Design & Implementation of Biometric Security System using Arduino and Fingerprint Sensor

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Declaration

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

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Certification

This is to certify that this project entitled " **Design & Implementation of Biometric Security System using Arduino and Fingerprint Sensor**" is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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ABSTRACT

Security is a major concern in our day to day life and the concept of locks have become an important part of these security systems. There are many types of security systems available to secure our place. Some examples are PIR based Security System, RFID based Security System, Digital Lock System, bio-matrix systems, Electronics Code lock.We have designed a biometric scurity system using arduino and fingerprint sensor. In this work , we will **Interface a Fingerprint Sensor Module with Arduino** and will build a **Fingerprint based Biometric Security System** with door locking. Finger Print is considered one of the safest key to lock or unlock any system as it can recognize any person uniquely and can't be copied easily.

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LIST OF ABBREVIATIONS

DC	Direct Current
AC	Alternating Current.
LCD	Liquid Crystal Display
ADC	Analog-to-Digital Converter
IR	Infrared Receiver
IC	Integrated Circuit
LED	Light Emitting Diode
PCB	Printed Circuit Board

CHAPTER I

INTRODUCTION

1.1 Introduction:

Human beings have something unique that only belongs to them. This gives the idea of making the uniqueness of humanity as identity. Fingerprint is different to each of people, even for the twin. This makes fingerprints be appropriate used for biometrics technology. Another advantage of fingerprints is its practicality and durability. [1] Biometric fingerprint is a technology with physical characteristics of fingerprints. This type of biometrics is popularly used because it has a good performance and uniqueness. Moreover, fingerprints are permanent in one's lifetime, quite immune to aging and biological changes [2] Biometric technology has great potential in various technical fields such as network security, public security, and financial industry systems. [3] At this time, the most developed technology is fingerprint recognition by using fingerprint sensor. Fingerprint sensor is a sensor used to detect fingerprint using optical system, where the detection is done by reading the contours (high level of the surface) fingerprint and static electricity body. The match rate of False Acceptance Rate (FAR) is up to <0.001% and the match rate limit of the Average Rejection Rate (FRR) is up to <1% [4] However, the fingerprint sensor can only identify the user's fingerprint registered in the sensor. Therefore, we need a method that makes fingerprint recognition using a fingerprint sensor to be centralized. With the Arduino and Raspberry Pi, supporting data can be centralized to identify the user's fingerprint entirely and can perform fingerprint recognition in different fingerprint sensors. Using WebSocket makes it possible to provide a variety of interactions between browsers and websites. In this way, two-way continuous conversations can be made between browsers and servers

1.2 Research Methodology:

The identification of fingerprints for the attendance and security system using Arduino and Raspberry Pi which is built on this project consisted of several stages. The first stage is done with the initialization of the Fingerprint sensor, Arduino, Ethernet Shield and Raspberry Pi. The next stage is Fingerprint Sensor.

1.3 Objectives:

Our proposed fingerprint based lock system is a reliable and very secure lock that will not only ensure safer environment but also ease lifestyle. This system can prove very useful in housing buildings, large offices, universities and so on. Because it offers the flexibility to add more features to the system. Users do not need to implement many systems from scratch. They can simply use our fingerprint lock system because fingerprint scanning is more accurate and cost effective method. It is also secure because fingerprint duplication is authentication system for security purposes to ensure access to not enrolled people.

1.4 Project Organization:

In this report, Chapter one covers introduction, background, objectives. Chapter two represents theory, description of the microcontroller, wind, solar & generator, LCD display and other components. Chapter three describes and working principle of the project. In chapter four we have discussed result and discussion, cost estimation, future modification, conclusion.

CHAPTER II

THEORY OF THE PROJECT

2.1 Introduction:

This chapter includes the total over view of the device. In this chapter we have followed-up the theory of Arduino Uno,LCD Display, Resistor, Diode (IN 4007), , Transistor, briefly describe of Microcontroller (ATMEGA 328P), Crystal, LCD display (16x2), Vero board, and other components. Here we can know that the total system overview of the projects. And we will also know that how the equipment are working with each other.

2.2 Theory:

Working of this **Fingerprint Sensor Door Lock** is easy. In this project, we have used a gate that will be open when we place stored finger at the finger print module. First of all, the user needs to enroll finger with the help of push button/keys. To do this user need to press ENROLL key and then LCD asks for entering location/ID where finger will be a store. So now user needs to enter ID (Location) by using UP/DOWN keys. After selecting Location/ID user needs to press an OK key (DEL key). Now LCD will ask for placing finger over the finger print module. Now user needs to put his finger over finger print module. Then LCD will ask to remove the finger from finger print module and again ask for placing the finger. Now user needs to put his finger again over finger print module. Now finger print module takes an image and converts it into templates and stores it by selected ID in to the finger print module's memory. Now user can open the gate by placing the same finger that he/she have added or enrolled into the system and then press MATCH key (UP/Down key). By the same method, the user can add more fingers. Check the Video below for full demonstration.

2.3 Arduino Uno:

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language and the Arduino Software (IDE), based on Processing.

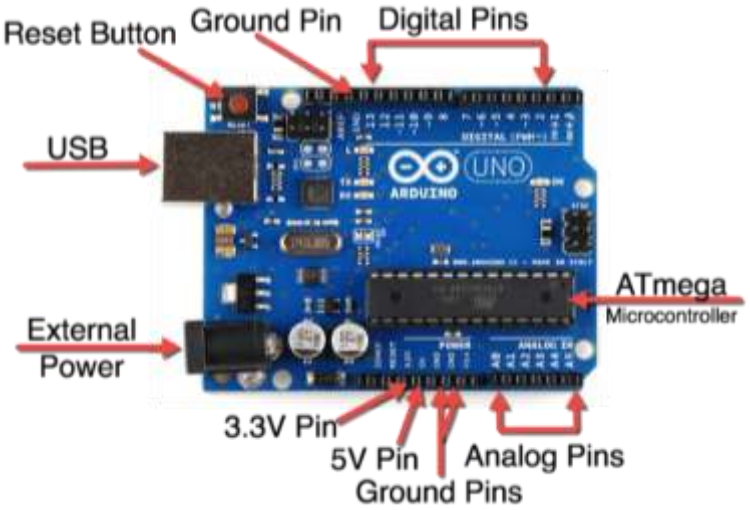


Fig: 2.3.1: Arduino UNO Pin Diagram

2.4 The Technical specifications have been table:

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P)of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz

