

Wireless Network

Report of

LAB3: RFID Technology Using an Arduino

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I. BRIEF DESCRIPTION

This work is oriented to implement an electronic system to identify valid users by using a MFRC522 RFID with Arduino Uno. RFID stands for Radio-Frequency IDentification. The RFID device works in the same way that a bar code or a magnetic strip of a credit card because it provides of an unique code for that object. In this way, the RFID device transmits the identity, which is a serial number, of an object (tag) through wireless connection [1]. The communications between a RFID tag and a RFID reader (via the antenna) occurs using a process known as electromagnetic coupling. There are two types of coupling. The first is Inductive, where a near-field antenna uses inductive coupling which means that it uses a magnetic field to energize the RFID tag. The second one is capacitive where a far-field antenna uses capacitive coupling (or propagation coupling) to energize the RFID tag.

This system will identify if an user is valid or invalid. The users are going to be the tags. If the user is valid, a blue led will turn on, and the buzzer is going to performance a shot sound. In contrast, if it is an invalid user, a red led will turn on, and the buzzer is going to performance a long sound.

To develop this work, it is necessary to know certain concepts like: what is the frequency that it works, why kind of electromagnetic field it is using. According to NXP Semiconductors, "The MFRC522 is a highly integrated reader/writer IC for contactless communication at 13.56 MHz"[2]. This frequency is in the HF (High Frequency) category of the electromagnetic spectrum. It is used for shortwave radio. Its wavelength is 10-100 meters. The electromagnetic spectrum (EM) as stated in "Imagine the universe"website is the range of all types of radiation that EM has. In the same way, this website explains that "radiation is energy that travels and spreads out as it goes"[3]. To understand the electromagnetic spectrum there is a law called Faraday's law, which Jim Lucas in his work "What Is Faraday's Law of Induction?", says that it "describes how an electric current produces a magnetic field and, conversely, how a changing magnetic field generates an electric current in a conductor"[4].

The goals of this work are:

- Understand the basic principles of radio communications
- Figure out the technology used in RFID cards and readers
- Understand the basic hardware and software features of MFRC522 RFID cards
- Learn to use the open source MF522.h library.
- Learn how connect other devices to work together with the MFRC522 RFID.

II. IMPLEMENTATION AND DEVELOPMENT

For the implementation of this system we need the following materials:

- 1 x Arduino Uno
- 1 x RFID reader with tags (RFID MFRC522)
- 1 x Breadboard
- 2 x LEDs
- 2 x 200 Ω resistors
- 1 x Buzzer
- Jumper wires

The schematic of the circuit is shown in the figure 1. In this figure are all the devices connected through a breadboard. The schematic was done in fritzing.

