A
Project Report
On

SMART LOCK WITH OTP AUTHENTICATION USING ARDUINO

Submitted to

AP IIIT RAJIV GANDHI UNIVERSITY OF KNOWLEDGE TECHNOLOGIES
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partial fulfillment of the requirements for the award of the Degree of

BACHELOR OF TECHNOLOGY IN
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DECLARATION

We hereby declare that the project report entitled " **SMART LOCK WITH OTP AUTHENTICATION USING ARDUINO** " submitted to the Department of **ELECTRONICS AND COMMUNICATION ENGINEERING** in partial fulfillment of requirements for the award of the degree of **BACHELOR OF TECHNOLOGY.** This project is result of our own effort and that it has not been Submitted to any other University or Institution for the award of any degree or diploma other than specified above.

ABSTRACT

SMART LOCK WITH OTP AUTHENTICATION USING ARDUINO

This report discusses the development and implementation of a smart lock system using an Arduino platform, integrated with an OTP (One-Time Password) authentication mechanism. The project aims to enhance security by providing a flexible, user-friendly solution for door access. The system utilizes multiple components, including an Arduino microcontroller, GSM module, keypad, servo motor, and I2C LCD display, to create a seamless, secure, and efficient locking mechanism.

The core functionality of the smart lock revolves around OTP authentication. Upon entering the correct OTP, generated by a mobile app or server-side script, the Arduino verifies the code, and if valid, it activates the servo motor to unlock the door. The system ensures that only authorized users, with the correct OTP, can gain access. The OTP can be dynamically generated, ensuring it is time-limited and one-time use, further securing the access process

The I2C-enabled LCD display is used to provide real-time feedback to the user, showing information such as OTP status, system messages, and errors. The use of I2C allows for a simpler and more efficient wiring setup, while the keypad ensures that only authorized personnel can input the OTP. This integrated system combines multiple technologies to create a robust, easy-to-use, and highly secure smart locking solution suitable for residential or commercial applications.

The GSM module plays a crucial role in this system by enabling communication bertween smart lock and user's mobile device. The GSM module is responsible for sending OTP to user's mobile via SMS.When access is requested ,the system generates a unique OTP and send's it to user's moblie via SMS.

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CHAPTER 1

INTRODUCTION

Introduction to Smart Lock with OTP Authentication Using Arduino

The need for enhanced security in both residential and commercial environments has led to the development of intelligent access control systems. One such system is a **smart lock** that integrates advanced authentication methods to ensure secure access to restricted areas. Traditional mechanical locks have been widely used for securing premises, but they lack flexibility and can be easily bypassed. In contrast, a **smart lock system** offers a modern solution by combining hardware and software technologies to provide secure, user-friendly, and remote access control.

This project focuses on the design and implementation of a **smart lock system** using an **Arduino platform**, with **OTP (One-Time Password)** authentication as the core security mechanism. OTP authentication is a time-sensitive and one-time-use code, making it a highly secure method for access control, as it eliminates the risk of reused or stolen passwords. The system is designed to generate and send an OTP to an authorized user's mobile phone, who then inputs the code into a keypad for verification.

Key components of the system include an **Arduino microcontroller**, a **GSM module**, a **keypad**, a **servo motor**, and an **I2C LCD display**. The **Arduino microcontroller** serves as the central control unit, executing the logic for OTP verification and unlocking the door. The **GSM module** enables communication between the system and the user's mobile phone, sending the OTP via SMS for secure delivery. The **keypad** allows the user to input the OTP, which is then validated by the Arduino. Upon successful authentication, the **servo motor** is activated to unlock the door, providing physical access . The **I2C LCD display** offers real-time feedback to the user, showing system status, error messages, and OTP validation results.

The integration of these components into a cohesive system results in a **secure, reliable, and efficient smart lock solution**. This system not only ensures that only authorized users can gain access, but it also enhances convenience by enabling remote authentication via SMS. The flexibility of this system makes it suitable for a variety of applications, from home security to access control in office or commercial environments. With the rise of the Internet of Things (IoT) and increasing concerns about security, this smart lock system offers a practical and scalable solution for modern access management.

CHAPTER 2

DESIGN AND IMPLEMENTATION

2.1: HARDWARE EQUIPMENTS

These are the hardware requirements that are necessary to build the assembly of the temperature based fan speed control and monitoring using Arduino.