Table 2.4.1: Technical specifications of Arduino UNO

2.5 Biometric Security System using Arduino and Fingerprint Sensor:

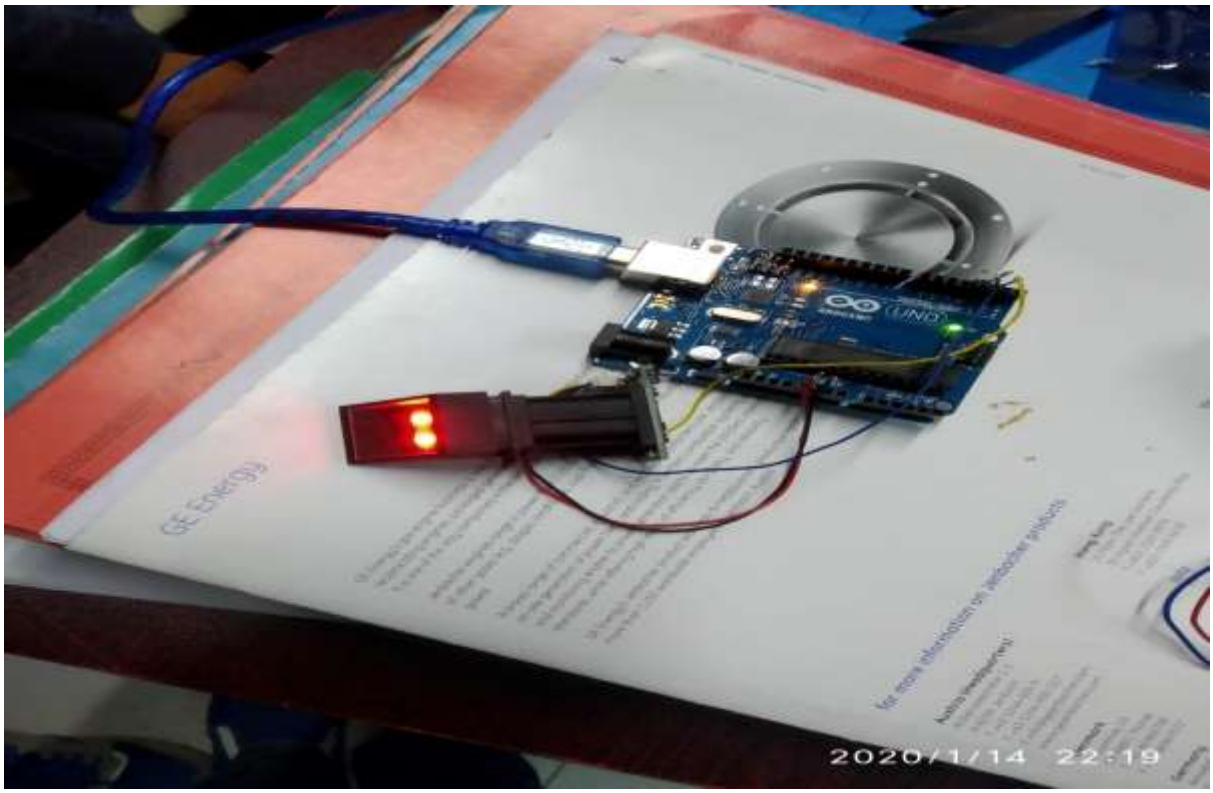


Fig: 2.5.1:Biometric Security System using Arduino and Fingerprint Sensor

Security is a major concern in our day to day life, and digital locks have become an important part of these security systems. There are many types of security systems available to secure our place. Some examples are PIR based Security System, RFID based Security System, Digital Lock System, bio-matrix systems, Electronics Code lock. In this post, we will **Interface a Fingerprint Sensor Module with Arduino** and will build a **Fingerprint based Biometric Security System** with door locking. Finger Print is considered one of the safest key to lock or unlock any system as it can recognize any person uniquely and can't be copied easily.

2.6 Components Required:

1. Arduino Uno
2. Finger Print Module
3. LEDs
4. Power Supply
5. Connecting wires
6. Cardboard Box
7. Magnetic door lock
8. 16x2 LCD

2.7 Finger Print Sensor Module with Arduino:

Finger Print Sensor Module or Finger Print Scanner is a module which captures finger's print image and then converts it into the equivalent template and saves them into its memory on selected ID (location) by Arduino. Here all the process is commanded by Arduino like taking an image of finger print, convert it into templates and storing location etc.



Fig:2.7.1: Finger Print Sensor Module with Arduino

2.8 LCD Display 16x2:

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

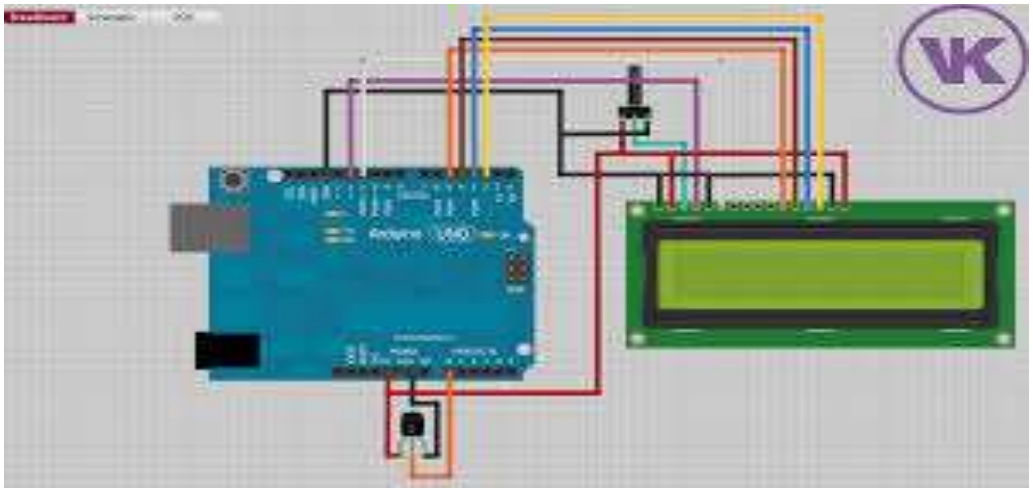


Fig: 2.8.1: LCD Display 16x2

CHAPTER III

DESING & FEBRICATION

3.1 Introduction:

In this chapter fully cover with discuss design and fabrication of this project. Here we will discuss about developed block diagram and briefly describe about the circuit description and also learn about working principle. Total project flow chart is also available in this chapter.