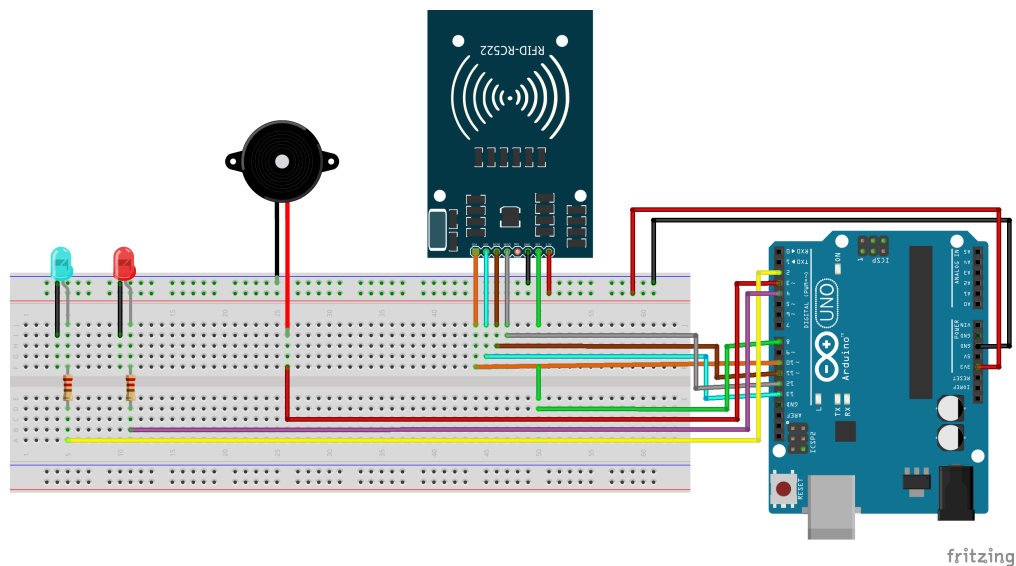


Figura 1: Schematic of the circuit

The code of the implementation in arduino is:

```
1
2 #include <SPI.h>
3 #include <MFRC522.h>
4
5 #define RST_PIN      8           // Configurable, see typical pin layout above
6 #define SS_PIN       10          // Configurable, see typical pin layout above
7 #define Buzzer        3
8 MFRC522 mfrc522(SS_PIN, RST_PIN); // Create MFRC522 instance
9
10 byte LecturaUID[4];
```

```

11 byte Usuario1[4]={0X86,0XFB,0X70,0X13};
12 byte Usuario2[4]={0X2C,0XEA,0XF1,0XC5};
13 int led1=4;
14 int led2=2;
15
16 void setup() {
17     Serial.begin(9600); // Initialize serial communications with the PC
18     SPI.begin(); // Init SPI bus
19     pinMode(Buzzer, OUTPUT); // Set buzzer pin to an Output pin
20     digitalWrite(Buzzer, LOW); // Buzzer Off at startup
21     mfrc522.PCD_Init(); // Init MFRC522
22     Serial.println("ready");
23     pinMode(led1,OUTPUT);
24     pinMode(led2,OUTPUT);
25     digitalWrite(led1,LOW);
26     digitalWrite(led2,LOW);
27 }
28
29 void loop() {
30     // Look for new cards
31     if ( ! mfrc522.PICC_IsNewCardPresent() )
32         return;
33
34     // Select one of the cards
35     if ( ! mfrc522.PICC_ReadCardSerial() )
36         return;
37
38     Serial.print("UID:");
39     for (byte i=0;i<mfrc522.uid.size;i++)
40     {
41         if (mfrc522.uid.uidByte[i]<0*10){
42             Serial.print(" 0");
43         }
44         else {
45             Serial.print(" ");
46         }
47
48         Serial.print(mfrc522.uid.uidByte[i],HEX);
49         LecturaUID[i]=mfrc522.uid.uidByte[i];
50     }
51
52     Serial.print("\t");
53     if (comparaUID(LecturaUID,Usuario1)){
54         digitalWrite(led2,HIGH);
55         delay(500);
56         digitalWrite(led2,LOW);
57         digitalWrite(led1,LOW);
58         Serial.println("Welcome User 1");
59
60         for (int y = 0; y < 3; y++){
61             digitalWrite (Buzzer, HIGH) ;// Buzzer On
62             delay (50) ;// Delay 1ms
63             digitalWrite (Buzzer, LOW) ;// Buzzer Off
64             delay (50) ;// delay 1ms
65         }
66         delay(1500);
67     }else {

```

```

68     digitalWrite(led1,HIGH);
69     delay(500);
70     digitalWrite(led1,LOW);
71     digitalWrite(led2,LOW);
72     Serial.println("Denied Acces");
73     for (int y = 0; y < 3; y++){
74         digitalWrite (Buzzer, HIGH) ;// Buzzer On
75         delay (300) ;// Delay 1ms
76         digitalWrite (Buzzer, LOW) ;// Buzzer Off
77         delay (400) ;// delay 1ms
78     }
79     delay(1500);
80 }
81 mfrc522.PICC_HaltA();
82 }
83
84 boolean comparaUID(byte lectura[],byte usuario[]){
85
86 for (byte i=0; i<mfrc522.uid.size;i++){
87     if (lectura[i]!=usuario[i])
88         return(false);
89     }
90     return(true);
91 }

```

Listing 1: Arduino Code: MFRC522 RFID with Arduino Uno

III. RESULTS

The system works properly, we put the blue tag for the valid user and the white tag for the invalid user. Furthermore, the buzzer emit a short sound for valid user and a long song for invalid user. The figure 2 shows the blue led on for the valid user. The figure 3 shows the red led on for invalid user.

