BIOMETRIC SAFE SYSTEM USING VOICE AND FINGERPRINT

Submitted in fulfilment for the J-Component of CSE3009 – Internet of Things

Project by:

BATCH ID- O15

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DECLARATION

I hereby declare that the report entitled "Biometric Safe System using Voice and Fingerprint" submitted by us, for the CSE3009 Internet of Things (EPJ) to Vellore Institute of Technology is a record of bonafide work carried out by me under the supervision of Dr. DEEPA K.

I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for any other courses in this institute or any other institute or university.

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ACKNOWLEDGEMENT

With due regards, we would like to thank our faculty Prof. DEEPA K. for constantly supporting us in making our project work. Without her much needed support, it would have been impossible for us to carry out our work. Her guidance laid the foundation of our project.

At last, we would also like to thank VIT University for providing us the proper ambience to carry out our project work successfully. We even learned to carry out a project in a group by dividing the workload.

CONTENTS

1. ABSTRACT

A smart safe system is required for securing precious assets as it is difficult to secure valuable belongings and accessories with efficient and well-structured security. If we analyse the existing securing locking systems, they mainly consist of password-based systems. The security systems or lockers using single or less than two traits have greater threats of theft and can be easily broken into. Therefore, it is important to raise the security of the locker system by increasing the layers. The prime focus of our project is to ensure a multi-level system that is cost-efficient and contains a biometric security system as biometric traits are specific to individuals and cannot be copied easily. Arduino UNO is used as the main device which is to be installed near the lock. Sensors including a voice sensor and fingerprint sensor are interfaced to make the system coherent. Our prototype brings together the biometric trait of voice recognition and fingerprint recognition together as a two-layer security system; all in a sequential order providing security to the best of their capabilities.

2. INTRODUCTION

When it comes to security systems, it is one of the most pressing worries in today's fast-paced society, when humans are unable to manually secure their personal possessions. Instead, they seek out an alternative solution that is both better and more dependable. Safes are typically used to hold highly private information, valuable items, or huge sums of money. We typically see password or fingerprint identifying approaches among common safe lock system methods. It is, however, relatively simple to crack a password or transfer a person's fingerprint from one surface to another. Because of the dangers, it's critical to have a better security mechanism for accessing safes. Biometric recognition technologies are more secure and convenient than traditional recognition methods. Fingerprints combined with a personal code form a multi-layered biometric security system. For door opening and closing, this system centres on the usage of code phrases and fingerprints. Users can be enrolled and validated via a database using the speech recognition module. The fingerprint recognition software allows valid users of the safe to have their fingerprints stored in a database. Before any user may open the safe, their code word and fingerprint image are compared to the code word and fingerprint pairs in the databases, with users who do not have a match in the

database being denied access. The data equivalent of a user's code word and fingerprint is stored in a microcontroller. The microcontroller makes a comparison between the enrolled data and the data of the individual going to use the safe.

3. LITERATURE SURVEY

PAPER TITLE	JOURNAL AND YEAR	AUTHOR	DESCRIPTION
Security Lock with Effective Verification Traits	ResearchGate, 2019	Syed Umaid Ahmed, Arbaz Sabir, Talha Ashraf, Usama Ashraf	This research paper explains five levels of security include entering of password on interactive GUI, thumbprint, facial recognition, speech pattern recognition, and vein pattern recognition. This project is unique and effective in a sense that it incorporates five levels of security in a single prototypeThe system comprises of two segments, first one to process signals which is received by a microphone and second segment is to interpret the processed signal. System recognizes voice commands and converts them to desired data coordination and data transmission via microcontroller (Arduino Uno).
Smart Door Lock System with	Researchgate, 2019	Piash Paul, Md. Abdullah Al	This research paper focuses on using our

Fingerprint Interface		Achib, Hazrat Sauda Hossain, Md. Kaviul Hossain	fingerprints as the locking system. The method proposed in this paper uses 2 Atmega328p microcontroller along with R307 Optical Fingerprint Reader Sensor Module. The system gives user 5 tries to unlock the door if no correct fingerprint is given in those 5 tries then an alarm is sounded and the owner is notified about it. This paper has also compared and studied pros and cons of various locking mechanisms like key and lock, biometric lock etc. this research paper focuses on fingerprint locking system because of the fact that the fingerprint of person remains same from birth till death and cannot be duplicated easily.
Smart Door Lock System	International Journal for Modern Trends in Science and Technology 2019	Shashidhar Rudregowda	Here, they use fingerprint sensor, GSM module and arduino. The fingerprints of authorized person are previously stored in Arduino, by using matching algorithm they check whether if the person is authorized or not. If the person is

			authorized, OTP (One Time Password) is sent to that authorized person's mobile number using GSM. If the fingerprint does not match with previously stored fingerprints the he is unauthorized person so OTP will not sent to his mobile number instead buzzer will turn on indicating that someone is trying to access the door.
Smart Door Lock Design using Voice Recognition based on RASPBERRY PI 3	CERITA, 2018	Diah Aryani , Dedy Iskandar, Fitri Indriyani	Voice recognition is divided into 2 parts namely speech recognition and speaker recognition. The design of this tool is made using Raspberry pi 3 as the processing center and ULN2803 as ic to increase the voltage so that it can move the solenoid that serves to move the doorlock. Then raspberry gives command to the servo motor to open the door. Thus, the design of smart door lock tool using voice recognition raspberry-based pi 3 provides a level of security and access more computerized.
Design and Implementation of a Fingerprint Based	IEEE, 2017	Jayasree Baidya, Trina Saha, Ryad Moyashir,	This research paper focuses on a multi-locking

Lock System for Shared Access		Rajesh Palit	system that uses fingerprint as well as a 4-digit password. The proposed system uses arduino uno, fingerprint scanner and a matrix keypad mainly. The system gives user 2 tries for entering the correct passcode otherwise the owner is reported about wrong entries. The paper also explain various types of locking systems. This paper also discusses the challenges and limitations of this system as well as the improvements that can be done.
Biometric Voice Recognition in Security System	Indian Journal of Science and Technology, 2014	H.N.M. Shah, Ab Rashid, M.Z., Abdollah, MohdFairus, Kamarudin, Muhammad Nizam, C.K. Lin, and Z. Kamis	MATLAB software is used for the voice recognition part while the ARDUINO software focus on the communication system part such as control the LED indicator switch, LCD screen display and the on/off of the magnet door. The voice recognition algorithm is developed by using MFCC. During a speaker uttered speech, his/her voice will produce a waveform and known as voice pattern. If the voice input is accepted and

			the systems determine as the admin user, then Arduino Uno there will activate the LCD display to display "WELCOME HOME, SIR", green LED indicator will turn on, and the magnet door lock will open. IF the voice is rejected, the door remains closed.
Intelligent Voice-Based Door Access Control System Using Adaptive-Network-based Fuzzy Inference Systems (ANFIS) for Building Security	Journal of Computer Science, 2007	Wahyudi, W. Astuti, and S. Mohamed	Consists of three main components:voice sensor, speaker verification system and door access control. A microphone is used as voice sensor to record the person voice. The recorded voice is then sent to the voice-based verification system which will verify the authenticity of the person based on their voice. A PC equipped with sound card is used for speaker verification implementation. The sound card records the voice data based on the sampling frequency of 22 kHz. In this system, all of the voice data processing and speaker verification algorithms are implemented in PC.Equal-loudness

			pre-emphasis, intensity-loudness power conversion, inverse discrete Fourier transform, all-pole coefficients are applied.

