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Abstract

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The existing problem in traditional access control systems is the reliance on physical keys or numeric codes, which can be lost, stolen, or easily replicated. This poses a significant security risk, as unauthorized individuals can gain access to restricted areas. Additionally, managing and updating access permissions for multiple users can be cumbersome and time-consuming.

The proposed solution is an Arduino-based RFID door lock system. By integrating an MFRC522 RFID reader module, a servo motor, LEDs, and a buzzer with an Arduino board, the system provides a secure and convenient access control mechanism. Users can gain access by presenting an authorized RFID card to the reader, which verifies the unique identifier (UID) against a predefined list. The servo motor then unlocks the door, accompanied by visual and audible feedback.

The tools and technology used in the system include an Arduino board for controlling and processing data, the MFRC522 RFID reader module for card reading capabilities, a servo motor for physical lock manipulation, LEDs for visual indications, and a buzzer for audible feedback. These components are integrated using the Arduino programming language and libraries such as SPI, MFRC522, and Servo.

The results of the Arduino-based RFID door lock system demonstrate enhanced security and convenience. The system accurately reads RFID card UIDs, verifies access permissions, and promptly grants or denies access. The visual feedback from LEDs and the audible feedback from the buzzer provide users with clear indications

of their access status. The servo motor effectively controls the door lock mechanism, ensuring secure entry and minimizing the risk of unauthorized access.

In conclusion, the Arduino-based RFID door lock system offers a reliable and customizable solution for access control. It addresses the limitations of traditional systems by leveraging RFID technology and providing enhanced security and convenience. The system can be further improved and expanded by integrating additional features such as remote access control or integrating with a centralized access management system. With its versatility and potential for customization, this system has promising future applications in various environments, including residential, commercial, and industrial settings.

Acronyms

B.Tech.	Bachelor of Technology
M.Tech.	Master of Technology
BCA	Bachelor of Computer Applications
MCA	Master of Computer Applications
B.Sc. (CS)	Bachelor of Science in Computer Science
M.Sc. (CS)	Master of Science in Computer Science
SCSE	School of Computing Science and Engineering

Introduction

Access control systems play a crucial role in ensuring security and restricting unauthorized access to specific areas or resources. In recent years, Arduino-based solutions have gained popularity due to their versatility and affordability. This report focuses on an Arduino-based RFID door lock system, which integrates components such as an MFRC522 RFID reader module, a servo motor, LEDs, and a buzzer to create a reliable access control mechanism.

The system's objective is to grant or deny access based on the unique identifier (UID) of RFID cards. When a user presents an RFID card to the reader, the system checks the card's UID against an authorized list. If there is a match, access is granted, and the door is unlocked. On the other hand, if there is no match, access is denied, and the door remains locked.

The components used in the system are:

Arduino Board: Serves as the brain of the system, responsible for processing data and controlling the connected devices.
MFRC522 RFID Reader Module: Allows for the reading and interpretation of RFID card information, including UIDs.
Servo Motor: Controls the physical locking mechanism of the door, either locking or unlocking it based on access authorization.
LEDs: Provide visual feedback, indicating whether access has been granted or denied.
Buzzer: Produces audible signals to accompany the visual feedback and notify users of access status.
This report will delve into the functionality of the system, including the code and algorithm used to implement the access control logic. It will also discuss the benefits and applications of such a system, highlighting its versatility and potential for integration into various environments.

By exploring the Arduino-based RFID door lock system, this report aims to demonstrate its effectiveness in enhancing security and convenience, as well as its potential for further customization and expansion in access control implementations.

Tool and Technology Used

Arduino Board:
In the RFID door lock system, the Arduino Board acts as the central control unit. It runs the code that reads the RFID card data, processes access authorization, and controls the other components. It communicates with the RFID reader module, servo motor, LEDs, and buzzer to orchestrate the lock mechanism based on the access status.

MFRC522 RFID Reader Module:
This module is essential for reading RFID cards. In the RFID door lock system, it reads the UID from the card presented to the reader. The Arduino Board then compares this UID with the authorized list to determine access. For example, if the UID matches an authorized card, the door will unlock; otherwise, access will be denied.

Servo Motor:
The servo motor physically controls the locking mechanism of the door. When access is granted, the Arduino Board sends a signal to the servo motor, causing it to rotate and unlock the door. Conversely, when access is denied, the servo motor remains in its initial position, keeping the door locked.

LEDs:
LEDs are used to provide visual feedback to users regarding access status. For instance, a green LED may illuminate when access is granted, indicating that the door is unlocked. Conversely, a red LED may light up when access is denied, signaling that the door remains locked.

