any of the authorized IDs, the Arduino sends a signal to the relay module, which energizes the solenoid lock and unlocks the door for a few seconds. Simultaneously, the buzzer produces a short beep sound, and the LCD displays the message “Access Granted.” After the delay, the Arduino turns off the relay, locking the door again automatically.
- If the scanned RFID tag is not authorized, the Arduino activates the buzzer for multiple beeps to indicate an invalid access attempt. The LCD displays “Access Denied,” and the solenoid lock remains in the locked position. The system then resets and returns to the ready state, waiting for the next card scan.
  The buzzer and LCD module together provide audio-visual feedback to the user, enhancing usability and interaction. The system operates on a 5V DC power supply, ensuring compatibility with Arduino and other low-power electronic components.
  This design demonstrates an efficient integration of hardware and software for secure access control. It provides a **contactless, reliable, and cost-effective** door locking solution suitable for homes, offices, and laboratories. The system can be further upgraded with features such as **data logging, GSM alerts, or IoT connectivity** for advanced monitoring and control.

Pictures of Prototype: (Clear Image Required)

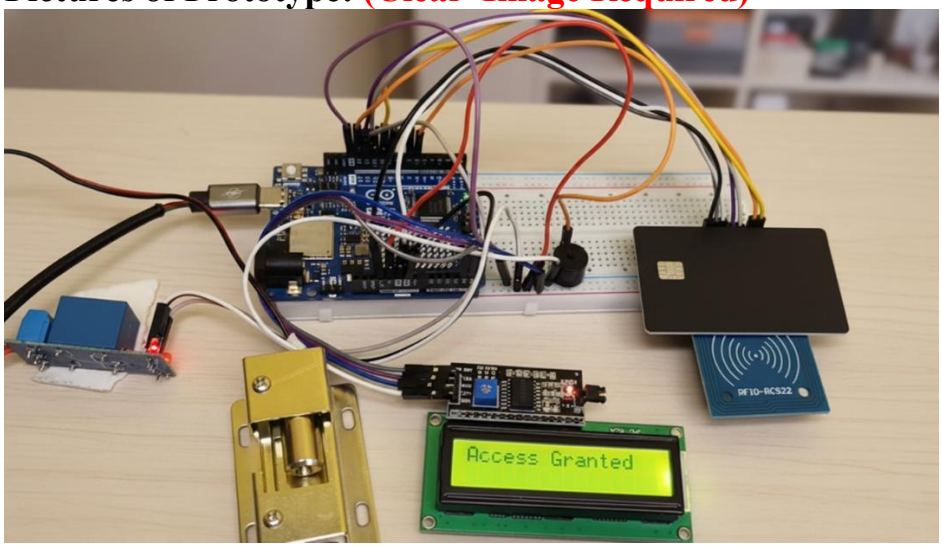
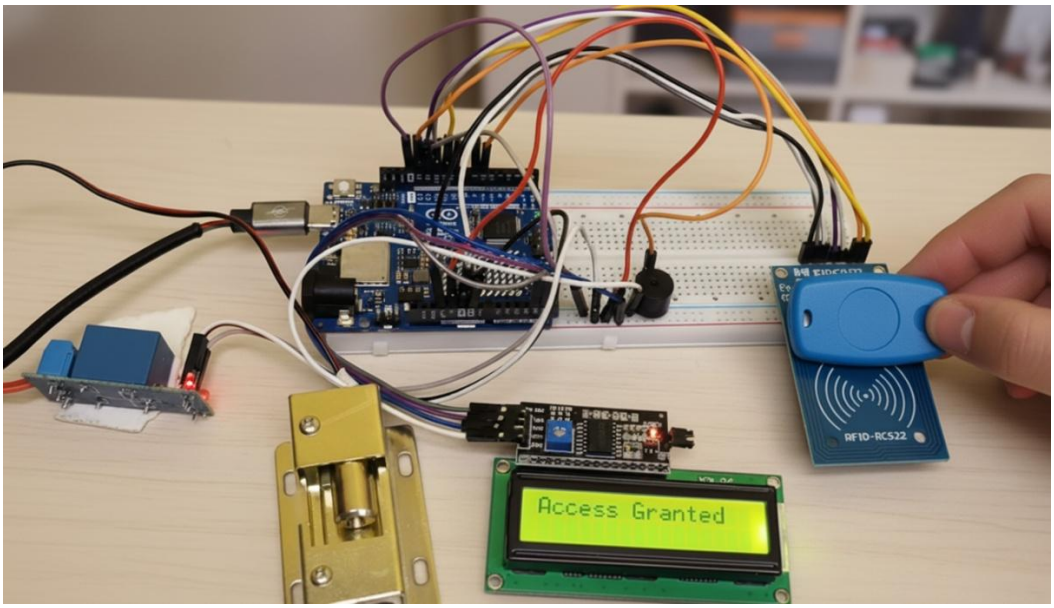


Figure 1 : Designed Model

Output of Deigned Model/Prototype (Paste Images of output)



Learning outcomes (What I have learnt):

- **Understanding of Embedded Systems:**
  Through this project, I learned how hardware components and software interact in an embedded environment. The integration of the **RC522 RFID reader**, **relay module**, **solenoid lock**, and **LCD display** with the **Arduino UNO** provided hands-on experience in designing and programming real-time microcontroller-based systems.

- **Practical Knowledge of Arduino Programming:**
  I gained practical experience in **Arduino programming** using C/C++ syntax, understanding **pin configuration**, and managing **serial communication** between devices. I also learned to use important libraries such as **MFRC522.h** and **LiquidCrystal.h** to interface sensors and modules efficiently.

- **Application of RFID Authentication Logic:**
  The project enhanced my understanding of **RFID-based authentication systems**. Implementing tag verification, data comparison, and secure access control helped me strengthen my logical thinking and problem-solving skills in embedded programming.

- **Circuit Design and Hardware Interfacing Skills:**
  I learned how to connect and interface multiple components like the **RC522 module**, **relay**, **buzzer**, and **solenoid lock** on a single circuit. This improved my ability to design circuits, handle wiring connections, manage power requirements, and ensure safe hardware operation.