4. OBJECTIVE

A smart safe system is required for securing precious assets as it is difficult to secure valuable belongings and accessories with efficient and well-structured security. If we analyze the existing securing locking systems, they mainly consist of password-based systems. The security systems or lockers using single or less than two traits have greater threats of theft and can be easily broken into. Therefore, it is important to raise the security of the locker system by increasing the layers. The prime focus of our project is to ensure a multi-level system that is cost-efficient and contains a biometric security system as biometric traits are specific to individuals and cannot be copied easily. Arduino UNO is used as the main device which is to be installed near the lock. Sensors including a voice sensor and fingerprint sensor are interfaced to make the system coherent. Our prototype brings together the biometric trait of voice recognition and fingerprint recognition together as a two-layer security system; all in a sequential order providing security to the best of their capabilities.

5. PROPOSED WORK

5.1 METHODOLOGY:

This project deals with a Biometric Voice detection Safe System. It consists of the following modules: Voice Recognition Sensor, Biometric Sensor, Arduino UNO, and LCD Display.

On connecting the power supply with the circuit, firstly 3 options will be stated to the user. They include:

SET- Where they can enter the data, which should be stored in the database and will be used

to compare with the other sample data. This is the initial step if the user is new to this system or wants to be a new member of the already existing user.

OPEN- This is selected if the member is already registered and is interested to open the safe by providing the codeword and fingerprint.

RESET- When the user wants to delete the code word or the fingerprint this option is picked. Usually in case of privacy issues or transfer of safe from one person to another.

TWO LAYERS:

i. Voice Recognition –

Includes two-phase which are the training phase and the testing phase. In the training phase, the codeword along with that person's voice is fed to the system which is user-specific and stored. Later, in the testing phase, the same process is repeated where a person tries to open the safe using the code word. If the codeword and the frequency of that person's voice match with the already existing data the safe will be directed to the next step.

ii. Biometric Authentication –

The biometric recognition process involves three steps: acquisition, feature extraction, and comparison.

First, biometric characteristics are acquired through measurements. A sensor, here fingerprint detection sensor, captures the specific characteristics of a subject and creates a digital representation.

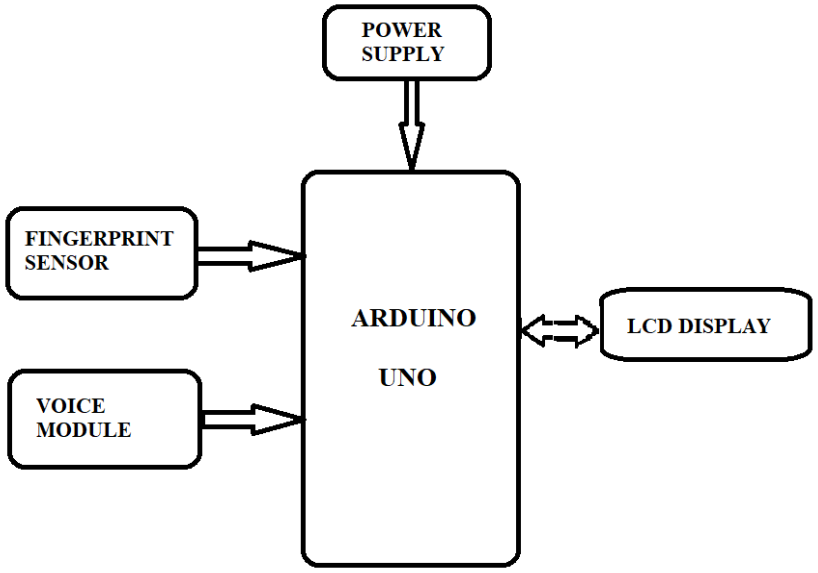
Feature extraction is a mathematical transformation that extracts distinguishing and reproducible data from the sample. A template is a set of these features which is compared directly with biometric features from other samples. The enrolment process stores one or more biometric samples or templates in a database and attributes them to a subject. This reference data can then be used for comparison in future identification or verification processes.

The final step is to compare an individual's biometric characteristics against the biometric references of one or more individuals. This process produces a score that indicates the similarity (a value close to, but rarely, one) or dissimilarity (a value close to zero) of two