- Arduino Board
- GSM module
- Keypad
- I2C Display
- Servo Motor
- SIM card
- Connecting wires
- Power Supply

2.2: COMPONENTS DESCRIPTION:

1. ARDUINO UNO R3:

Arduino UNO is a development board which contains microcontroller in the board itself. It is an open-source software. In the electronics platform, Arduino is easy to use hardware and software. The Arduino boards can read inputs so that they can understand and give as some of the outcomes like light on a sensor, a finger on a button, activating a motor, turning on an LED, publishing something manually in online etc. that are all given as output to us. The most of the applications on everyday life.

Arduino is a part of the application. The reason is that the Arduino follows the instruction correctly that fed by us. How can we send the instructions to the Arduino board? The instructions can be fed to the Arduino board by these tools, one is the Arduino programming language (based on Wiring), and the other one is **Arduino Software (IDE),** based on Processing.

For a long period of time Arduino has been the master brain for thousands of projects, from everyday objects to complicated scientific instruments. All kind of people around the worldwide like students, hobbyists, artists, programmers, and professionals can make use of this open-source software platform, so that it can be very helpful to the users. The Arduino UNO was founded by the Ivrea Interaction Design Institute as an easy tool with easy access for fast prototyping, targeted at students without a background in electronics and programming. Quickly it interacts the wider community, the Arduino UNO board started facing to adapt to new needs and difficulties as per the product. All the Arduino boards are full and fully open-

source platform, helps the users to build them freely andclearly adapt them to their particular needs. The software is very easy to access for all kind of users includes the beginners and the new learners, also flexible enough for advanced users. This software is applicable to all systems like Mac, Windows, and Linux. In the educational area the teachers and the students independently access this software.

This paves the way to the technology development and new innovations. Other microcontrollers offer similar functionality. All of these things are taken the sufficient details of microcontroller programming and pack it up in a proper function for the use. Arduino UNO makes the working process simple with the microcontrollers.

- Inexpensive – The Arduino UNO board is comparatively low cost when compared to the other microcontrollers that available in the market.

- Cross-platform - The Arduino UNO Software (IDE) easily access all kind of the platforms like Windows, Macintosh OSX, and Linux operating systems. Most of the microcontroller systems are limited to Windows.

- Simple programming platform - The Arduino Software (IDE) is very easy and simple for the beginners, available also for the advanced users to take advantage of as well. Also for the teaching staffs it is applicable to teach the students for the basic programming here.

- Open source and extensible software - The Arduino IDE software is Typographic as open source tools, available for experienced programmers. This can access the C++ libraries in the IDE software itself.

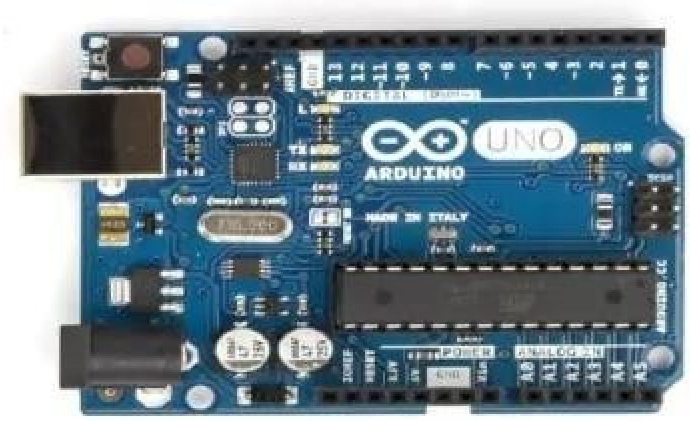


Fig 2.2.1: Arduino UNO

Specifications:

1. Microcontroller- ATmega328

2. Operating Voltage- 5V Input Voltage

3. Input Voltage – 6 to 20V

4. Digital I/O Pins- 14Analog Input Pins :6

5. DC Current for the 3.3V Pin- 50 mA

6. Flash Memory- 32 KB SRAM :2 KB

7. EEPROM- 1 KB

8. Clock Speed- 16 MHz

General Pin functions:

1. LED: In that a LED is in-built with the digital pin 13. So that the differ in valuescauses the LED ON/OFF. It is simple in that pin the value is high the LED is in ON stateand the value is low the LED in OFF state.

2. VIN: This Input Voltage pin is used to access the external power supply rather thanconnecting the USB port. So the additional power source is get access the board throughthis pin.

