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RFID (Radio Frequency Identification) Application for Door Security Systems

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ABSTRACT

The door security system is an important thing which is quite a complicated problem, especially in big cities. A door security system is required to have higher security, due to the many cases of theft and burglary because it is not properly protected. In order to overcome this problem, in this research a prototype design for a door security system based on RFID (Radio Frequency Identification) will be created. RFID card testing aims to determine the ability of the RFID reader in the process of reading RFID tags in the form of cards from various distances. The distance from the registered RFID card has different capabilities to be read by the RFID reader. The maximum distance that the RFID reader can successfully read is 1.5 cm with a delay of 1.58 s. Meanwhile, the minimum distance that can be successfully read by an RFID reader is 0 cm with a delay of 1.13 s. Therefore, we can draw the conclusion that the best position for RFID reader users who will carry out the RFID scanning process is to place the RFID tag at a distance of 0 cm. This is because the closer the distance between the RFID reader and the RFID tag, the stronger the radio signal emitted will be.

Keywords: *Security system, RFID, distance*

1 Introduction

The door security system is an important thing which is quite a complicated problem, especially in big cities. A door security system is required to have higher security, due to the many cases of theft and burglary because it is not properly protected. Theft is sometimes not only caused by the owner's negligence in installing additional keys or padlocks outside the door, but also because the door security system is not good. Door security systems have begun to be implemented in buildings, homes, schools, offices, hotels, etc(Sahal & Fauza, 2023).

In order to overcome this problem, in this research a prototype design for a door security system based on RFID (Radio Frequency Identification) will be created. This RFID technology has experienced rapid development compared to the existing identification system, namely barcobe. RFID is quite effective in carrying out identification because when detecting it you have to touch or have direct contact with the object to be identified(Saktioto et al., 2021).

RFID (Radio Frequency Identification) is a wave-based identification technology. The identification method uses a means called an RFID label or transponder (tag) to store and retrieve data remotely. This technology is able to identify multiple simulants without the need for direct contact (or within a short distance)(Hairi & Meyzia, 2023). RFID implementation is effectively used in manufacturing or industrial environments that require accurate and speedy identification of large numbers of different objects over a wide area. However, RFID is not only limited to manufacturing or industrial facilities, it has further penetrated many other fields, including as an information technology that makes it easier for humans to identify various things automatically. (Finkenzeller, 2003).

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Quite a lot of research has been carried out using RFID, including the use of RFID in hospitals studied by (Wang et al., 2006) who conducted a study on how the application of RFIF technology in a hospital in Taiwan showed a decrease in operating costs, increased patient safety and increased quality of medical services. Whereas (Orji & Nduanya, 2019) who researched the benefits and obstacles of using RFID in hospitals in Indonesia. Another researcher who uses RFID is for a computerized parking system with financing automation (Verma & Tripathi, 2010).

Based on the above, the topic of this research will discuss the application of RFID for home door security systems. This topic was taken because of the increasing number of thefts and house break-ins through doors which are caused by human error because thieves usually take advantage of the homeowner's negligence. For homeowners, negligence usually occurs because they install the lock outside the door, whereas if the lock is outside the door, thieves will easily break into it by cutting or breaking the lock. So it is hoped that this scientific article can improve the ability of the home door security system so that it can suppress and prevent theft and house breaking(Azhar et al., 2021).

2 Research Methodology

This system consists of 3 (three) main modules. The microcontroller module consists of an Arduino UNO. The RFID module serves as the input point for the microcontroller, as the registered card required to open the door must be scanned into the system through the module. The mechanical module gears the mechanical action (opening and closing) of the door, namely the servo motor.

The mechanism for making this door security system is explained in Figure 1.

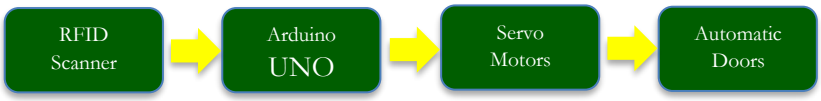


Figure 1. Door Security System Mechanism

There are 4 (four) main processes used by this system, including RFID Scanner, Arduino UNO, Servo Motor, and Mechanical Door. First, the RFID tag will be scanned by the RFID scanner, then the command will be entered into the Arduino. Arduino will check whether the card is registered or not, then the command will go to the servo motor according to the servo motor's programming. The servo motor will be rotated 900 so that the mechanical door lock will work.