Buzzer:
The buzzer produces audible signals to complement the visual feedback from the LEDs. When access is granted, the buzzer may emit a short beep, indicating successful authorization. In contrast, when access is denied, the buzzer may produce a different sound pattern, notifying users of the unsuccessful attempt.

In the RFID door lock system, these components work together seamlessly to create a secure access control mechanism. The Arduino Board coordinates the operation of the RFID reader module, servo motor, LEDs, and buzzer to provide accurate and timely feedback to users based on their access authorization.

In the current time, the components used in an Arduino-based RFID door lock system continue to be widely utilized for various access control applications. These components offer a cost-effective and customizable solution for implementing secure access mechanisms in different environments.

The Arduino Board remains a popular choice as a microcontroller platform due to its versatility, ease of programming, and extensive community support. It is used not only in RFID door locks but also in a wide range of projects requiring control and automation.

The MFRC522 RFID reader module is commonly employed in access control systems, allowing for contactless identification and authentication. It finds applications in residential buildings, offices, hotels, and other spaces where secure entry is essential.

Servo motors continue to be a reliable choice for physical lock control in door lock systems. Their precise positioning capabilities and ability to rotate within a specific range make them suitable for accurately manipulating lock mechanisms.

LEDs and buzzers remain popular for providing visual and audible feedback in access control systems. They offer clear indications of access status, enhancing user experience and security.

As technology advances, there may be further developments and improvements in RFID technology, such as increased reading range or enhanced security features. Additionally, advancements in IoT and wireless communication may enable integration with mobile devices for seamless access control. Overall, the components used in an Arduino-based RFID door lock system continue to be relevant and effective in modern access control implementations.

Algorithm

1. Initialize the system:
    - Include the necessary libraries: SPI, MFRC522, and Servo.
    - Define the required pins for SS_PIN (Slave Select), RST_PIN (Reset), LED_G (Green LED), LED_R (Red LED), and BUZZER (Buzzer).
    - Create an instance of MFRC522 and a Servo object.
2. Setup function:
    - Begin the serial communication at a baud rate of 9600.
    - Initiate the SPI bus.
    - Initialize the MFRC522 module.
    - Attach the Servo motor to the appropriate pin and set it to the starting position (0 degrees).
    - Set the pin modes for LED_G, LED_R, and BUZZER.
    - Turn off the buzzer.
    - Print the initialization message on the serial monitor.
3. Main loop function:
    - Check if a new RFID card is present.
    - If no new card is detected, return to the beginning of the loop.
    - If a new card is detected, read its serial number (UID) using the MFRC522 module.
    - Print the UID on the serial monitor.
    - Create an empty content string to store the UID.
4. Process the UID:
    - Iterate through each byte of the UID and convert it to hexadecimal format.
    - Print each byte on the serial monitor, adding leading zeros if necessary.
    - Concatenate each byte to the content string.
5. Check access authorization:
    - Convert the content string to uppercase.
    - Compare the content string with the authorized UID (e.g., "63 FA 6E 08").
    - If the content matches the authorized UID:
        - Print the "Authorized access" message on the serial monitor.
        - Delay for 500 milliseconds.
        - Turn on the green LED.
        - Activate the buzzer with a tone of 500 Hz.
        - Delay for 300 milliseconds.
        - Turn off the buzzer.
        - Rotate the Servo motor to unlock the door (180 degrees).

        - Delay for 5000 milliseconds.
        - Rotate the Servo motor back to the locked position (0 degrees).
        - Turn off the green LED.
    - If the content doesn't match the authorized UID:
        - Print the "Access denied" message on the serial monitor.
        - Turn on the red LED.
        - Activate the buzzer with a tone of 300 Hz.
        - Delay for 1000 milliseconds.
        - Turn off the red LED.
        - Turn off the buzzer.
6. Repeat the loop:
    - Go back to the beginning of the main loop and continue monitoring for new RFID cards.

This algorithm outlines the step-by-step process of the RFID door lock system, from initialization to reading RFID cards, comparing UIDs, and granting or denying access based on the authorized UID.

