Universidad Ana G. Méndez, Departamento de Ingeniería

Microprocessors I – Prof. Daniel Mera

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**Proyecto Final:**

**Access Control System with “Two-Factor Authentication”**

1. Abstract

As part of the final project for the Microcontrollers course, Professor Mera has instructed us to form groups and think of a problem that we can solve by implementing a circuit. Taking advantage of the fact that we group members are also enrolled in the 'Capstone 1' course, we have decided to use this project to begin developing one of its subcomponents - a more secure access control system than usual. As per Professor Mera's requirements, we have been tasked with implementing more than one verification method in the system, so we have applied a two-factor verification method, consisting of an authorized RFID key and a correct PIN code.

1. Introduction

In the world we live in, the security of our data and physical resources has become a fundamental priority. However, traditional access control systems based on simple passwords have proven susceptible to various forms of vulnerability exploitation, from brute-force attacks to identity theft.

In response to these challenges, we seek to design and implement a circuit system, seizing the opportunity to develop one of the components for our Capstone 1 project. We have developed a two-factor access control system that aims to address these vulnerabilities and provide a robust and effective solution. Our system combines the convenience of RFID technology with the additional security of a four-digit PIN, creating a barrier to entry that more effectively protects our assets and sensitive data.

Now, let's look at how we have successfully carried out this project.

1. Circuit Design
2. Materials:

* Arduino Mega
* RFID RC522
* Pin pad 4x3
* LCD Screen 16x2
* Lock style Solenoid
* Low-Level Trigger Relay
* Colored Leds
* 220 Ohms Resistance
* Jumper Wires

1. Circuit Implementation

As part of the implementation of our project, we have integrated a Pin Pad module and RFID sensors and actuators module to send data to the microcontroller. Since our system is intended to be ultimately implemented in furniture, we have obtained a solenoid specifically for this style of applications as a locking mechanism. The solenoid operates passively, so while the solenoid does NOT receive a 9-12V signal, it will remain in the 'locked' position, and upon receiving the signal, the lock is released. To control the solenoid's behavior, we have implemented a low-level relay. For user visualization and interaction, an LCD screen has been implemented, allowing instructions and results to be displayed.

1. Fotos Funcionamiento

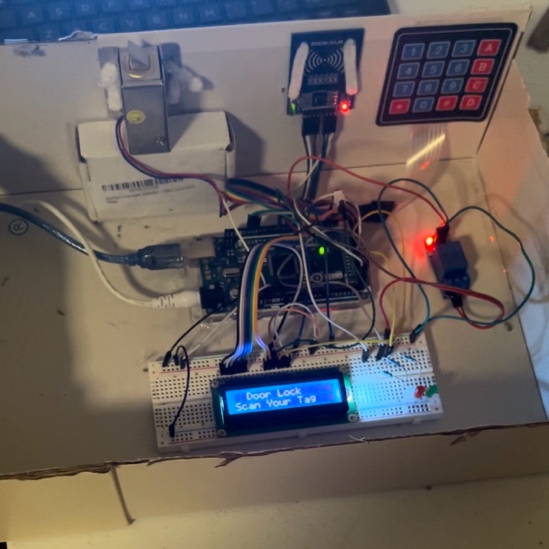


Figura 1 - Instruyéndole al usuario a insertar llave

A hand holding a blue screen with wires and a small display

Description automatically generated

Figura 2 – Tag no autorizado

A person's hand holding a device with wires

Description automatically generated

Figura 3 – Tag autorizado

A machine with wires and a blue screen

Description automatically generated

Figura 4 – Si entra el tag correcto, sistema pide contraseña

A machine with wires and a screen

Description automatically generated

Figura 5 – Si la contraseña coincide, el sistema abre

1. Conclusions

We have successfully implemented functions that complement the security of an access control system. To achieve this, we have added a dual-authentication function in which the user must enter both the RFID key and the correct PIN to gain access. Possible improvements could include:

* PIN change from the user's perspective
* Different profiles to save individual keys and PINs
* Wi-Fi control

1. References
2. Guide for MFRC522 library and RC522 use (last updated Dec 2023)

[https://github-com.translate.goog/miguelbalboa/rfid](https://github-com.translate.goog/miguelbalboa/rfid?_x_tr_sl=en&_x_tr_tl=es&_x_tr_hl=es-419&_x_tr_pto=sc)

1. Adafruit Lock style Solenoid Store and Guide

<https://www.adafruit.com/product/1512>

1. Link GITHUB:

<https://github.com/eeeeero/2FA--Access-Control-System>

1. **Flowchart**

**A diagram of a system

Description automatically generated**

1. **CODIGO**

// Include required libraries

#include <MFRC522.h>

#include <LiquidCrystal.h>

#include <Keypad.h>

#include <SPI.h>

// Create instances

LiquidCrystal lcd(11, 12, 26, 28, 30, 32);

int Contrast=75;

MFRC522 mfrc522(53, 5); // MFRC522 mfrc522(SS\_PIN, RST\_PIN)

char initial\_password[4] = {'1', '2', '3', '4'}; // Variable to store initial password