3 .5V: This pin functions to send as a 5V as an output that passed through the regulatoron the board. We can give supply to the board through the DC power source(7V-20V),also through USB port(5V). If the voltage supplied through the 5V or 3.3V, the board getdamaged.

4. 3.3V: A 3.3volt supply generated by the on-board regulator. Maximum current draw is50 mA.

5. GND: It is ground pin, used for grounding.6. IOREF: Based on the microcontroller operations the voltage references provided by the board itself.

7. Reset: This reset pin is normally used to reset the program that stored in board.

8. Special Pin Functions: All the 14 Digital pins and the 6 Analog pins on the Arduino UNO board can be use as input/output. Each pin can operate at 5V. Based on the operating condition each pin can provide or receive as 20 mA and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. The value does not exceeds 40 mA on any of the I/O pins to avoid the permanent damage to the microcontroller. The Arduino Uno has 6 analog inputs, named A0-A5, which provide 10 bits of resolution (i.e. 1024different values). Initially they measure from the ground to 5V, though it is possible to change the upper end of their range with the help of the AREF pin and the analog reference () function.

9. Serial: This pin specially functions for receiving and transmitting. The pins 0 (RX) and1 (TX). It is used to receive (RX) and transmit (TX) TTL serial data. Pins of theATmega8U2 USB-to-TTL Serial chip are connected with these pins.

10. External Interrupts: The pins 2 and 3 are the external interrupts. These pins can be assigned to trigger an interrupt on a low value and a high value.

11. PWM (Pulse Width Modulation): The pins 3, 5, 6, 9, 10, and 11 can provide 8-bitPWM output with the analog write function.

12. SPI (Serial Peripheral Interface): The pins 10 (SS), 11 (MOSI), 12 (MISO), 13(SCK) supports the SPI communication by using the SPI library.

13. TWI (Two Wire Interface): The A4 or SDA pin and A5 or SCL pin supports TWI communication by using the wire library.

14. AREF (Analog Reference): It is the Reference voltage for the analog inputs

2. GSM Module:

The **GSM module** is a communication device that allows microcontrollers, such as Arduino, to send and receive text messages (SMS), make voice calls, and connect to the internet via cellular networks. It enables remote communication by integrating a SIM card to access mobile networks. In the context of a smart lock system, the GSM module is used to send **One-Time Passwords (OTPs)** to a user's mobile phone via SMS for secure authentication. It provides a simple and reliable method for wireless communication, making it ideal for access control and remote management. The GSM module is widely used in IoT applications due to its low cost and ease of integration with various microcontrollers.

Fig :GSM Module

Properties:

1.Wireless Communication

2.SIM Card Integration

3.SMS Support

4.Voice communication

5. AT Commands Interface

6. Data Transmission Capabilities

7. Compatability

8. Wide Network Coverage

9. Compact Design

3 . 4x4 KEYPAD:

The “4x4 keypad” is a compact input device with 16 keys arranged in 4 rows and 4 columns, used for entering numeric or alphanumeric data. It is commonly used in Embedded systems and applications like security, control panels, and user authentication.

Fig : 4x4 Keypad

4. SERVO MOTOR:

A “servo motor” is a small, precise motor used for controlling angular position, often used in robotics, automation, and control systems. It operates through feedback mechanisms, allowing accurate movement to specific angles based on input signals.

Fig : Servo Motor

5 .I2C Crystal Display:

Liquid crystal displays (LCDs) have found enormous success in the past couple of decades. They are used everywhere in our day to life. Some of the examples are from cellular phones, e-books, GPS devices, computer monitors, and automotive displays to projectors and TVs to name a few.