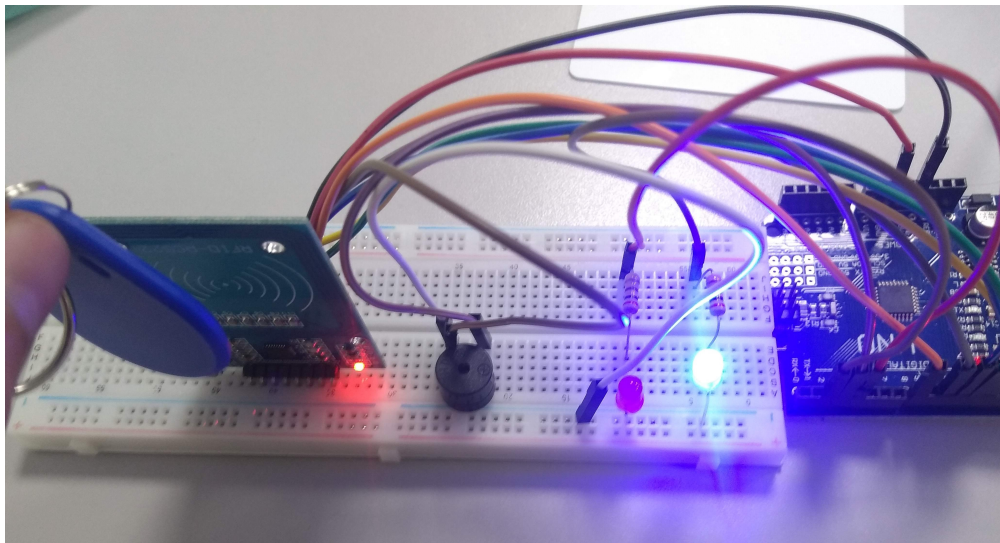


Figura 2: Led blue on, indicating that it is a valid user

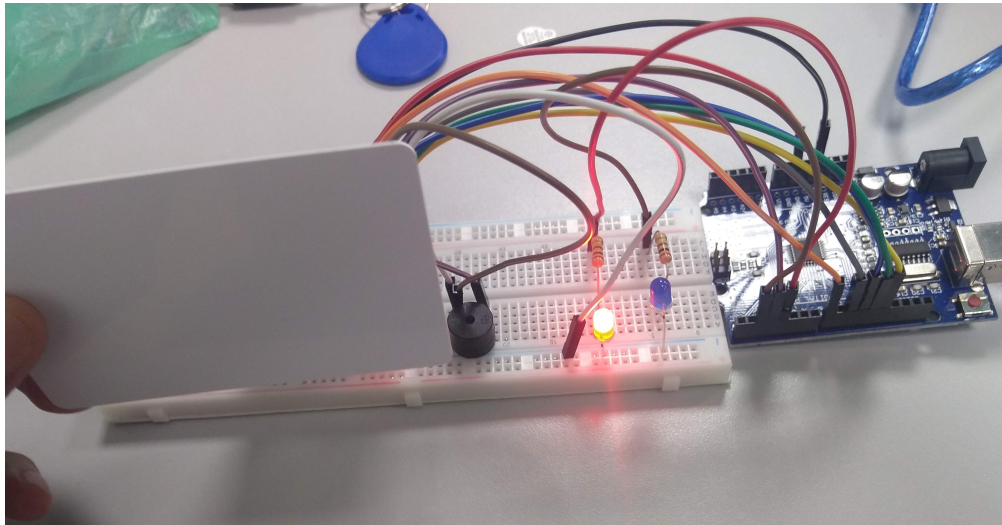


Figura 3: Led red on, indicating that it is a valid user

IV. DISCUSSION

The most important part of the implementation is to be sure that the pins connected are in the correct place in both sides, Arduino Uno and RFID. Some problems found were that in the code the assignment of the pins of the leds were wrong. Also, the `serial.begin` was incorrect, we have to use the number of the last practice in the lab. If the `serial.begin` is wrong, the message shown in the console are unreadable. Furthermore, we notice that there exist a short latency between the leds get on and the buzzer sounds. In this way is important the well managing of the delays in the code.

REFERENCES

- [1] Violino B. (January, 2005). *What is RFID?*. Retrieved from <https://www.rfidjournal.com/articles/view?1339>
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- [3] ImagineTheUniverse. (March, 2013). *The Electromagnetic Spectrum*. Retrieved from <https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html>
- [4] Lucas J. (January, 2016). *What Is Faraday's Law of Induction?*. Retrieved from <https://www.livescience.com/53509-faradays-law-induction.html>