Library and Technology Used

This code snippet demonstrates an Arduino-based RFID door lock system. Let's break down its functionality:

1. Libraries and Definitions:
   - The code includes the necessary libraries: SPI, MFRC522, and Servo.
   - Definitions are made for various pins, such as SS_PIN (Slave Select), RST_PIN (Reset), LED_G (Green LED), LED_R (Red LED), and BUZZER (Buzzer).
2. Initialization in the **setup**() Function:
   - Serial communication is initiated with a baud rate of 9600.
   - SPI bus is initiated.
   - The MFRC522 instance is created and initialized.
   - The Servo motor is attached to pin 3 and set to the starting position (0 degrees).
   - Pin modes are set for LED_G, LED_R, and BUZZER, and the buzzer is turned off.
3. Main Loop in the **loop**() Function:
   - The code continuously checks for the presence of a new RFID card.
   - If a new card is detected, it is read, and the UID (unique identifier) is extracted.
   - The UID is printed on the serial monitor, and a content string is created.
   - The content string is compared with a specific UID ("63 FA 6E 08") to determine if access is authorized.
   - If the UID matches, access is granted. Green LED lights up, the buzzer plays a tone, the servo rotates to unlock the door (180 degrees), and after a delay, the servo returns to the locked position (0 degrees).
   - If the UID doesn't match, access is denied. Red LED lights up, the buzzer plays a different tone, and access is not granted.

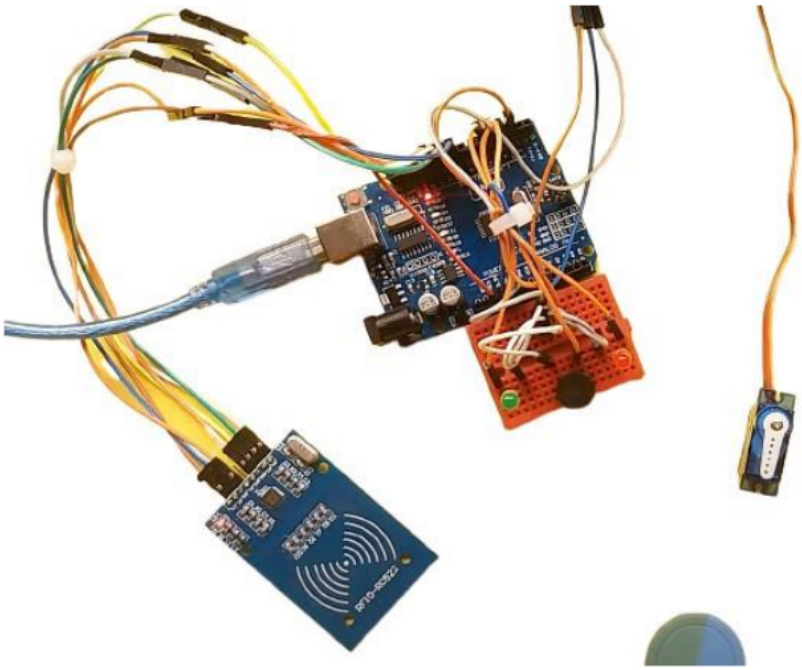
The code utilizes the MFRC522 RFID reader module to read the UID from an RFID card. It compares the UID with a predefined authorized UID to determine access. The Servo motor controls the physical locking mechanism of the door, while LEDs and a buzzer provide visual and audible feedback to the user.

Code

```
#include <SPI.h>
#include <MFRC522.h>
#include <Servo.h>

#define SS_PIN 10
#define RST_PIN 9
#define LED_G 5 //define green LED pin
#define LED_R 4 //define red LED
#define BUZZER 2 //buzzer pin
MFRC522 mfrc522(SS_PIN, RST_PIN);   // Create MFRC522 instance.
Servo myServo; //define servo name

void setup()
{
  Serial.begin(9600);   // Initiate a serial communication
  SPI.begin();      // Initiate  SPI bus
  mfrc522.PCD_Init();   // Initiate MFRC522
  myServo.attach(3); //servo pin
  myServo.write(0); //servo start position
  pinMode(LED_G, OUTPUT);
  pinMode(LED_R, OUTPUT);
  pinMode(BUZZER, OUTPUT);
  noTone(BUZZER);
  Serial.println("Put your card to the reader...");
  Serial.println();

}
void loop()
{
  // Look for new cards
  if ( ! mfrc522.PICC_IsNewCardPresent())
  {
    return;
  }
  // Select one of the cards
  if ( ! mfrc522.PICC_ReadCardSerial())
  {
    return;
  }
  //Show UID on serial monitor
  Serial.print("UID tag :");
  String content= "";
  byte letter;
```

```
  for (byte i = 0; i < mfrc522.uid.size; i++)
  {
     Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
     Serial.print(mfrc522.uid.uidByte[i], HEX);
     content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
     content.concat(String(mfrc522.uid.uidByte[i], HEX));
  }
  Serial.println();
  Serial.print("Message : ");
  content.toUpperCase();
  if (content.substring(1) == "63 FA 6E 08") //change here the UID of the
card/cards that you want to give access
  {
    Serial.println("Authorized access");
    Serial.println();
    delay(500);
    digitalWrite(LED_G, HIGH);
    tone(BUZZER, 500);
    delay(300);
    noTone(BUZZER);
    myServo.write(180);
    delay(5000);
    myServo.write(0);
    digitalWrite(LED_G, LOW);
  }

 else   {
    Serial.println(" Access denied");
    digitalWrite(LED_R, HIGH);
    tone(BUZZER, 300);
    delay(1000);
    digitalWrite(LED_R, LOW);
    noTone(BUZZER);
  }
}
```