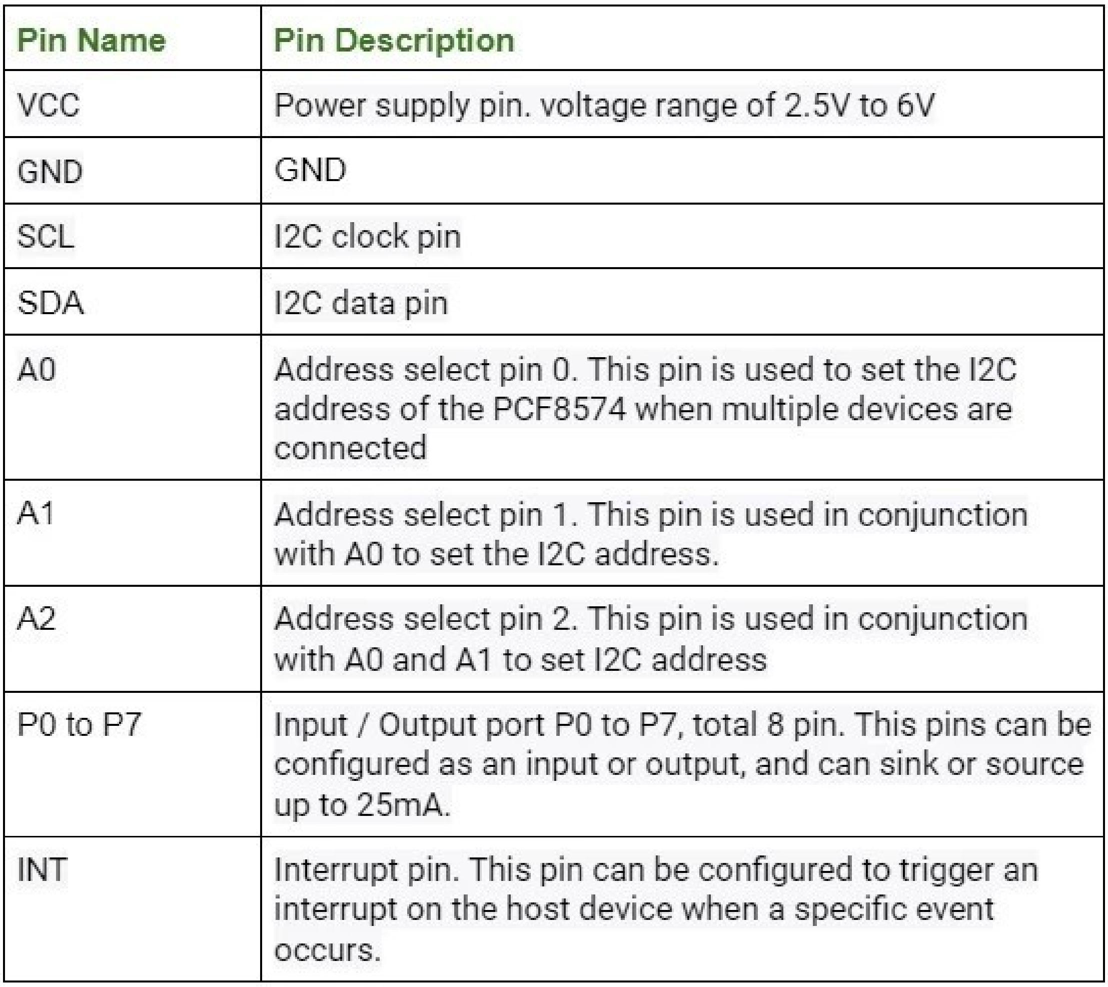
They play a critical role in the information age and are import elements of our daily life .Liquid crystals do not emit light. Their function is to modify the state of light produced by a light source in order to display images.

The light is produced by either a direct backlight, which is placed directly beneath the liquid crystal panel, or edge light which is placed at the edge of a waveguide sheet. Backlight is more suitable for large-size LCDs, because it can provide high light intensities, but it is bulky. Edge light is more suitable for small-size handheld LCDs, because it is compact, but its light output is limited.

The common light sources for LCD lighting are cold cathode fluorescent lamps (CCFL),light emitting diodes (LED), external electrode fluorescent lamps (EEFL), and flat fluorescent lamps (FFL). CCFL consists of a glass tube with a cathode and an anode at the ends.

The tube is filled with mercury gas. The inner surface of the tube is coated with a fluorescent (phosphor) material. When a voltage is applied across the two electrodes, some (primary) electrons are emitted by thermal motion in the cathode and accelerated toward the anode. There are also dichroic reflective polarizers, which have the advantage of high light efficiency. They pass incident light polarized in one direction and reflect incident light polarized in the orthogonal direction.

The reflected light can be recycled by rotating its polarization into the direction of the transmission axis of the polarizers. The rotation of the polarization can be achieved either by a half waveplate or by a scattering medium.