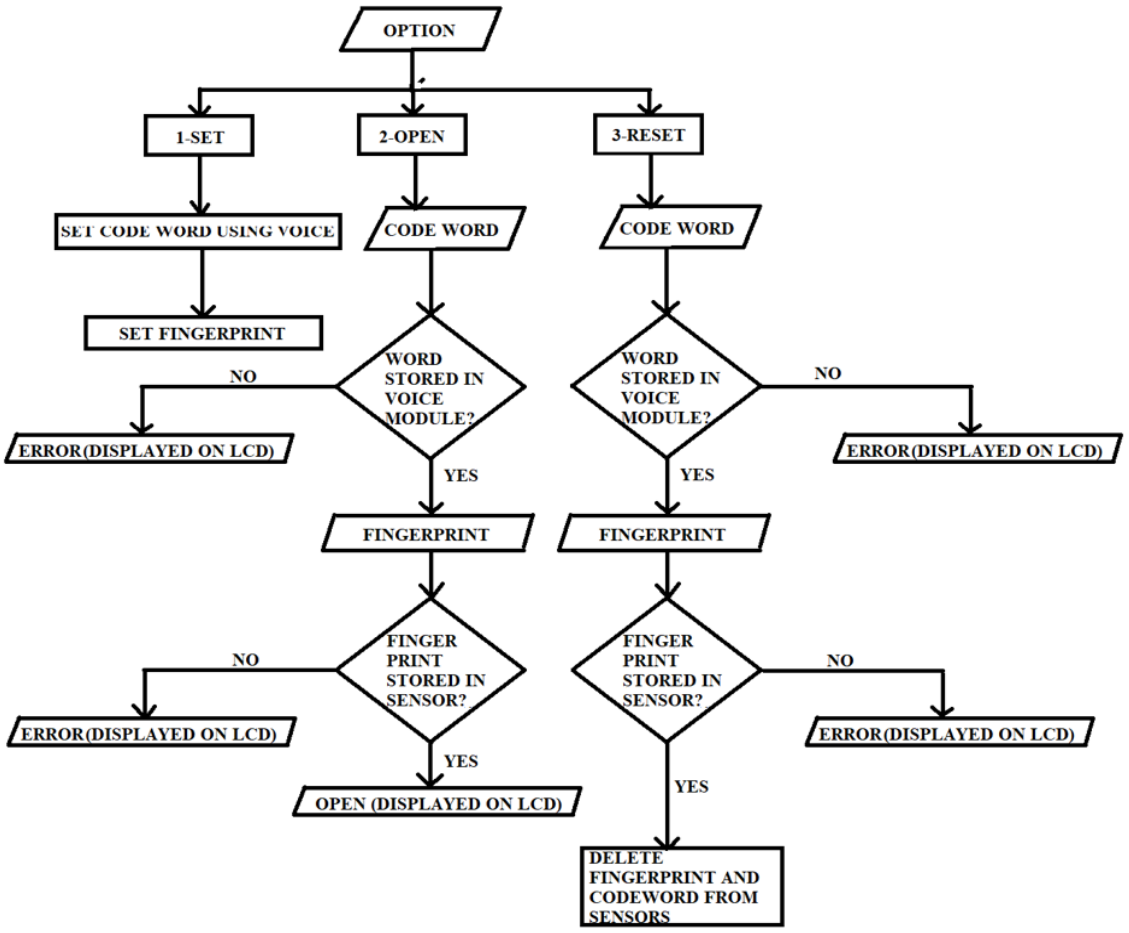
samples. Only by comparison can the recognition system decide if a presented sample matches a stored reference.

Thus, only if the similarity is one, the safe open with a message on the LCD screen. The ARDUINO software focuses on the communication system part such as LCD screen display.

5.2 ARCHITECTURAL DIAGRAM:



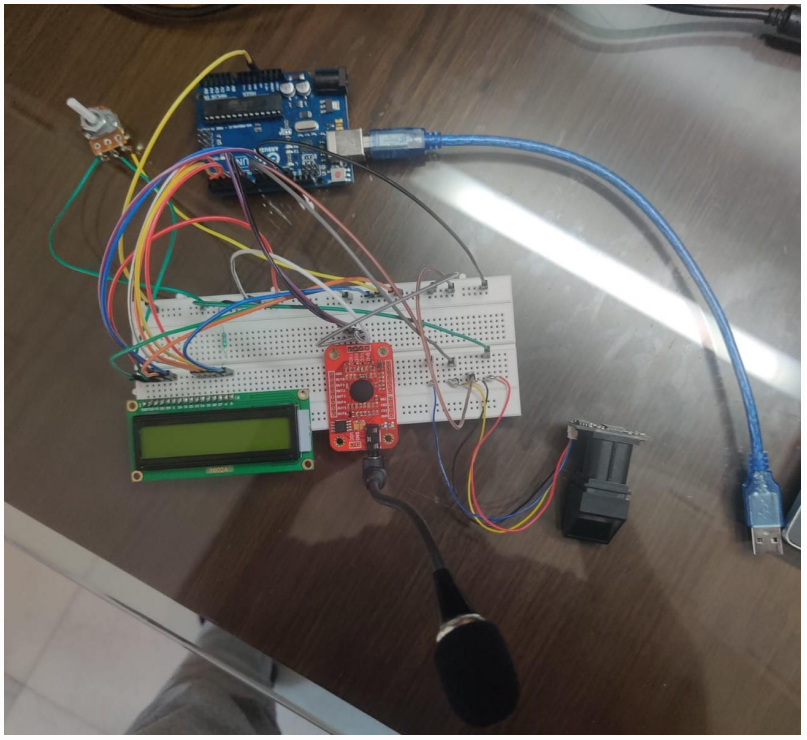
5.3 FLOWCHART:



5.4 COMPONENTS:

1. **Arduino UNO** - Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button.
2. **Voice Recognition Sensor V3** - Speak (Voice) Recognition Module V3 compatible with Arduino is a compact and easy-control speaking recognition board. Speak (Voice) Recognition Module V3 product is a speaker-dependent voice recognition module. It supports up to 80 voice commands in all. Max 7 voice commands could work at the same time. Any sound could be trained as the command.
3. **R305 Red Digital Persona Fingerprint Recognition Sensors** - The R305 Fingerprint Identification Module Fingerprint Lock Optical Development Board is ALL-in-One Fingerprint reader can lead optional advancement can be installed into an assortment of final results Smart low power utilization, compact size, efficient execution Proficient optical scanning, module fabrication using best methods Great image handling abilities, can effectively catch picture up to resolution 500 dpi.
4. **LCD** - Easy interface a liquid crystal display (LCD) with an Arduino to provide a user interface. Liquid crystal displays (LCDs) are commonly used to display data in devices.
5. **Breadboard** - Breadboard is a way of constructing electronics without having to use a soldering iron. Components are pushed into the sockets on the breadboard and then extra 'jumper' wires are used to make connections.

5.5 CIRCUIT



6. IMPLEMENTATION

6.1 CODE

Code for Training Voice Recognition V3

Inbuilt Code of Voice Recognition library is used to train the Voice Recognition V3 for the code word used later for verification

Code that is uploaded on Arduino Uno to run our Safe System:

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IOT

```
#include <Adafruit_Fingerprint.h>
#include <LiquidCrystal.h>
#include <SoftwareSerial.h>
#include "VoiceRecognitionV3.h"

#if (defined(__AVR__) || defined(ESP8266)) && !defined(__AVR_ATmega2560__)
SoftwareSerial myserial(10,9);

#else
#define myserial Serial1

#endif

Adafruit_Fingerprint finger = Adafruit_Fingerprint(&myserial);
uint8_t id;

VR myVR(6,7);    // 6:RX 7:TX, you can choose your favourite pins.

uint8_t records[7]; // save record //default
uint8_t buf[64];

#define codeword    (20)

LiquidCrystal lcd(12,11,5,4,3,2);


void printSignature(uint8_t *buf, int len)
{
  int i;
  for(i=0; i<len; i++)
  {
    if(buf[i]>0x19 && buf[i]<0x7F)
    {
```