3.2 Flow Chart:

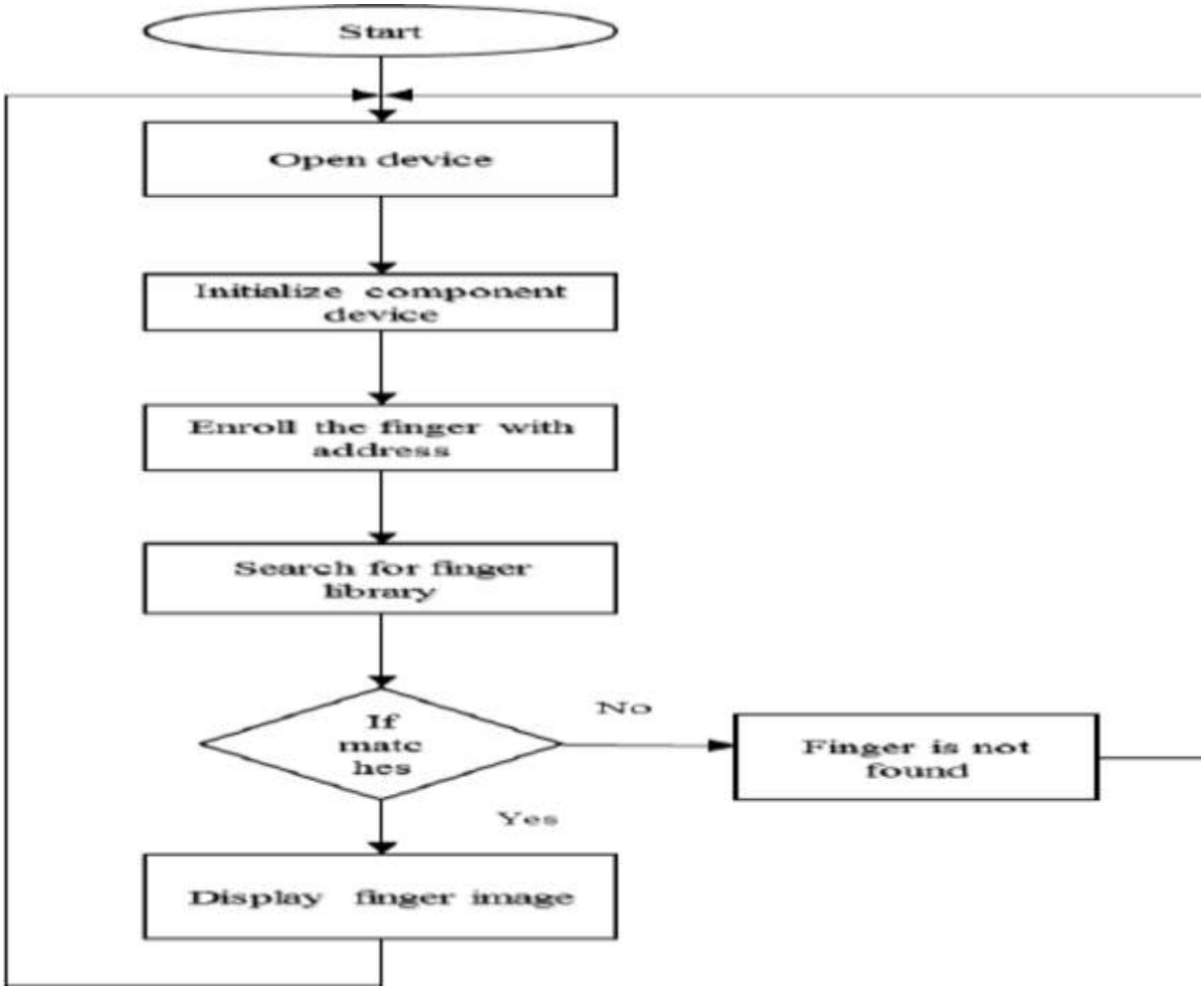


Fig: 3.2.1:Flow chart of the project

In this flowchart we can easily determine the working process of our system. Starting with some control initializations our control system reads/measures the voltage and current of both energy sources. The voltage and current is shown & updated every second in a LCD display. The control system continuously checks if the supply voltage is less than the threshold voltage set by us on the program. If the supply voltage gets down below the threshold voltage, it switches the supply line to the other source. Or if both sources drops the threshold voltage, then the controller

combines those two sources. For example if somehow solar source drops the threshold voltage, the controller switches the supply line to the wind source. If wind source drops the threshold voltage, the controller switches the supply line to the solar source. If both solar and wind source drops the threshold voltage, the controller combines (in series) the sources.