Pin Name	Pin Description
VCC	Power supply pin. voltage range of 2.5V to 6V
GND	GND
SCL	I2C clock pin
SDA	I2C data pin
A0	Address select pin 0. This pin is used to set the I2C address of the PCF8574 when multiple devices are connected
A1	Address select pin 1. This pin is used in conjunction with A0 to set the I2C address.
A2	Address select pin 2. This pin is used in conjunction with A0 and A1 to set I2C address
P0 to P7	Input / Output port P0 to P7, total 8 pin. This pins can be configured as an input or output, and can sink or source up to 25mA.
INT	Interrupt pin. This pin can be configured to trigger an interrupt on the host device when a specific event occurs.

Fig : I2C DISPLAY

6. SIM Card:

A SIM card (Subscriber Identity Module) is a small chip that stores a user's mobile network credentials, allowing access to cellular services like voice, SMS, and data. It is used in mobile devices and GSM modules for authentication and communication over cellular networks.

Fig : SIM Card

7. Arduino Software:

The Arduino IDE (Integrated Development Environment) is a software platform used to write, compile, and upload code to Arduino microcontrollers. It provides an easy-to-use interface for programming and managing Arduino projects with support for various libraries and tools.

Fig : Arduio software

8. CONNECTING WIRES:

Connecting wires allows an electrical current to travel from one point on a circuit to another because electricity needs a medium through which it can move. A jump wire is an electrical wire, or group of them in a cable, with a connector or pin at each end which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

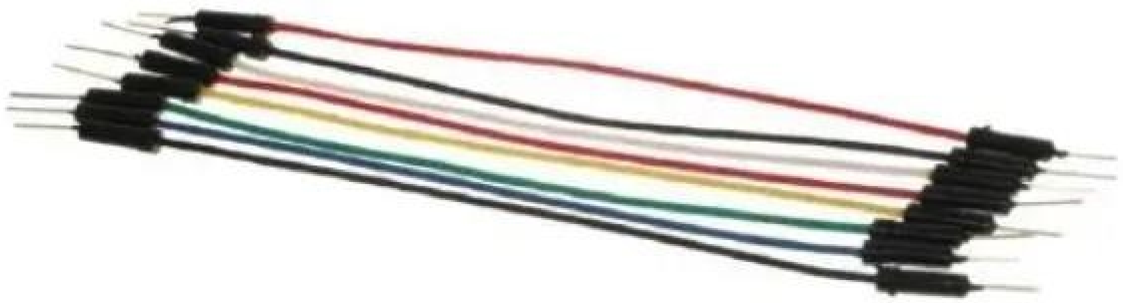
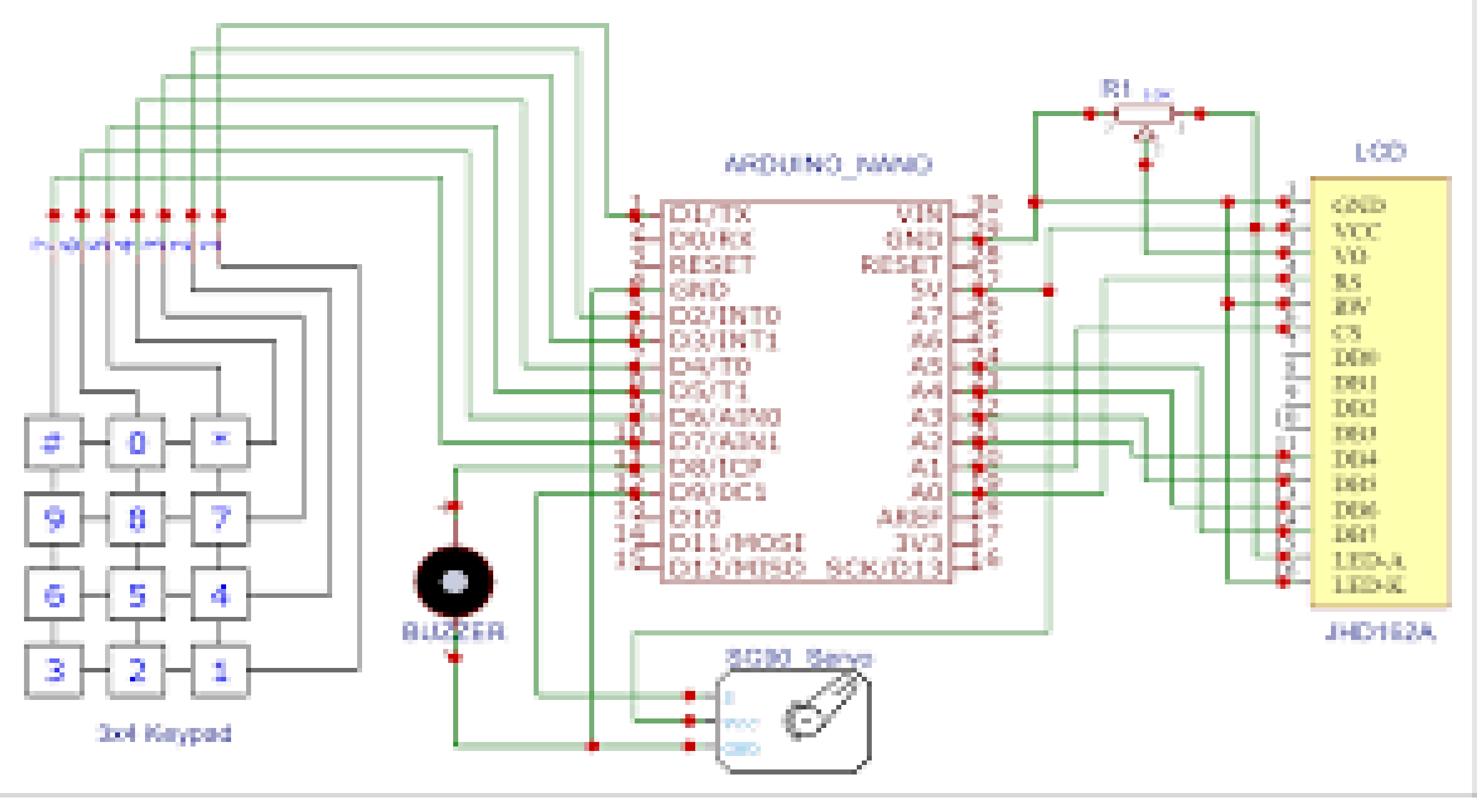