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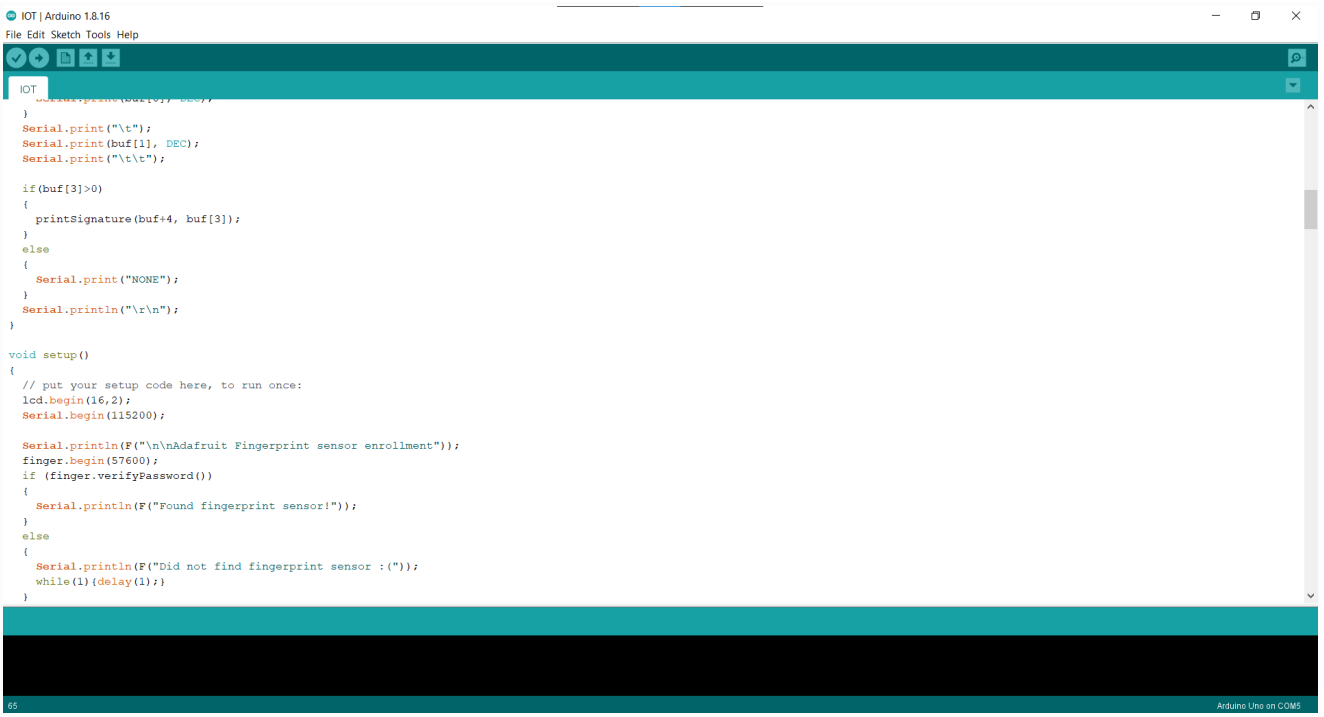
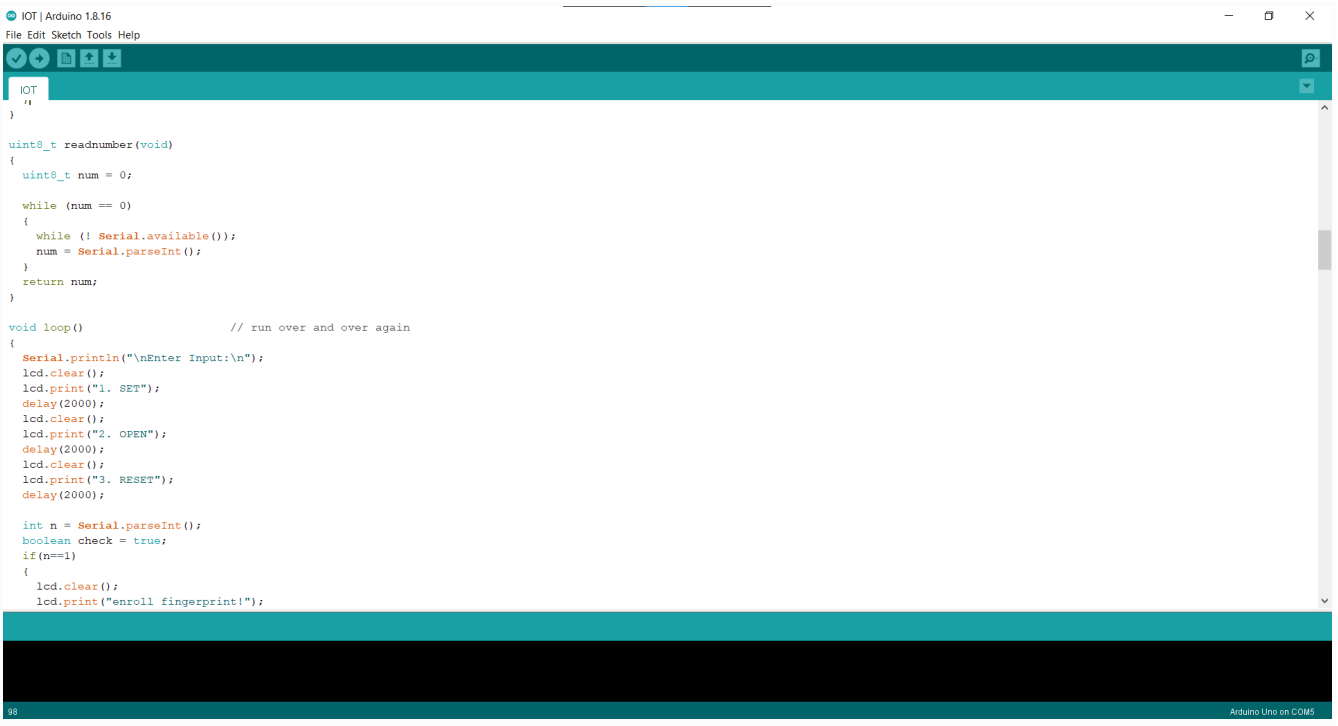
IOT

```
    {
      Serial.write(buf[i]);
    }
    else
    {
      Serial.print("[");
      Serial.print(buf[i], HEX);
      Serial.print("]");
    }
  }
}


void printVR(uint8_t *buf)
{
  Serial.println("VR Index\tGroup\tRecordNum\tSignature");

  Serial.print(buf[2], DEC);
  Serial.print("\t\t");

  if(buf[0] == 0xFF)
  {
    Serial.print("NONE");
  }
  else if(buf[0]&0x80)
  {
    Serial.print("UG ");
    Serial.print(buf[0]&(~0x80), DEC);
  }
  else
  {
    Serial.print("SG ");
    Serial.print(buf[0], DEC);
```

