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Smart Card Entry System

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TABLE OF CONTENTS

1. INTRODUCTION

The use of Radio Frequency Identification (RFID) technology has significantly transformed the way we approach access control systems by enabling secure, contactless authentication. This project is centered around the development of an RFID-based gate opener system using an Arduino Uno microcontroller. The system reads RFID tags, checks their unique identifiers (UIDs), and accordingly grants or denies access. An LCD screen provides immediate feedback to users, while a servo motor simulates the physical action of opening and closing a gate. The project emphasizes hands-on learning about interfacing microcontrollers with different peripherals such as sensors, displays, and actuators. This system is ideal for DIY enthusiasts, students learning embedded systems, and developers exploring IoT security applications.

2. COMPONENTS REQUIRED

- Arduino Uno - Microcontroller board for controlling all components.
- RFID Module (MFRC522) - For reading RFID cards/tags.
- RFID Tags/Cards - Store unique IDs used for authentication.
- SG90 Servo Motor - Simulates gate movement.
- 1602A LCD Display with I2C Module - Displays user messages.
- Jumper Wires - For electrical connections.
- USB Cable for Arduino - For power supply and programming.
- External Power Supply (Optional) - Provides additional power if needed.

3. CIRCUIT CONNECTION

Connections for the system are as follows:

RFID Module to Arduino:

- SDA -> D10
- SCK -> D13
- MOSI -> D11
- MISO -> D12
- RST -> D9
- GND -> GND
- 3.3V -> 3.3V

Servo Motor to Arduino:

- Signal -> D6
- VCC -> 5V
- GND -> GND

LCD Display (with I2C module) to Arduino:

- SDA -> A4
- SCL -> A5
- VCC -> 5V
- GND -> GND

4. SOFTWARE AND LIBRARIES USED

The project uses the following software and libraries:

- Arduino IDE: Used to write, compile, and upload code.
- LiquidCrystal_I2C: Controls the LCD display via I2C communication.
- SPI: Enables communication between Arduino and RFID module.
- MFRC522: Manages RFID card reading functions.
- Servo: Controls the servo motor for gate operation.

5. WORKING PRINCIPLE

The system operates through the following steps:
1. Initialization: Arduino initializes all connected peripherals.
2. Idle Mode: LCD displays a prompt message 'Put your card'.
3. Card Detection: RFID reader detects a nearby card.
4. UID Reading: The system reads the UID of the card.
5. Authorization Check: Compares the read UID with stored authorized UIDs.
6. Action: If authorized, the servo opens the gate and LCD shows 'Access Granted'. Otherwise, it shows 'Access Denied'.
7. Reset: After action or timeout, the system resets for the next scan.

This approach ensures secured access control and demonstrates a clear real-world application of embedded systems technology.

6. CODE EXPLANATION

The code starts by initializing necessary libraries, setting up serial communication, LCD, RFID module, and servo motor. It continuously checks for a new RFID card. Once detected, it reads the card's UID and checks against predefined UIDs. Upon successful authentication, the gate is opened momentarily using the servo. The use of separate functions for authorization checks enhances code modularity and readability.

7. ARDUINO CODE

```
#include <SPI.h>
#include <MFRC522.h>
#include <Servo.h>
#include <LiquidCrystal_I2C.h>

#define RST_PIN 9
#define SS_PIN 10
#define SERVO_PIN 6

Servo myServo;
byte readCard[4];
byte masterCard1[4] = {0xEC, 0x31,
0xF7, 0x03};
byte masterCard2[4] = {0xC9, 0xA1,
0xCC, 0x01};

LiquidCrystal_I2C lcd(0x27, 16, 2);
MFRC522 mfrc522(SS_PIN, RST_PIN);

boolean isAuthorized();

void setup() {
  Serial.begin(9600);
  lcd.init();
  lcd.backlight();
  SPI.begin();
```

```
  mfrc522.PCD_Init();
  lcd.setCursor(2, 0);
  lcd.print("Put your card");
  myServo.attach(SERVO_PIN);
  myServo.write(0);
}

void loop() {
  if (!mfrc522.PICC_IsNewCardPresent()
|| !mfrc522.PICC_ReadCardSerial())
return;
  for (uint8_t i = 0; i < 4; i++) {
    readCard[i] =
mfrc522.uid.uidByte[i];
  }
  if (isAuthorized()) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Access Granted");
    myServo.write(90);
    delay(3000);
    myServo.write(0);
  } else {
    lcd.clear();
    lcd.setCursor(0, 0);
  lcd.print("Access Denied");
    delay(3000);
```

```
  }
  delay(1000);
  lcd.clear();
  lcd.setCursor(2, 0);
  lcd.print("Put your card");
  mfrc522.PICC_HaltA();
}

boolean isAuthorized() {
  boolean authorized = true;
  for (byte i = 0; i < 4; i++) {
    if (readCard[i] != masterCard1[i])
{
      authorized = false;
      break;
    }
  }
  if (authorized) return true;
  authorized = true;
  for (byte i = 0; i < 4; i++) {
    if (readCard[i] != masterCard2[i])
{
      authorized = false;
      break;
    }
  }
  return authorized; }
```

8. RESULTS

Extensive testing was conducted to validate the system's reliability:

- Authorized Cards: LCD displayed 'Access Granted', servo motor rotated to 90 degrees simulating gate opening.
- Unauthorized Cards: LCD displayed 'Access Denied', no movement of servo motor.
- Stability: System reliably reset after each authentication cycle, ready for the next scan.

This shows high reliability and real-world applicability for controlled access points.

9. CONCLUSION

This project successfully demonstrates the use of Arduino Uno to build an efficient and secure RFID-based gate control system. The integration of peripherals like an LCD display and servo motor enhances user interaction and system feedback. Future improvements could include wireless remote access, database management for multiple users, and mobile app integration for greater functionality in home automation or office security.

10. SAFETY AND PRECAUTIONS

- Ensure correct polarity in connections to prevent component damage.
- Use stable and regulated 5V supply for Arduino and peripherals.
- Avoid excessive mechanical load on the servo motor.
- Handle all components with anti-static precautions.
- Double-check wiring before powering the circuit.