3.3 Block Diagram:

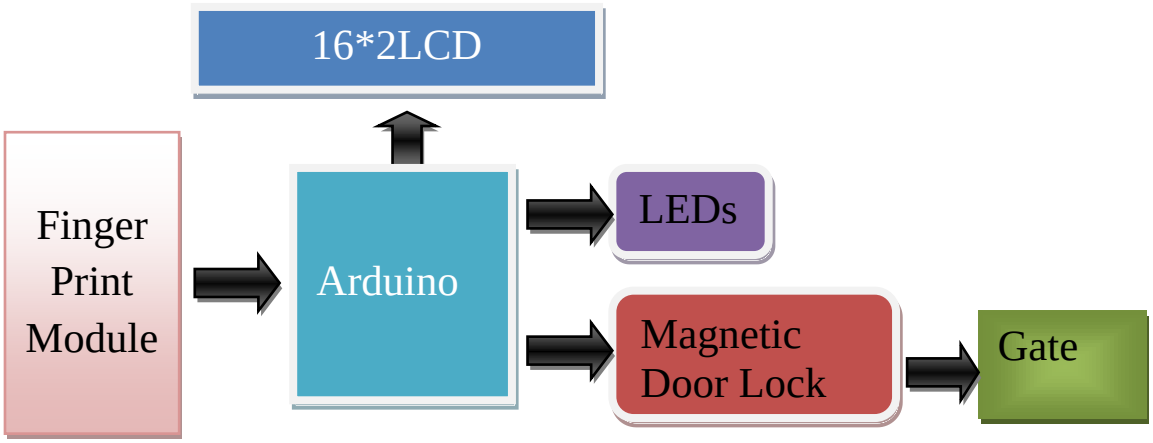


Fig:3.3.1: Block Diagram

Working of this **Fingerprint Sensor Door Lock** is easy. In this project, we have used a gate that will be open when we place stored finger at the finger print module. First of all, the user needs to enroll finger with the help of push button/keys. To do this user need to press ENROLL key and then LCD asks for entering location/ID where finger will be a store. So now user needs to enter ID (Location) by using UP/DOWN keys. After selecting Location/ID user needs to press an OK key (DEL key). Now LCD will ask for placing finger over the finger print module. Now user needs to put his finger over finger print module. Then LCD will ask to remove the finger from finger print module and again ask for placing the finger. Now user needs to put his finger again over finger print module. Now finger print module takes an image and converts it into templates and stores it by selected ID in to the finger print module's memory. Now user can open the gate by placing the same finger that he/she have added or enrolled into the system and then press MATCH key (UP/Down key). By the same method, the user can add more fingers. Check the Video below for full demonstration. Now if the user wants to remove or delete any of stored ID then he/she need to press DEL key, after pressing DEL key, LCD will ask for select location

means select ID that to be deleted. Now user needs to select ID and press OK key (same DEL key). Now LCD will let you know that finger has been deleted successfully. Now the user may check it was deleted or not by placing the same finger over the finger print module and pressing .

3.4 Circuit Description:

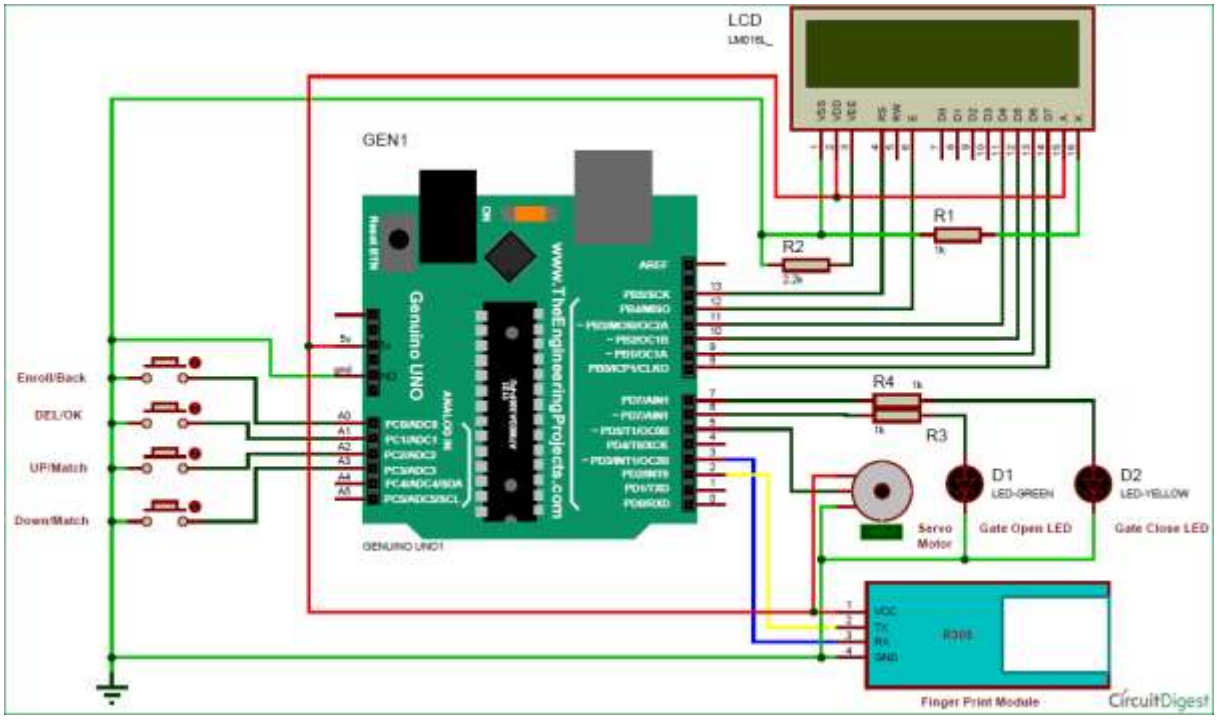


Fig: 3.4.1:Circuit diagram of the Project

The circuit of this **Arduino Fingerprint Security System** is very simple which contains Arduino which controls whole the process of the project, push button, buzzer, and LCD. Arduino controls the complete processes.The push button is directly connected to pin D14(ENROL),D15(DEL), D16(UP) and D17(DOWN) of Arduino with respect to ground And Yellow LED is connected at Digital pin D7 of Arduino with respect to ground through a 1k resistor and Green LED is connected to D6 of Arduino with the same method. Finger Print Module's Rx and Tx directly connected at Software Serial or Digital pin D2 and D3 of Arduino. 5v supply is used for powering finger print module taken from Arduino board and Servo motor is also connected to PWM pin D5 of Arduino. A 16x2 LCD is configured in 4-bit mode and its RS, EN, D4, D5, D6, and D7 are directly connected at Digital pin D13, D12, D11, D10, D9, and D8 of Arduino.