Fig : Connecting Wires

2.3: BLOCK DIAGRAM



Now Arduino is very progressive among all electronic circuits, thus we employed Arduino board for fan speed control. The proposed system is designed to detect the temperature of the room and send that information to Arduino board.

Then the Arduino board executes the contrast of current temperature and set temperature based on inbuilt program of the Arduino.

The outcome obtained from the operation is given through the output port of an Arduino board to the LCD display of related data.

The generated pulses from the board which is further fed to the driver circuit to get the preferred output to the fan.

2.4: CIRCUIT DIAGRAM

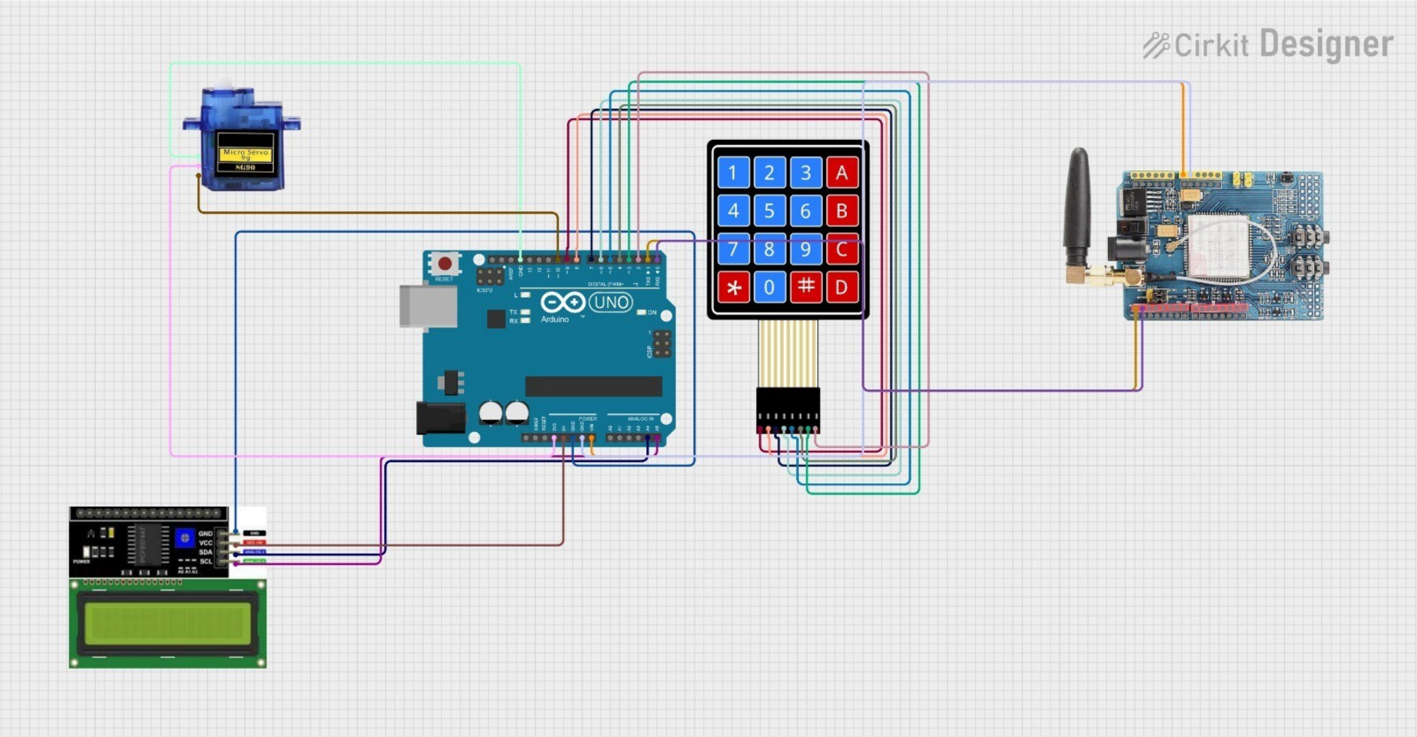


Fig 2.4: Circuit diagram

CHAPTER 3

RESULT AND DISCUSSION

3.1: WORKING:

- The input is taken from a GSM module.
- The output pins are connected to I2C Display.
- The control pins of GSM is connected to the Arduino. The time is taken by the Arduino to convert analog data into digital form is dependent on the frequency of clock sequence.
- Different value for the temperature representation are selected, which in turn are provided to display port. Display port includes LCD display device.
- GSM generates OTP and sends it to mobile device via SMS.
  GMS genrates OTP uniquely for ever attempt for security resons of the lock by the Arduino UNO Board.
- If we enter the OTP in the display,then the display will show the the commands like access denied,door unlocked.
- When the OTP entered correctly then servo motor starts rotating.
- If OTP entered incorrectly then it displays “Access Denied”.
- Servo Motor rotates clockwise when OTP is correctly entered and then then Gets back to its original position after few seconds.