65 Arduino Uno on COM5


IOT | Arduino 1.8.16
File Edit Sketch Tools Help
IOT
}
Serial.print("\t");
Serial.print(buf[1], DEC);
Serial.print("\t\t");
if(buf[3]>0)
{
printSignature(buf+4, buf[3]);
}
else
{
Serial.print("NONE");
}
Serial.println("\r\n");
}
void setup()
{
// put your setup code here, to run once:
lcd.begin(16,2);
Serial.begin(115200);
Serial.println(F("\n\nAdafruit Fingerprint sensor enrollment"));
finger.begin(57600);
if (finger.verifyPassword())
{
Serial.println(F("Found fingerprint sensor!"));
}
else
{
Serial.println(F("Did not find fingerprint sensor :("));
while(1){delay(1);}
}
65
Arduino Uno on COM5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File Edit Sketch Tools Help
IOT
}
uint8_t readnumber(void)
{
uint8_t num = 0;
while (num == 0)
{
while (! Serial.available());
num = Serial.parseInt();
}
return num;
}
void loop()
// run over and over again
{
Serial.println("\nEnter Input:\n");
lcd.clear();
lcd.print("1. SET");
delay(2000);
lcd.clear();
lcd.print("2. OPEN");
delay(2000);
lcd.clear();
lcd.print("3. RESET");
delay(2000);
int n = Serial.parseInt();
boolean check = true;
if(n==1)
{
lcd.clear();
lcd.print("enroll fingerprint!");
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Arduino Uno on COM5

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IOT

```
    Serial.println(F("Please type in the ID # (from 1 to 127) you want to save this finger as..."));
    id = readnumber();
    if (id == 0)
    {// ID #0 not allowed, try again!
      return;
    }
    Serial.print(F("Enrolling ID #"));
    Serial.println(id);

    while(!getFingerprintEnroll());
    lcd.clear();
    lcd.print("Fingerprint stored");
    delay(5000);

    lcd.clear();
    lcd.print("Store Voice");
    delay(4000);
  }
  else if (n==2)
  {
    lcd.clear();
    lcd.print("Fingerprint verification");
    finger.getTemplateCount();
    Serial.print(F("Sensor contains ")); Serial.print(finger.templateCount); Serial.println(F(" templates"));
    Serial.println(F("Waiting for valid finger..."));
    while(!getFingerprintIDez());

    myVR.begin(9600);
    Serial.println(F("\nElechouse Voice Recognition V3 Module\r\nIOT Safe System Project"));
    if(myVR.clear()==0)
    {
      Serial.println(F("Recognizer cleared."));
    }
```

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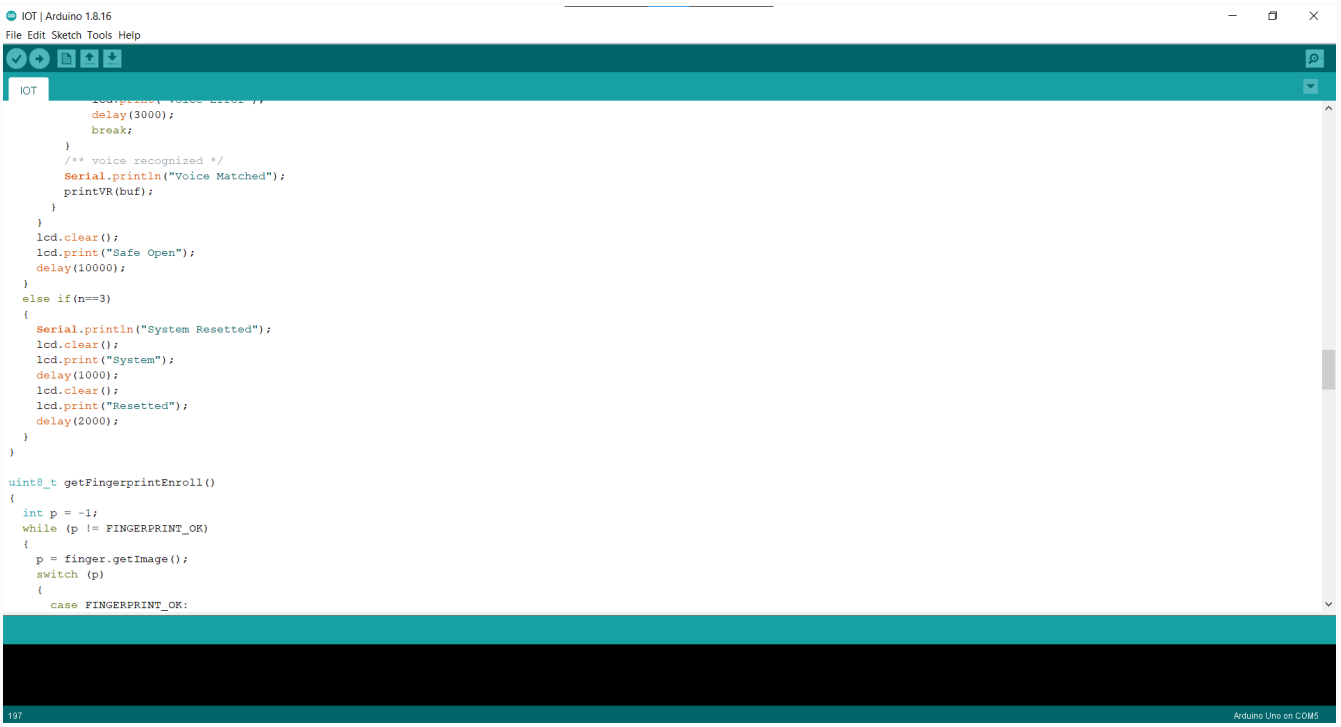
IOT

```
    "
    else
    {
      Serial.println(F("Not find VoiceRecognitionModule."));
      Serial.println(F("Please check connection and restart Arduino."));
      while(1);
    }
    if(myVR.load((uint8_t)codeword)>=0)
    {
      Serial.println(F("Codeword Loaded"));
    }

    Serial.println(F("\nWaiting for valid voice command..."));
    lcd.clear();
    lcd.print("Voice Verification");
    while(check)
    {
      //delay(100);
      int ret;
      ret = myVR.recognize(buf, 50);

      if(ret>0)
      {
        switch(buf[1])
        {
          case codeword:
            lcd.clear();
            lcd.print("Voice Matched");
            delay(5000);
            check = false;
            break;
          default:
            lcd.clear();
            lcd.print("Voice Error");
```