3.5 Image of the Project

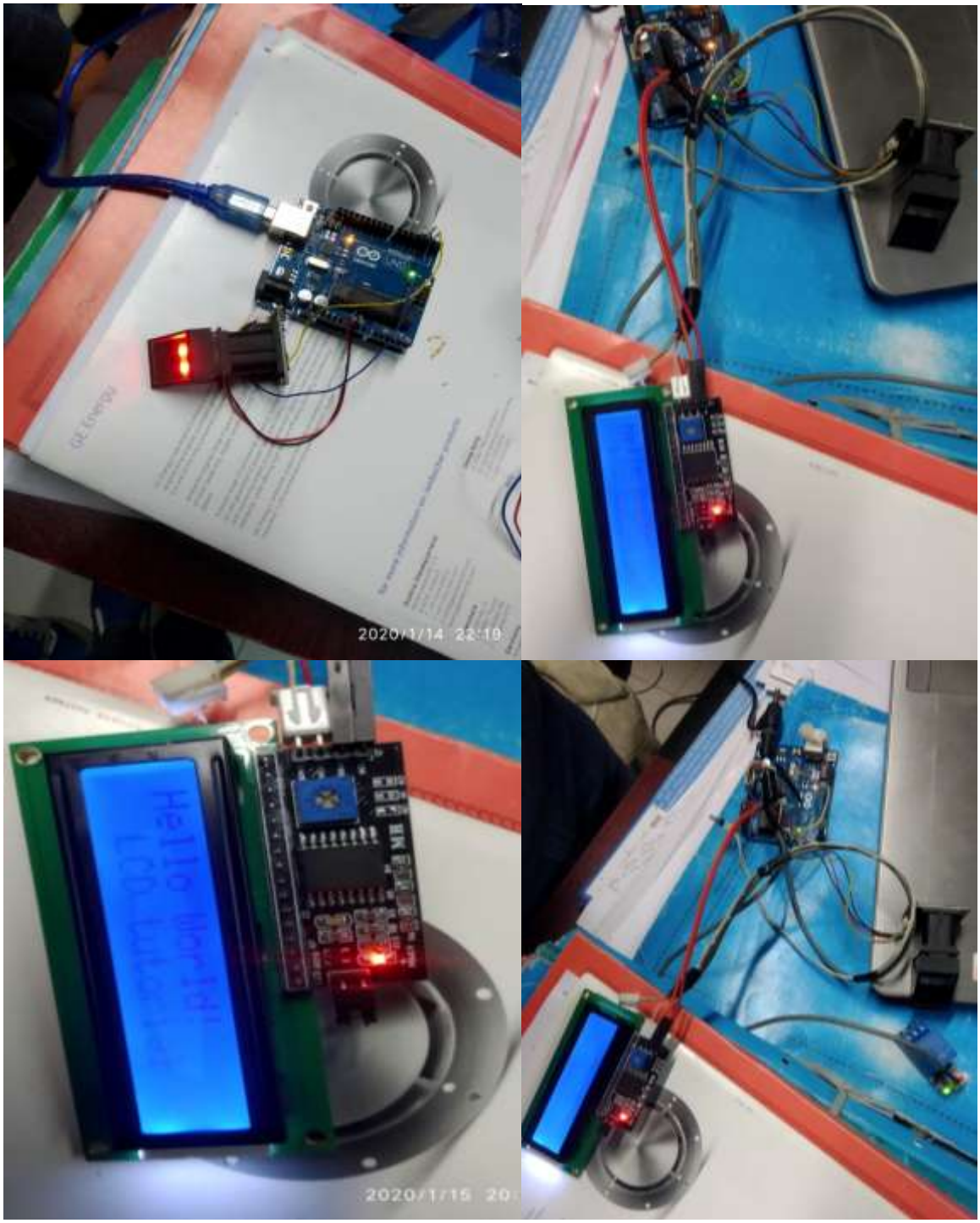


Fig: 3.5.1:Real image of the project

Chapter IV

RESULT& DISCUSSION

4.1 Introduction

This chapter contains the results obtained and discussion about the project. We have also covered discussions about advantages, disadvantages and limitation of current version of the protection system.

4.2 Result and Discussion

This stage will display the results of fingerprint sensor testing during registration. In the designed system, registration mode is selected manually in the fingerprint sensor by pressing the button on the sensor and test results can be seen picture. At this stage, it will display the sample results of fingerprint sensor testing while matching. Further details of the test results can be seen through