The circuit in this research uses 3 (three) separate parts, namely reader, controller, mechanical door lock. In this circuit the reader reads the RFID tag, the controller is used to receive data from the RFID reader and controls the output of the door lock and red, green LEDs. When a door lock is installed on a door and tested with a 12 volt DC current supplied using a 12 volt 2A adapter in the door security system, the servo motor can pull the wire connected to a lock (latch) so that it opens easily.

The circuit diagram of a door security system using Arduino is shown in Figure 2.

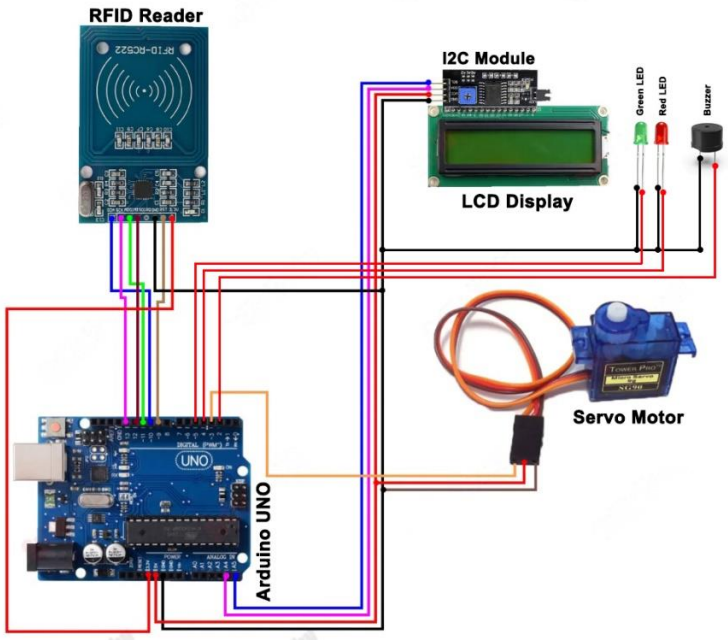


Figure 2. Door Security System Circuit Diagram

Working Method

First, the door security system will start, the card scanning process occurs. If the card has been previously registered, the DOOR OPEN or DOOR LOCKED message appears with the green LED on and the buzzer sounding strong and briefly, then the command will continue. If the message does not appear WRONG CARD! with a red LED on and a strong and long buzzer sound. The command when the card has been registered, the servo motor rotates 900 and pulls the wire connected to the latch so that the door opens/locks(Irawan et al., 2023). The work method flow diagram is explained in Figure 3.