- GMS genetares OTP by SIM card.

3.2: PROGRAM:

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <SoftwareSerial.h>
#include <Keypad.h>
#include <Servo.h>

// LCD setup
const int lcdColumns = 16; // For 16x2 LCD (change to 20 if you have a 20x4 LCD)
const int lcdRows = 2;
const int lcdAddress = 0x27; // Your detected I2C address
LiquidCrystal_I2C lcd(lcdAddress, lcdColumns, lcdRows);

// Keypad setup
SoftwareSerial sim800(10, 11); // TX, RX
Servo myServo;                // Servo motor object
String password;             // Variable to store the generated password
String inputPassword = "";    // Variable to store the entered password

const byte ROWS = 4; // Four rows
const byte COLS = 4; // Four columns
char keys[ROWS][COLS] = {
  {'1', '2', '3', 'A'},
  {'4', '5', '6', 'B'},
  {'7', '8', '9', 'C'},
  {'*', '0', '#', 'D'}
};
byte rowPins[ROWS] = {9, 8, 7, 6}; // Connect keypad ROW0, ROW1, ROW2, ROW3
                                    to these Arduino pins
byte colPins[COLS] = {5, 4, 3, 2}; // Connect keypad COL0, COL1, COL2, COL3 to
                                    these Arduino pins
Keypad keypad = Keypad(makeKeymap(keys), rowPins, colPins, ROWS, COLS);
void setup() {
  Serial.begin(9600);
  sim800.begin(9600);
  myServo.attach(12); // Attach servo to pin 12
  myServo.write(0);   // Set initial position of servo
  // / Initialize LCD
  lcd.init();
  lcd.backlight();

  // Print a message on the LCD
  lcd.setCursor(0, 0);
  lcd.print("Enter Password: "); // Display prompt
  lcd.setCursor(0, 1);
  lcd.print("Input: ");         // Display another message
  Serial.println("Testing SIM800A Module");
  delay(3000); // Wait for SIM800A to initialize