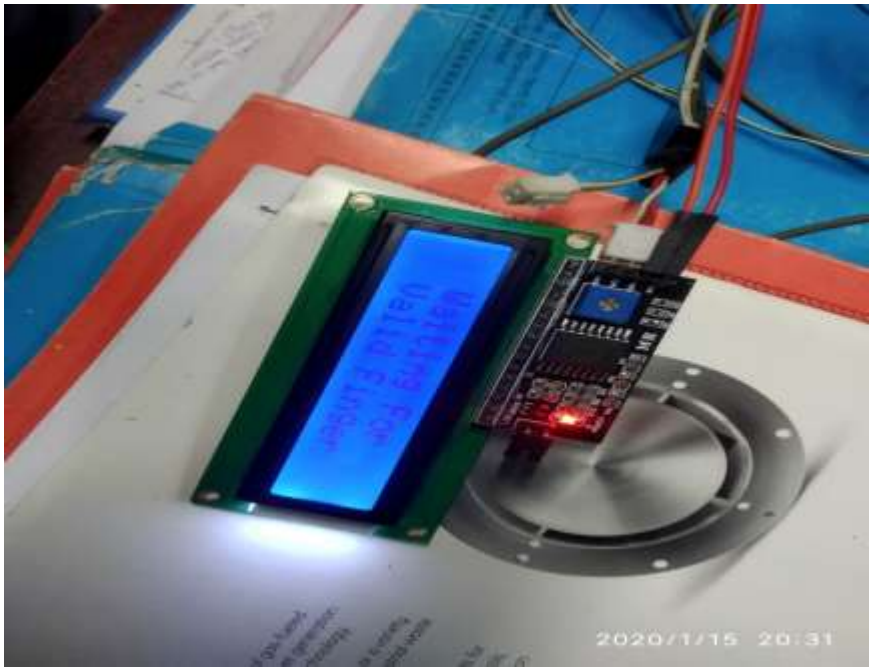


Fig:4.2.1: Result and Discussion

4.3 Testing Implementation

Table 4.3.1: Testing Implementation

No.	Tested case	Test input	Expected outcome	Actual outcome	Result	Tested on
1	fingerprint	Start fingerprint	To start the fingerprint after knock pattern accepted	Started the fingerprint sensor	passed	13.01.2020
2	Enrol new fingerprint	Enrol a fingerprint	To enrol a new fingerprint in the system	Enrolled new fingerprint	passed	14.01.2020
3	delete fingerprint	Deleting a fingerprint by a id	To delete a fingerprint	delete a fingerprint	passed	14.01.2020
4	Door unlock	Door lock open by knocking and fingerprin	To open door using knock and fingerprint	Door opened using knock and fingerprint	passed	15.01.2020
5	Door unlock	Door unlocking by unauthorized perso	To not open the door	Door didn't open	passed	15.01.2020

4.4 Cost Estimation

Table 4.4.1: Cost Estimation

SI	Particulars	Specification	Qty.	Unit Price	Total Price
1	Arduino Uno		1	300	300
2	Microcontroller	ATMEGA328P	1	250	250
3	IR Sensor	RX and TX	1	50	50
4	LCD Display	16×2	1	250	250
5	Wire	As per need	10ft	20	200
6	Transistor	TIP 122	1	20	20
7	Door Lock		1	500	500
8	Fingerprient	R 307 optical	1	2000	2000
9	Power supply			200	200
10	Soldering Cost			50	50
11	Others			100	100
			Total Cost =		**3920**

4.5 Applications

At this stage, it will show the results of the interface design implementation of the built system. Here is a built-in interface page view:

1. Add User Page On this page, admin does not need to fill the member ID and fingerprint data because the data is obtained when the user scans his fingerprint on the fingerprint sensor.

4.6 Scope

• Performance can be increased in terms of speed and memory.

• A speaking voice alarm can be used to indicate unauthorized person accessing the ATM.

• The system can be made to communicate with modems or mobile phones.

4.7 Limitation

• Replacement will be a pain

• Power failure

• Enrol everyone

4.8 Conclusion

Every product has its merits and disadvantages. In the case of the fingerprint door lock, I have listed 5 above to give a sense of whether is it worth changing your current door lock system to this biometric type.

Chapter V

Conclusion and Future Scope

5.1 Program Explanation :

In a program, we have used Adafruit Fingerprint Sensor Library for interfacing fingerprint module with Arduino board. You can check the complete Code below, it can be easily understood. Here we are explaining main functions of the Arduino Program. Below piece of code is used to take Finger Print as input and take action according to validation of finger. If finger will be validated gate will be open otherwise remain closed.

5.2 Discussion and Conclusion :

Life in this modern world is becoming highly dependent on computer-based systems. From coffee making to dishwashing everything is done by modern appliances. Now comes the issue of our sweet home's security. "2 step door lock security system" is a cost-efficient system that can be used to ensure the security of our beloved nest. Even small organizations can use it easily as it identifies a particular knock-based pattern and then takes a fingerprint to open up the door. No key required in this system. If any of the pattern is mismatched an alarm will let others know that somebody unauthorized is trying to enter the house and an email will be sent to the owner so that he can take necessary actions.

5.3 Scope for Further Development :

The scope of the project development we have planned many things. Such as-

● A camera module can be added in future to take picture of all users who are going towards the process of the security system.

● A log file of all users can be created and be informed to the admin through Email. This project can also be further enhanced with retina scan, voice recognition and etc. Thus, can be widely used in offices hospitals, laboratories and even in cars.

Appendix

Appendix A: Project Reflection

The purpose of this appendix is to provide an introduction to Project Reflection. The group research project was a challenging and enjoyable experience typical of the course as a whole. We have had little exposure to group work at university so it was a nice change to be part of an effective and dynamic team. I think we complemented one another quite well both in bringing together interdisciplinary perspectives and in balancing the work at hand. The experience taught us that planning and crafting responses takes a longer time in teams than on your own. The extensive effort required was ultimately a good thing. When working alone, you can end up with a result that is identical to your initial plans. In our group, we were constantly developing and refining one another's ideas. It was fascinating just how productive our group meetings were. The time seemed to fly and yet we always got a lot done and managed to help another along the way towards the endpoint of having a substantive policy.

Program

```
for(int i=0;i<5;i++)
  {
    lcd.clear();
    lcd.print("Place Finger");
    delay(2000);
    int result=getFingerprintIDez();
    if(result>=0)
    {
        digitalWrite(openLight, HIGH);
        digitalWrite(closeLight, LOW);
        lcd.clear();
        lcd.print("Allowed");
        lcd.setCursor(0,1);
        lcd.print("Gete Opened   ");
        myServo.write(0);
        delay(5000);
        myServo.write(180);
        digitalWrite(closeLight, HIGH);
        digitalWrite(openLight, LOW);
        lcd.setCursor(0,1);
        lcd.print("Gate Closed   ");
```

Given void *checkKeys()* function is used for checking Enroll or DEL key is pressed or not and what to do if pressed. If the ENROL key pressed the *Enroll()* function is called and DEL key press then *delete()* function is called.

```
void checkKeys()

{

  if(digitalRead(enroll) == 0)

  {

   lcd.clear();

   lcd.print("Please Wait");

   delay(1000);

   while(digitalRead(enroll) == 0);

   Enroll();

  }



  else if(digitalRead(del) == 0)

  {

   lcd.clear();

   lcd.print("Please Wait");

   delay(1000);

   delet();

  }

}
```

Given function is used for entering ID to be deleted and calling uint8_t delete Fingerprint (uint8_t id) function that will delete finger from records.

```
void delet()

{

  int count=0;

  lcd.clear();

  lcd.print("Delete Finger    ");

  lcd.setCursor(0,1);

  lcd.print("Location:");

  while(1)

  {

    lcd.setCursor(9,1);

    lcd.print(count);

    if(digitalRead(up) == 0)

    {

      count++;

      if(count>25)

      count=0;

      delay(500);

    }

.... .....

..... .....
```