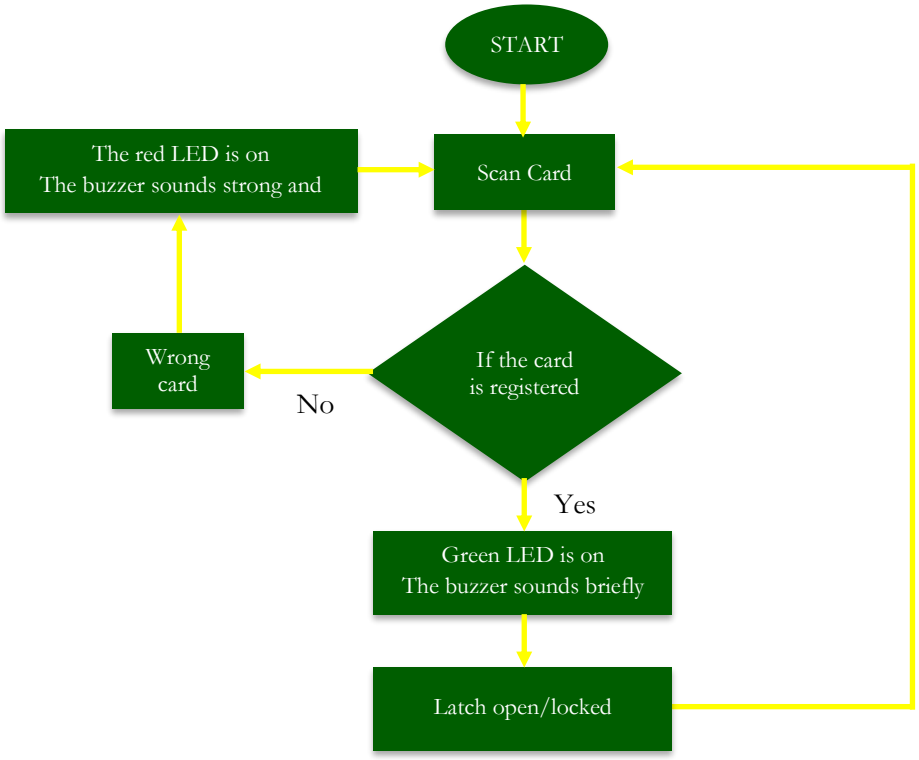
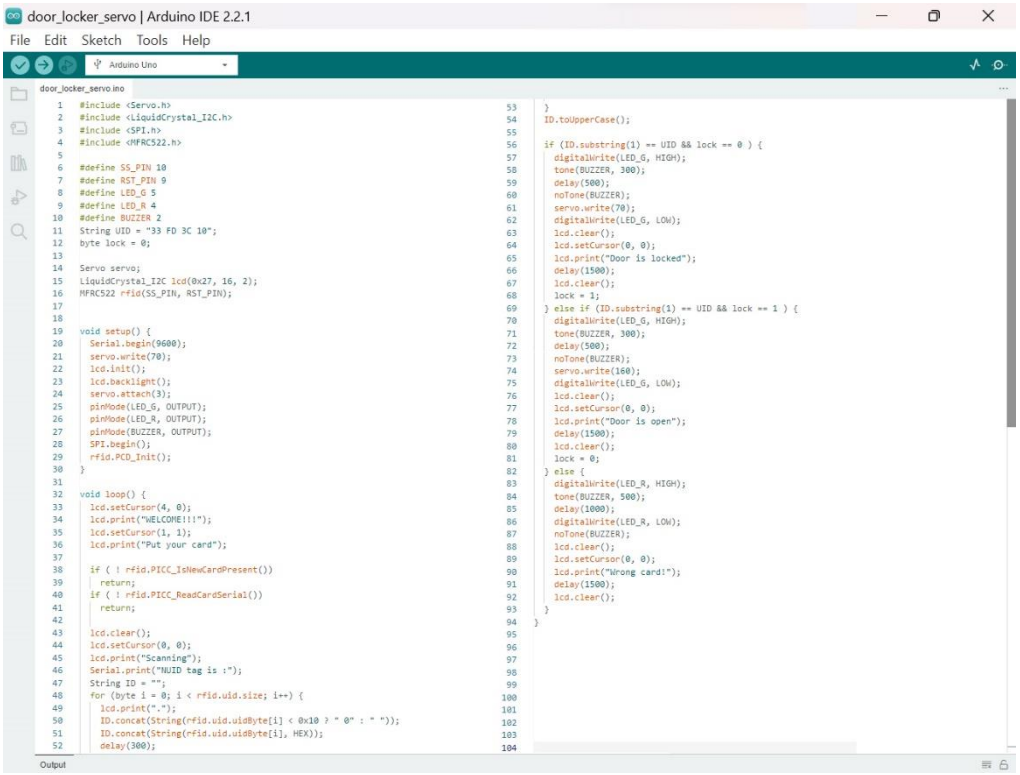


Figure 3. Work Method Flow Diagram

3 Results and Discussion

The door security system is designed with an RFID-based door locking system developed with the help of Arduino. This system is managed by a software system, let's look at the door security system in Figure 4.