String tagUID = "E7 C0 38 1B"; // String to store UID of tag. Change it with your tag's UID

char password[4]; // Variable to store users password

char userchoice[1];

volatile boolean RFIDMode = true; // boolean to change modes

char key\_pressed = 0; // Variable to store incoming keys

int i = 0; // Variable used for counter

// defining how many rows and columns our keypad have

const byte rows = 4;

const byte columns = 4;

// Keypad pin map

char hexaKeys[rows][columns] = {

{'1', '2', '3', 'A'},

{'4', '5', '6', 'B'},

{'7', '8', '9', 'C'},

{'\*', '0', '#', 'D'}

};

// Initializing pins for keypad

byte row\_pins[rows] = {35, 33, 31, 29};

byte column\_pins[columns] = {27, 25, 23};

// Create instance for keypad

Keypad keypad\_key = Keypad( makeKeymap(hexaKeys), row\_pins, column\_pins, rows, columns);

void setup() {

// Arduino Pin configuration

Serial.begin(9600);

pinMode(42, OUTPUT); //PIN LUZ BLANCA

pinMode(43, OUTPUT);

pinMode(44, OUTPUT);

pinMode(3, OUTPUT); // PIN SERVO

pinMode(10, OUTPUT);

analogWrite(10,Contrast);

RFIDMode = true;

lcd.begin(16,2); // LCD screen

digitalWrite(42, HIGH);

digitalWrite(43, HIGH);

digitalWrite(44,HIGH);

SPI.begin(); // Init SPI bus

mfrc522.PCD\_Init(); // Init MFRC522

lcd.setCursor(0, 0);

lcd.print("Access Control");

lcd.setCursor(0, 1);

lcd.print("Micro Prjt");

delay(5000);

digitalWrite(42, LOW);

digitalWrite(43, LOW);

digitalWrite(44, LOW);

digitalWrite(3, HIGH);

lcd.clear(); // Clear LCD screen

}

void loop() {

// System will first look for mode

if (RFIDMode == true) {

digitalWrite(3, HIGH);

lcd.setCursor(0, 0);

lcd.print(" Door Lock");

lcd.setCursor(0, 1);

lcd.print("Scan Your Tag");

// Look for new cards

if ( ! mfrc522.PICC\_IsNewCardPresent()) {

return;

}

// Select one of the cards

if ( ! mfrc522.PICC\_ReadCardSerial()) {

return;

}

//Reading from the card

String tag = "";

for (byte j = 0; j < mfrc522.uid.size; j++)

{

tag.concat(String(mfrc522.uid.uidByte[j] < 0x10 ? " 0" : " "));

tag.concat(String(mfrc522.uid.uidByte[j], HEX));

}

tag.toUpperCase();

Serial.println(tag);

//Checking the card

if (tag.substring(1) == tagUID)

{

// If UID of tag is matched.

lcd.clear();

lcd.print("Tag Matched");

digitalWrite(42, HIGH);

delay(3000);

digitalWrite(42, LOW);

lcd.clear();

lcd.print("Enter Password:");

lcd.setCursor(0, 1);

RFIDMode = false; // Make RFID mode false

}

else

{

// If UID of tag is not matched.

lcd.clear();

digitalWrite(43, HIGH);

lcd.setCursor(0, 0);

lcd.print("Wrong Tag Shown");

lcd.setCursor(0, 1);

lcd.print("Access Denied");

delay(3000);

lcd.clear();

digitalWrite(43, LOW);

}

}

// If RFID mode is false, it will look for keys from keypad

if (RFIDMode == false) {

key\_pressed = keypad\_key.getKey(); // Storing keys

if (key\_pressed)

{

password[i++] = key\_pressed; // Storing in password variable

lcd.print("\*");

}

if (i == 4) // If 4 keys are completed

{

delay(200);

if (!(strncmp(password, initial\_password, 4))) // If password is matched

{

lcd.clear();

lcd.print("Pass Accepted");

digitalWrite(3, LOW); // Door Opened

digitalWrite(44, HIGH);

delay(10000);

digitalWrite(44, LOW);

digitalWrite(3, HIGH); // Door Closed

i = 0;

RFIDMode = true; // Make RFID mode true

}

else // If password is not matched

{

lcd.clear();

lcd.print("Wrong Password");

digitalWrite(43, HIGH);

delay(3000);

lcd.clear();

digitalWrite(43, LOW);

i = 0;

RFIDMode = true;// Make RFID mode true

}

}

}

}

// Funciones no logramos implementar

void resetSystem(){ //NOT APPLIED

RFIDMode = true;

i = 0;

loop();

}

void changePassword() { //NOT APPLIED

lcd.setCursor(0, 0);

lcd.print("Enter new");

lcd.setCursor(0, 1);

lcd.print("password:");

// Wait for user input

char newPassword[5];

char getInputPinpad(newPassword, 4); // Function to get input from pinpad

// Update the initial password with the new password

strncpy(initial\_password, newPassword, 4);

// Confirmation message

lcd.clear();

lcd.print("Password");

lcd.setCursor(0, 1);

lcd.print("changed!");

delay(2000);

digitalWrite(42, LOW);

digitalWrite(3, HIGH); // Door Closed

i = 0;

RFIDMode = true; // Make RFID mode true

loop();

}