Given function is used for delete finger print from the record of selected ID.

```
uint8_t deleteFingerprint(uint8_t id)
```

```
{
 uint8_t p = -1;
 lcd.clear();
 lcd.print("Please wait");
 p = finger.deleteModel(id);
 if (p == FINGERPRINT_OK)
 {
  Serial.println("Deleted!");
  lcd.clear();
  lcd.print("Figer Deleted");
  lcd.setCursor(0,1);
  lcd.print("Successfully");
  delay(1000);
 }

 else
 {
  Serial.print("Something Wrong");
  lcd.clear();
  lcd.print("Something Wrong");
  lcd.setCursor(0,1);
  lcd.print("Try Again Later");
  delay(2000);
```

```
   return p;

  }

}
```

Given Function is used to taking finger print image and convert them into the template and save it by selected ID into the finger print module memory.

```
uint8_t getFingerprintEnroll()

{

  int p = -1;

  lcd.clear();

  lcd.print("finger ID:");

  lcd.print(id);

  lcd.setCursor(0,1);

  lcd.print("Place Finger");

  delay(2000);

  while (p != FINGERPRINT_OK)

  {

    p = finger.getImage();

..... .....

..... .....
```

So that is how we can use **Arduino with Finger Print Reader Module for Security System**.

Code

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(13,12,11,10,9,8);
#include <SoftwareSerial.h>
SoftwareSerial fingerPrint(2, 3);
#include<Servo.h>

Servo myServo;

#include <Adafruit_Fingerprint.h>
uint8_t id;
Adafruit_Fingerprint finger = Adafruit_Fingerprint(&fingerPrint);

#define enroll 14
#define del 15
#define up 16
#define down 17
#define openLight 6
#define closeLight 7
#define servoPin 5

void setup()
{
   delay(1000);
   myServo.attach(servoPin);
   myServo.write(180);
   pinMode(enroll, INPUT_PULLUP);
   pinMode(up, INPUT_PULLUP);
   pinMode(down, INPUT_PULLUP);
   pinMode(del, INPUT_PULLUP);
   pinMode(openLight, OUTPUT);
   pinMode(closeLight, OUTPUT);
   lcd.begin(16,2);
   lcd.print("Security System");
   lcd.setCursor(0,1);
   lcd.print("by Finger Print");
   delay(2000);
   lcd.clear();
   lcd.print("Circuit Digest");
   lcd.setCursor(0,1);
   lcd.print("Saddam Khan");
   delay(2000);
   finger.begin(57600);
   Serial.begin(9600);
   lcd.clear();
   lcd.print("Finding Module");
   lcd.setCursor(0,1);
   delay(1000);
   if (finger.verifyPassword())
   {
     Serial.println("Found fingerprint sensor!");
     lcd.clear();
     lcd.print("Found Module ");
     delay(1000);
   }
```

```
    else
    {
    Serial.println("Did not find fingerprint sensor :(");
    lcd.clear();
    lcd.print("module not Found");
    lcd.setCursor(0,1);
    lcd.print("Check Connections");
    while (1);
    }
}

void loop()
{
 lcd.setCursor(0,0);
 lcd.print("Press UP/Down ");
 lcd.setCursor(0,1);
 lcd.print("to start System");
 digitalWrite(closeLight, HIGH);
 if(digitalRead(up)==0 || digitalRead(down)==0)
 {
  for(int i=0;i<5;i++)
  {
    lcd.clear();
    lcd.print("Place Finger");
    delay(2000);
    int result=getFingerprintIDez();
    if(result>=0)
    {
        digitalWrite(openLight, HIGH);
        digitalWrite(closeLight, LOW);
        lcd.clear();
        lcd.print("Allowed");
        lcd.setCursor(0,1);
        lcd.print("Gete Opened   ");
        myServo.write(0);
        delay(5000);
        myServo.write(180);
        digitalWrite(closeLight, HIGH);
        digitalWrite(openLight, LOW);
        lcd.setCursor(0,1);
        lcd.print("Gate Closed   ");
        return;
     }
   }
 }
 checkKeys();
 delay(1000);
}

void checkKeys()
{
   if(digitalRead(enroll) == 0)
   {
    lcd.clear();
```

```
    lcd.print("Please Wait");
    delay(1000);
    while(digitalRead(enroll) == 0);
    Enroll();
   }

   else if(digitalRead(del) == 0)
   {
    lcd.clear();
    lcd.print("Please Wait");
    delay(1000);
    delet();
   }
}

void Enroll()
{
   int count=0;
   lcd.clear();
   lcd.print("Enroll Finger    ");
   lcd.setCursor(0,1);
   lcd.print("Location:");
   while(1)
   {
     lcd.setCursor(9,1);
     lcd.print(count);
     if(digitalRead(up) == 0)
     {
       count++;
       if(count>25)
       count=0;
       delay(500);
     }

     else if(digitalRead(down) == 0)
     {
       count--;
       if(count<0)
       count=25;
       delay(500);
     }
     else if(digitalRead(del) == 0)
     {
         id=count;
         getFingerprintEnroll();
         return;
     }

       else if(digitalRead(enroll) == 0)
     {
         return;
     }
 }
}
```

```
void delet()
{
  int count=0;
  lcd.clear();
  lcd.print("Delete Finger    ");
  lcd.setCursor(0,1);
  lcd.print("Location:");
  while(1)
  {
    lcd.setCursor(9,1);
    lcd.print(count);
    if(digitalRead(up) == 0)
    {
      count++;
      if(count>25)
      count=0;
      delay(500);
    }

    else if(digitalRead(down) == 0)
    {
      count--;
      if(count<0)
      count=25;
      delay(500);
    }
    else if(digitalRead(del) == 0)
    {
        id=count;
        deleteFingerprint(id);
        return;
    }

     else if(digitalRead(enroll) == 0)
    {
        return;
    }
 }
}

uint8_t getFingerprintEnroll()
{
 int p = -1;
 lcd.clear();
 lcd.print("finger ID:");
 lcd.print(id);
 lcd.setCursor(0,1);
 lcd.print("Place Finger");
 delay(2000);
 while (p != FINGERPRINT_OK)
 {
   p = finger.getImage();
   switch (p)
   {
```