164 Arduino Uno on COM5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File Edit Sketch Tools Help
IOT
delay(3000);
break;
}
/** voice recognized */
Serial.println("Voice Matched");
printVR(buf);
}
}
lcd.clear();
lcd.print("Safe Open");
delay(10000);
}
else if(n==3)
{
Serial.println("System Resetted");
lcd.clear();
lcd.print("System");
delay(1000);
lcd.clear();
lcd.print("Resetted");
delay(2000);
}
}
uint8_t getFingerprintEnroll()
{
int p = -1;
while (p != FINGERPRINT_OK)
{
p = finger.getImage();
switch (p)
{
case FINGERPRINT_OK:
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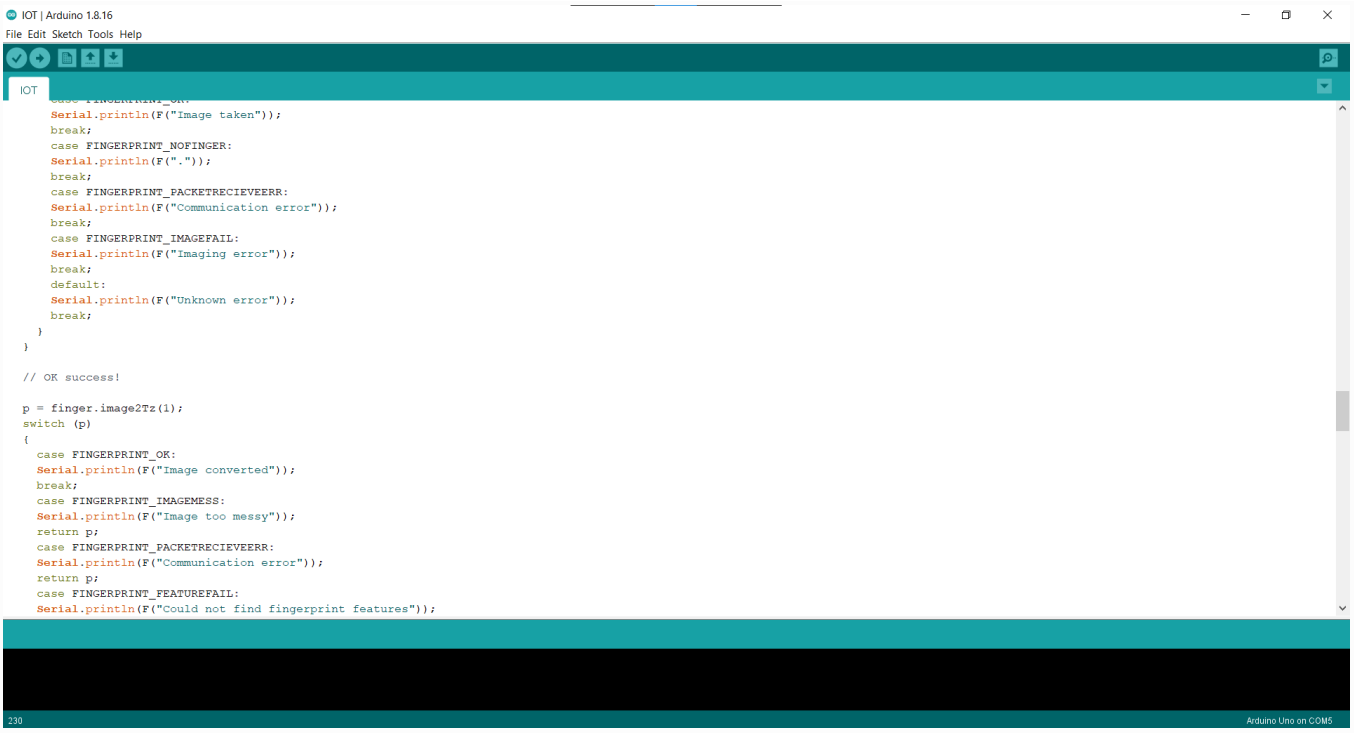
Arduino Uno on COM5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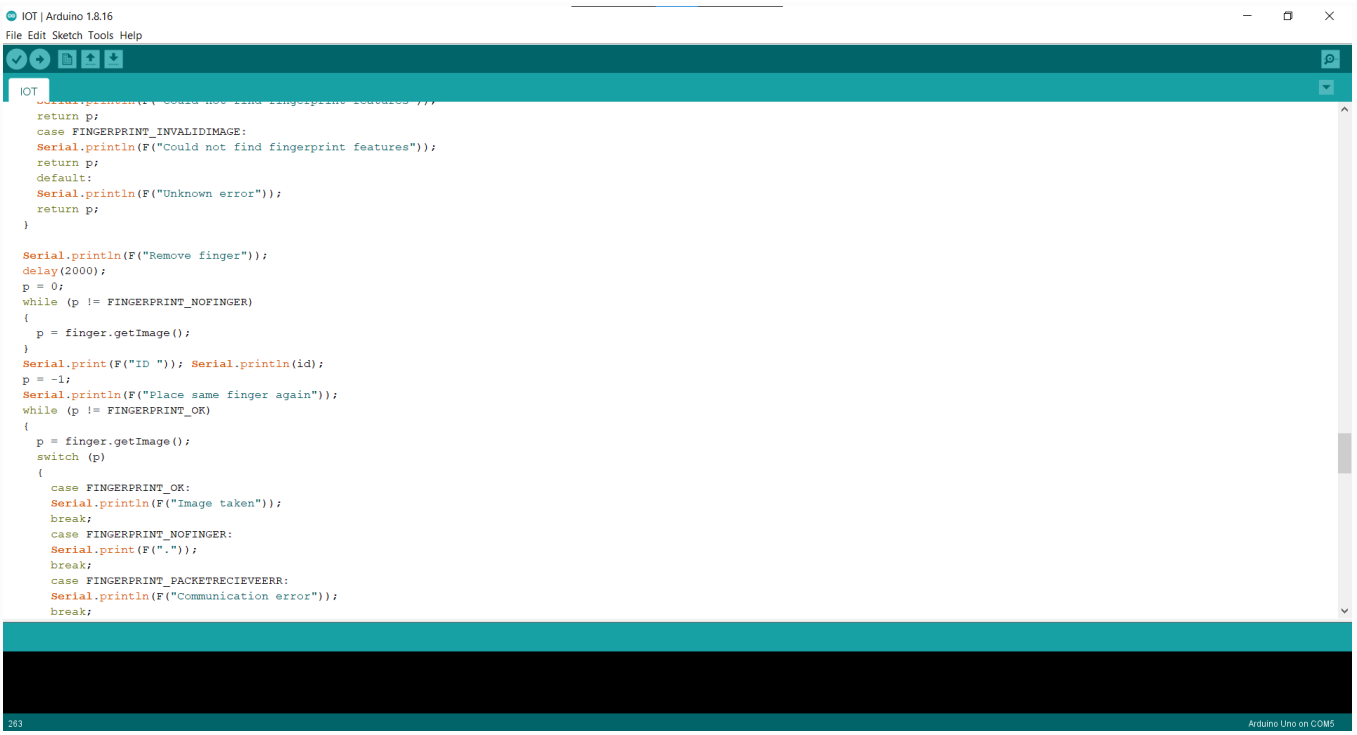
File Edit Sketch Tools Help
IOT
Serial.println(F("Image taken"));
break;
case FINGERPRINT_NOFINGER:
Serial.println(F("."));
break;
case FINGERPRINT_PACKETRECIEVEERR:
Serial.println(F("Communication error"));
break;
case FINGERPRINT_IMAGEFAIL:
Serial.println(F("Imaging error"));
break;
default:
Serial.println(F("Unknown error"));
break;
}
}
// OK success!
p = finger.image2Tz(1);
switch (p)
{
case FINGERPRINT_OK:
Serial.println(F("Image converted"));
break;
case FINGERPRINT_IMAGEMESS:
Serial.println(F("Image too messy"));
return p;
case FINGERPRINT_PACKETRECIEVEERR:
Serial.println(F("Communication error"));