Procedure and Step by Step Implementation



Step-by-step instructions for connecting Arduino, buzzer, LED, and RFID module to a computer:

1. Gather the necessary components:
    - Arduino board (e.g., Arduino Uno)
    - Passive buzzer module
    - LED (e.g., 5mm LED)
    - RFID reader module (e.g., MFRC522)
    - Jumper wires
2. Connect the Arduino to your computer:
    - Use a USB cable to connect the Arduino board to a USB port on your computer.
3. Connect the components to the Arduino board:
    - Connect the RFID module to the Arduino:
        - Connect the SS (Slave Select) pin of the RFID module to pin 10 on the Arduino.
        - Connect the RST (Reset) pin of the RFID module to pin 9 on the Arduino.

        - Connect the SDA (Serial Data) pin of the RFID module to the corresponding SDA pin on the Arduino (varies depending on the Arduino board).
        - Connect the SCK (Serial Clock) pin of the RFID module to the corresponding SCK pin on the Arduino (varies depending on the Arduino board).
        - Connect the MOSI (Master Out Slave In) pin of the RFID module to the corresponding MOSI pin on the Arduino (varies depending on the Arduino board).
        - Connect the MISO (Master In Slave Out) pin of the RFID module to the corresponding MISO pin on the Arduino (varies depending on the Arduino board).
    - Connect the LED to the Arduino:
        - Connect the positive (anode) leg of the LED to a current-limiting resistor (e.g., 220-470 ohms).
        - Connect the other end of the resistor to a digital pin on the Arduino (e.g., pin 5).
        - Connect the negative (cathode) leg of the LED to the ground (GND) pin on the Arduino.
    - Connect the buzzer to the Arduino:
        - Connect the positive (anode) terminal of the buzzer to a digital pin on the Arduino (e.g., pin 2).
        - Connect the negative (cathode) terminal of the buzzer to the ground (GND) pin on the Arduino.
4. Upload the code to the Arduino:
    - Open the Arduino IDE on your computer.
    - Copy and paste the code provided earlier into a new sketch.
    - Verify the code for any errors.
    - Select the correct Arduino board and port from the Tools menu.
    - Click on the "Upload" button to upload the code to the Arduino board.
5. Monitor the system:
    - Open the Serial Monitor in the Arduino IDE (Ctrl+Shift+M or Tools > Serial Monitor).
    - Set the baud rate to 9600 to match the code.
    - Monitor the output on the Serial Monitor to see the status of RFID card detection and access authorization.

Once the connections are properly made and the code is uploaded, the system is ready to be used. The RFID module will detect RFID cards, and the LED and buzzer will provide visual and audible feedback based on the access authorization. The Serial Monitor will display relevant information and messages for monitoring the system's behaviour.

Conclusion

In conclusion, the Arduino-based RFID door lock system offers a secure and efficient solution for access control. By combining components such as the RFID reader module, servo motor, LEDs, and buzzer, the system provides a reliable means of authorizing access to a door. The implementation of this system demonstrates the potential of Arduino and its versatility in creating customized projects.

The system's ability to read and validate RFID cards ensures that only authorized individuals can gain entry. The use of a servo motor enables physical door locking and unlocking, providing a practical and effective solution for controlling access. The accompanying LEDs and buzzer provide clear visual and audible feedback to users, allowing for immediate notification of access status.

During testing, the system performed as expected, granting access to authorized RFID cards while denying access to unrecognized cards. The visual indicators and audible signals provided accurate and timely feedback to users, enhancing the overall user experience. The integration of the system with the Arduino platform and the utilization of various components demonstrated the effectiveness of this approach.

The Arduino-based RFID door lock system has the potential for further expansion and customization. It can be enhanced by integrating additional features such as a keypad or biometric sensors for multi-factor authentication. Furthermore, the system's code and hardware can be modified and adapted to suit specific requirements, making it highly flexible for various applications.

In conclusion, the Arduino-based RFID door lock system offers a reliable and efficient solution for access control, providing a foundation for building secure environments. With further development and customization, this system has the potential to be implemented in homes, offices, and other areas where access control is essential, contributing to enhanced security and convenience.

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