```
  case FINGERPRINT_OK:
    Serial.println("Image taken");
    lcd.clear();
    lcd.print("Image taken");
    break;
  case FINGERPRINT_NOFINGER:
    Serial.println("No Finger");
    lcd.clear();
    lcd.print("No Finger");
    break;
  case FINGERPRINT_PACKETRECIEVEERR:
    Serial.println("Communication error");
    lcd.clear();
    lcd.print("Comm Error");
    break;
  case FINGERPRINT_IMAGEFAIL:
    Serial.println("Imaging error");
    lcd.clear();
    lcd.print("Imaging Error");
    break;
  default:
    Serial.println("Unknown error");
     lcd.clear();
    lcd.print("Unknown Error");
    break;
  }
}

// OK success!

p = finger.image2Tz(1);
switch (p) {
  case FINGERPRINT_OK:
    Serial.println("Image converted");
    lcd.clear();
    lcd.print("Image converted");
    break;
  case FINGERPRINT_IMAGEMESS:
    Serial.println("Image too messy");
     lcd.clear();
     lcd.print("Image too messy");
    return p;
  case FINGERPRINT_PACKETRECIEVEERR:
    Serial.println("Communication error");
    lcd.clear();
    lcd.print("Comm Error");
    return p;
  case FINGERPRINT_FEATUREFAIL:
    Serial.println("Could not find fingerprint features");
    lcd.clear();
    lcd.print("Feature Not Found");
    return p;
  case FINGERPRINT_INVALIDIMAGE:
    Serial.println("Could not find fingerprint features");
```

```
    lcd.clear();
    lcd.print("Feature Not Found");
    return p;
  default:
    Serial.println("Unknown error");
    lcd.clear();
    lcd.print("Unknown Error");
    return p;
 }

 Serial.println("Remove finger");
 lcd.clear();
 lcd.print("Remove Finger");
 delay(2000);
 p = 0;
 while (p != FINGERPRINT_NOFINGER) {
   p = finger.getImage();
 }
 Serial.print("ID "); Serial.println(id);
 p = -1;
 Serial.println("Place same finger again");
  lcd.clear();
    lcd.print("Place Finger");
    lcd.setCursor(0,1);
    lcd.print("    Again");
 while (p != FINGERPRINT_OK) {
   p = finger.getImage();
   switch (p) {
   case FINGERPRINT_OK:
     Serial.println("Image taken");
     break;
   case FINGERPRINT_NOFINGER:
     Serial.print(".");
     break;
   case FINGERPRINT_PACKETRECIEVEERR:
     Serial.println("Communication error");
     break;
   case FINGERPRINT_IMAGEFAIL:
     Serial.println("Imaging error");
     break;
   default:
     Serial.println("Unknown error");
     return;
   }
 }
```

```
// OK success!

 p = finger.image2Tz(2);
 switch (p) {
   case FINGERPRINT_OK:
     Serial.println("Image converted");
     break;
   case FINGERPRINT_IMAGEMESS:
```

```
    Serial.println("Image too messy");
    return p;
  case FINGERPRINT_PACKETRECIEVEERR:
    Serial.println("Communication error");
    return p;
  case FINGERPRINT_FEATUREFAIL:
    Serial.println("Could not find fingerprint features");
    return p;
  case FINGERPRINT_INVALIDIMAGE:
    Serial.println("Could not find fingerprint features");
    return p;
  default:
    Serial.println("Unknown error");
    return p;
}

// OK converted!
Serial.print("Creating model for #");  Serial.println(id);

p = finger.createModel();
if (p == FINGERPRINT_OK) {
  Serial.println("Prints matched!");
} else if (p == FINGERPRINT_PACKETRECIEVEERR) {
  Serial.println("Communication error");
  return p;
} else if (p == FINGERPRINT_ENROLLMISMATCH) {
  Serial.println("Fingerprints did not match");
  return p;
} else {
  Serial.println("Unknown error");
  return p;
}

Serial.print("ID "); Serial.println(id);
p = finger.storeModel(id);
if (p == FINGERPRINT_OK) {
  Serial.println("Stored!");
  lcd.clear();
  lcd.print("Stored!");
  delay(2000);
} else if (p == FINGERPRINT_PACKETRECIEVEERR) {
  Serial.println("Communication error");
  return p;
} else if (p == FINGERPRINT_BADLOCATION) {
  Serial.println("Could not store in that location");
  return p;
} else if (p == FINGERPRINT_FLASHERR) {
  Serial.println("Error writing to flash");
  return p;
}
else {
  Serial.println("Unknown error");
  return p;
```

```
  }
}

int getFingerprintIDez()
{
  uint8_t p = finger.getImage();

  if (p != FINGERPRINT_OK)
  return -1;

  p = finger.image2Tz();
  if (p != FINGERPRINT_OK)
  return -1;

  p = finger.fingerFastSearch();
  if (p != FINGERPRINT_OK)
  {
   lcd.clear();
   lcd.print("Finger Not Found");
   lcd.setCursor(0,1);
   lcd.print("Try Later");
   delay(2000);
  return -1;
  }
  // found a match!
  Serial.print("Found ID #");
  Serial.print(finger.fingerID);
  return finger.fingerID;
}

uint8_t deleteFingerprint(uint8_t id)
{
  uint8_t p = -1;
  lcd.clear();
  lcd.print("Please wait");
  p = finger.deleteModel(id);
  if (p == FINGERPRINT_OK)
  {
    Serial.println("Deleted!");
    lcd.clear();
    lcd.print("Figer Deleted");
    lcd.setCursor(0,1);
    lcd.print("Successfully");
    delay(1000);
  }

  else
  {
    Serial.print("Something Wrong");
    lcd.clear();
    lcd.print("Something Wrong");
    lcd.setCursor(0,1);
    lcd.print("Try Again Later");
    delay(2000);
```

```
    return p;
  }
}
```

\

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