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

#define SS_PIN 10
#define RST_PIN 9
#define LED_G 5
#define LED_R 4
#define BUZZER 2
String UID = "33 FD 3C 10";
byte lock = 0;

Servo servo;
LiquidCrystal_I2C lcd(0x27, 16, 2);
MFRC522 rfid(SS_PIN, RST_PIN);


void setup() {
  Serial.begin(9600);
  servo.write(70);
  lcd.init();
  lcd.backlight();
  servo.attach(3);
  pinMode(LED_G, OUTPUT);
  pinMode(LED_R, OUTPUT);
  pinMode(BUZZER, OUTPUT);
  SPI.begin();
  rfid.PCD_Init();
}

void loop() {
  lcd.setCursor(4, 0);
  lcd.print("WELCOME!!!");
  lcd.setCursor(1, 1);
  lcd.print("Put your card");

  if ( ! rfid.PICC_IsNewCardPresent())
    return;
  if ( ! rfid.PICC_ReadCardSerial())
    return;

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Scanning");
  Serial.print("NUID tag is :");
  String ID = "";
  for (byte i = 0; i < rfid.uid.size; i++) {
    lcd.print(".");
    ID.concat(String(rfid.uid.uidByte[i] < 0x10 ? " 0" : " "));
    ID.concat(String(rfid.uid.uidByte[i], HEX));
    delay(300);
  }
  ID.toUpperCase();

  if (ID.substring(1) == UID && lock == 0 ) {
    digitalWrite(LED_G, HIGH);
    tone(BUZZER, 300);
    delay(500);
    noTone(BUZZER);
    servo.write(70);
    digitalWrite(LED_G, LOW);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Door is locked");
    delay(1500);
    lcd.clear();
    lock = 1;
  } else if (ID.substring(1) == UID && lock == 1 ) {
    digitalWrite(LED_G, HIGH);
    tone(BUZZER, 300);
    delay(500);
    noTone(BUZZER);
    servo.write(160);
    digitalWrite(LED_G, LOW);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Door is open");
    delay(1500);
    lcd.clear();
    lock = 0;
  } else {
    digitalWrite(LED_R, HIGH);
    tone(BUZZER, 500);
    delay(1000);
    digitalWrite(LED_R, LOW);
    noTone(BUZZER);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Wrong card!");
    delay(1500);
    lcd.clear();
  }
}
```

Figure 4. Arduino-Based Door Security System Program

Where a 12 volt adapter is used for power supply and you can also use a 9 volt battery as a replacement for the power adapter. The LCD will display "put your card", when we bring the card close to the RFID tag, the Arduino will read it and the LCD will display "scanning". If the card that is brought close to the RFID tag has been registered, the RFID card will be scanned on the LCD Scanning display and accepted, then the door lock will be locked/open. Display on the LCD "Door is looking/Door is open", then the green LED light will light up accompanied by a buzzer sound for 300 seconds. If the card that is approached to the RFID tag has not been registered, the RFID card will be scanned on the LCD Scanning display and the card is rejected, then the display on the LCD will be "Wrong card!", the red LED light will light up accompanied by a buzzer sound for 1500 seconds.

RFID card testing aims to determine the ability of the RFID reader in the process of reading RFID tags in the form of cards from various distances.

Table 1. Test results for RFID reader reading distance to RFID tags

Distance (cm)	Delay (s)	Status
0	1,13	Accepted
0,5	1,32	Accepted
1	1,46	Accepted
1,5	1,58	Accepted
2	-	Rejected
Average	**1,3725**	**Accepted**

From Table 1 above, it can be seen that each distance from a registered RFID card has a different ability to be read by an RFID reader. The maximum distance that the RFID reader can successfully read is 1.5 cm with a delay of 1.58 s. Meanwhile, the minimum distance that can be successfully read by an RFID reader is 0 cm with a delay of 1.13 s. Therefore, we can draw the conclusion that the best position for RFID reader users who will carry out the RFID scanning process is to place the RFID tag at a distance of 0 cm. This is because the closer the distance between the RFID reader and the RFID tag, the stronger the radio signal emitted will be(Ali & Irawan, 2023).

From the overall test results, it can be said that the smartcard in charge of RFID is functioning well. Likewise, the software used as a database can function well.

4 Conclusion

From the test results it was found that the maximum distance that was successfully read by the RFID reader was 1.5 cm with a delay of 1.58 s. Meanwhile, the minimum distance that can be successfully read by an RFID reader is 0 cm with a delay of 1.13 s. Therefore, we can draw the conclusion that the best position for RFID reader users who will carry out the RFID scanning process is to place the RFID tag at a distance of 0 cm. This is because the closer the distance between the RFID reader and the RFID tag, the stronger the radio signal emitted will be.

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