  // Set SMS mode to text
  sim800.println("AT+CMGF=1");  // Set SMS mode to text
  delay(1000);

  // Generate random password and send
  generatePassword();
  sendOTP("9392950670", "Your password is " + password);
}
 if (key) {
    if (key == '#') { // '#' is used to confirm entry
      if (inputPassword == password) {
        Serial.println("Correct Password!");
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Correct Password!");
        rotateServo();  // Rotate the servo on correct password
        delay(2000);    // Show message for 2 seconds
        lcd.clear();
      }else {
        Serial.println("Incorrect Password.");
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Access Denied");
        delay(2000);    // Show "Access Denied" message for 2 seconds
        lcd.clear();
}
```

```
 inputPassword = ""; // Reset input password after checking
      lcd.setCursor(0, 0);
      lcd.print("Enter Password: "); // Display prompt again
      lcd.setCursor(0, 1);
      lcd.print("Input: ");
    } else if (key == ") { // " is used to clear entry
      inputPassword = "";
      lcd.setCursor(7, 1);
      lcd.print("        "); // Clear input on LCD
      Serial.println("Password Cleared");
    } else {
      inputPassword += key; // Append entered key to inputPassword
      lcd.setCursor(7, 1);   // Move cursor to the second line
      lcd.print(inputPassword); // Display the entered characters on LCD
      Serial.println("Current Input: " + inputPassword);
    }
  }
}
// Function to generate a random 4-character password with A-D and 0-9
void generatePassword() {
  randomSeed(analogRead(0)); // Seed random with a floating analog pin
  char characters[] = "ABCD0123456789"; // Character set

  password = ""; // Clear previous password
  for (int i = 0; i < 4; i++) {
    int randomIndex = random(0, sizeof(characters) - 1); // Random index
    password += characters[randomIndex]; // Append random character
  }

  Serial.println("Generated Password: " + password); // Display password in Serial
Monitor
}
// Function to send password via SMS
void sendOTP(const char* phoneNumber, String message) {
  sim800.print("AT+CMGS=\"");
  sim800.print(phoneNumber);
  sim800.println("\"");  // Command to specify phone number
  delay(1000);           // Wait for SIM800A to respond with '>'
sim800.print(message);  // Message content
  delay(500);
 sim800.write(26); // ASCII code for Ctrl+Z to send SMS
  delay(5000);      // Wait for message to send

  // Read module response
  while (sim800.available()) {
    Serial.write(sim800.read());
  }
}
// Function to rotate the servo motor
void rotateServo() {
  Serial.println("Rotating Servo Motor...");
  myServo.write(90);  // Rotate to 90 degrees
  delay(2000);        // Hold position for 2 seconds
  myServo.write(0);   // Return to 0 degrees
  delay(1000);
}
```

3.3: APPLICATIONS

1.Residential security

2.Ioffice and commercial buildings

3.Hotel room access

4.Airport and Transportation hubs

5.Smart Homes

6.Co-Workindg Spaces

7.Storage Units

8.Govenament and Milatary Facilities

9.Health care

10.Event venues

11.Self storage facility

12.Lockers

13.Home Security

14.Secret boxes

3.4: ADVANTAGES

1.Enhanced Security

2.Remote Access

3.NO Need of Physical Keys

4.Temporary Access Contro.

5.User Flexibility

6.Audit Trail

7.No Internet Dependency

8.Scalability

9.Easy Integration

10.Cost Effective

11.User Convience

12.Tamper Resistance

13.Customizable Access Levels

CHAPTER 4

CONCLUSION AND FUTURE SCOPE

CONCLUSION:

The smart lock systemwith OTP authenticationprovides a highly secure, user-friendly, and efficient solution for access control across various applications, from residential security to commercial and industrial use. By integrating an Arduino platform, GSM module, keypad, servo motor, and I2C LCD display, the system ensures that only authorized individuals can access protected areas, leveraging time-sensitiveand one-time-use OTPs for enhanced security. The use of SMS-based OTP delivery offers flexibility and remote access capabilities, while the system's simplicity and affordability make it an ideal choice for modern security solutions.

FURTURE SCOPE:

- Integration with IoT and Smart Homes and Biometric Integration and Adaptive access control.

- Cloud Based OTP Generation and AI and Machine Learninng for Enhanced Security.

- Blockchain for secure Record Kepping and Improved Energy Efficiency.

- Genofencing Compatability.