return p;
case FINGERPRINT_FEATUREFAIL:
Serial.println(F("Could not find fingerprint features"));
230
Arduino Uno on COM5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File Edit Sketch Tools Help
IOT
return p;
case FINGERPRINT_INVALIDIMAGE:
Serial.println(F("Could not find fingerprint features"));
return p;
default:
Serial.println(F("Unknown error"));
return p;
}
Serial.println(F("Remove finger"));
delay(2000);
p = 0;
while (p != FINGERPRINT_NOFINGER)
{
p = finger.getImage();
}
Serial.print(F("ID ")); Serial.println(id);
p = -1;
Serial.println(F("Place same finger again"));
while (p != FINGERPRINT_OK)
{
p = finger.getImage();
switch (p)
{
case FINGERPRINT_OK:
Serial.println(F("Image taken"));
break;
case FINGERPRINT_NOFINGER:
Serial.print(F("."));
break;
case FINGERPRINT_PACKETRECIEVEERR:
Serial.println(F("Communication error"));
break;
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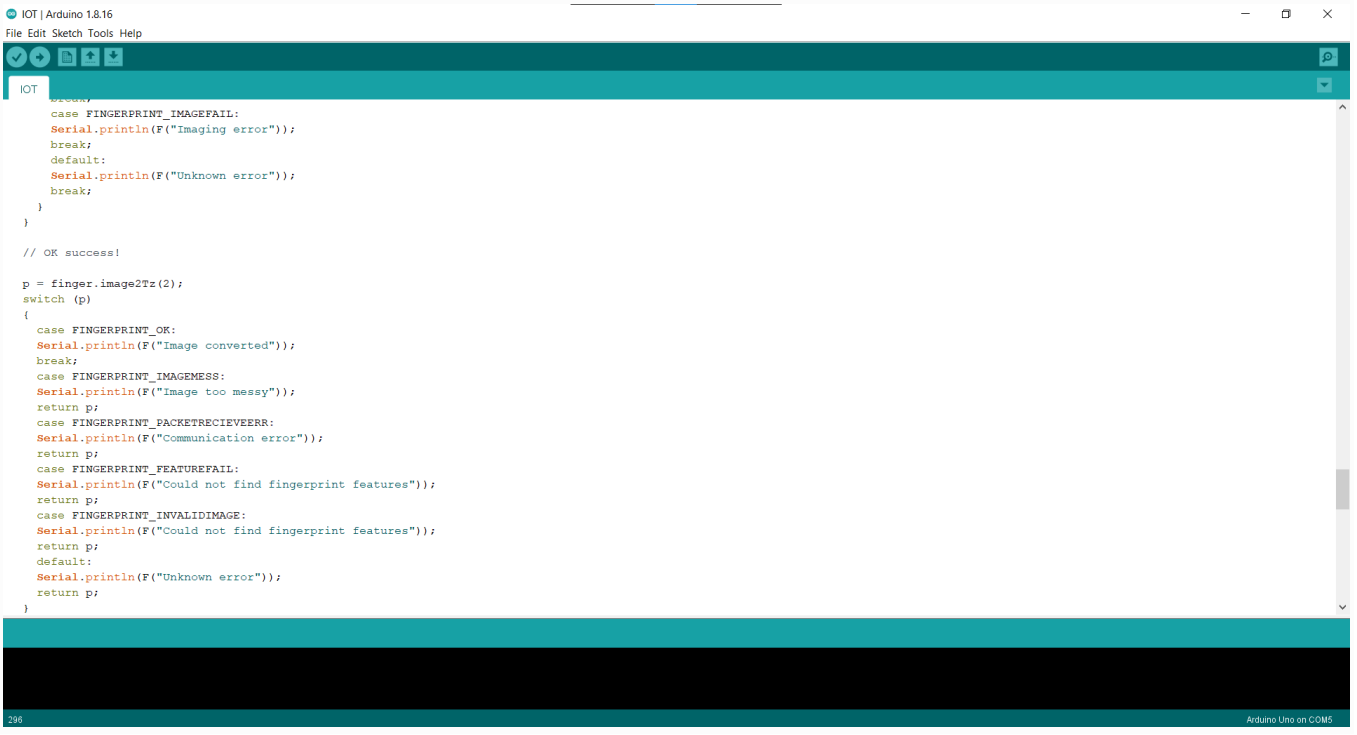
Arduino Uno on COM5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File Edit Sketch Tools Help
IOT
case FINGERPRINT_IMAGEFAIL:
Serial.println(F("Imaging error"));
break;
default:
Serial.println(F("Unknown error"));
break;
}
}
// OK success!
p = finger.image2Tz(2);
switch (p)
{
case FINGERPRINT_OK:
Serial.println(F("Image converted"));
break;
case FINGERPRINT_IMAGEMESS:
Serial.println(F("Image too messy"));
return p;
case FINGERPRINT_PACKETRECIEVEERR:
Serial.println(F("Communication error"));
return p;
case FINGERPRINT_FEATUREFAIL:
Serial.println(F("Could not find fingerprint features"));
return p;
case FINGERPRINT_INVALIDIMAGE:
Serial.println(F("Could not find fingerprint features"));
return p;
default:
Serial.println(F("Unknown error"));
return p;
}
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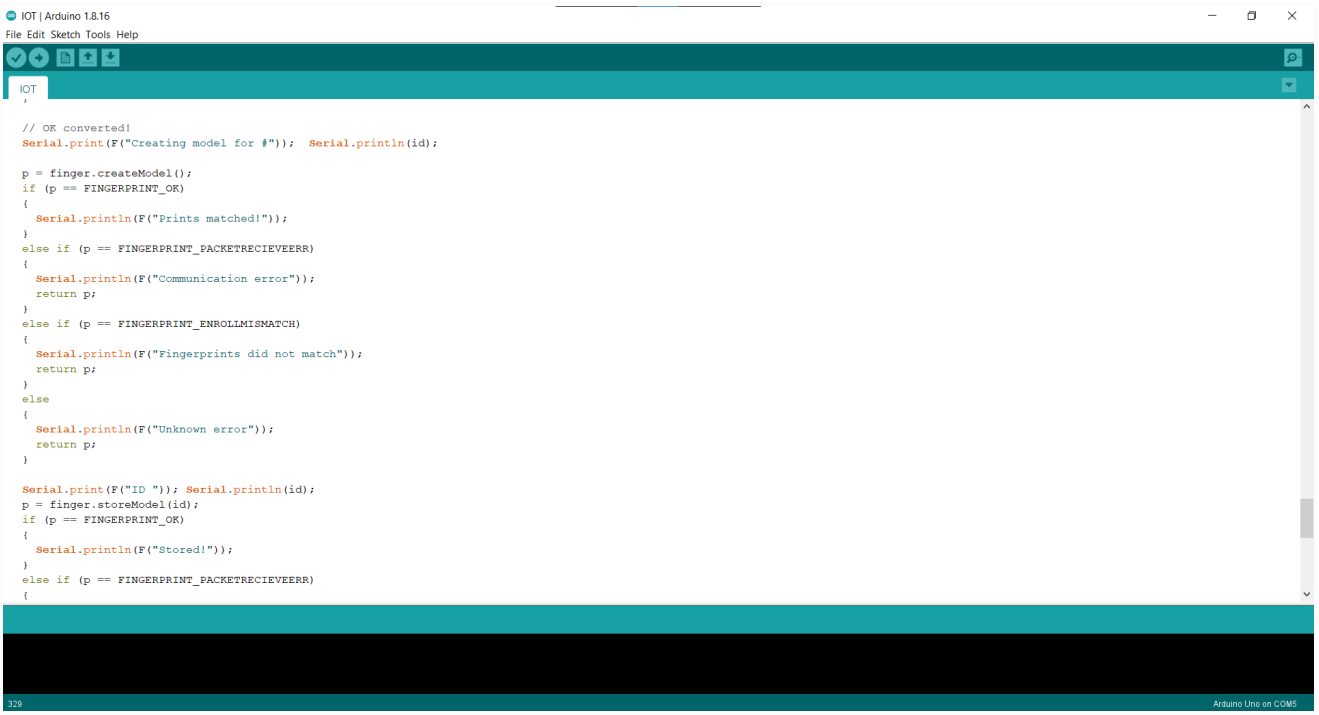
Arduino Uno on COM5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File Edit Sketch Tools Help
IOT
'
// OK converted!
Serial.print(F("Creating model for #")); Serial.println(id);
p = finger.createModel();
if (p == FINGERPRINT_OK)
{
Serial.println(F("Prints matched!"));
}
else if (p == FINGERPRINT_PACKETRECIEVEERR)
{
Serial.println(F("Communication error"));
return p;
}
else if (p == FINGERPRINT_ENROLLMISMATCH)
{
Serial.println(F("Fingerprints did not match"));
return p;
}
else
{
Serial.println(F("Unknown error"));
return p;
}
Serial.print(F("ID ")); Serial.println(id);
p = finger.storeModel(id);
if (p == FINGERPRINT_OK)
{
Serial.println(F("Stored!"));
}
else if (p == FINGERPRINT_PACKETRECIEVEERR)
{
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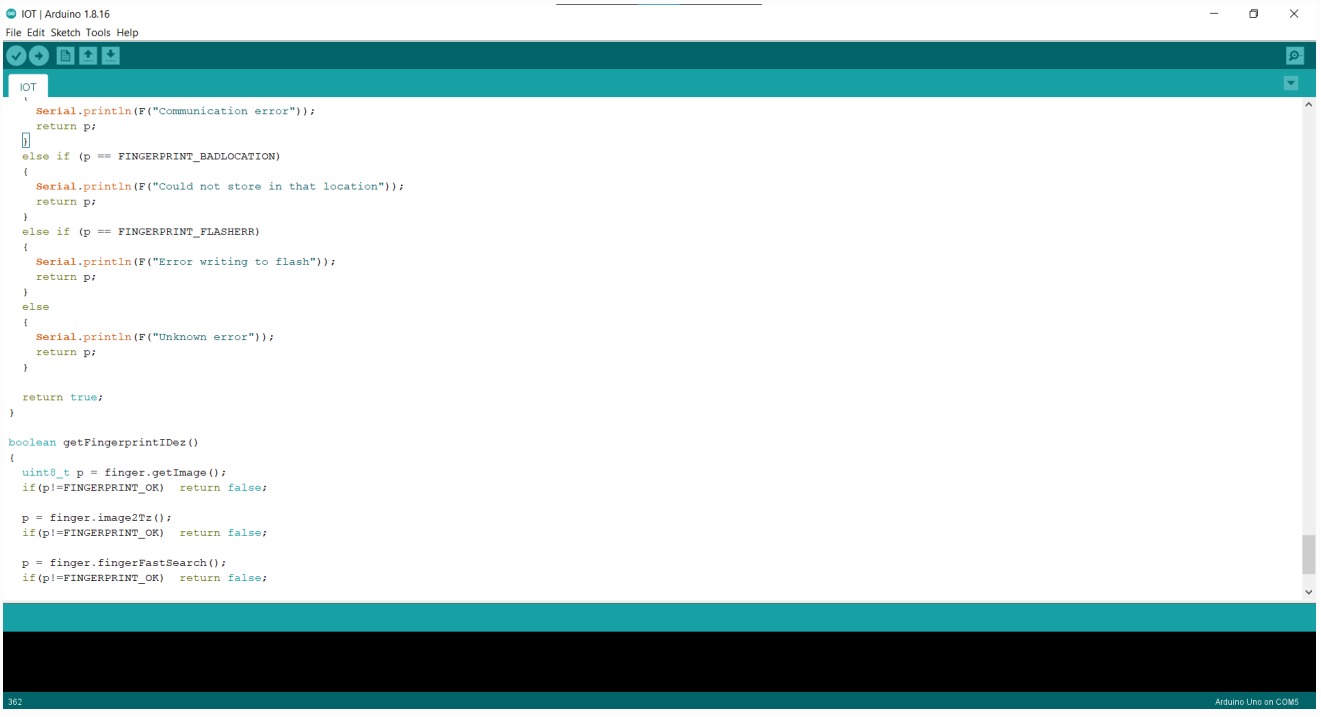
Arduino Uno on COM5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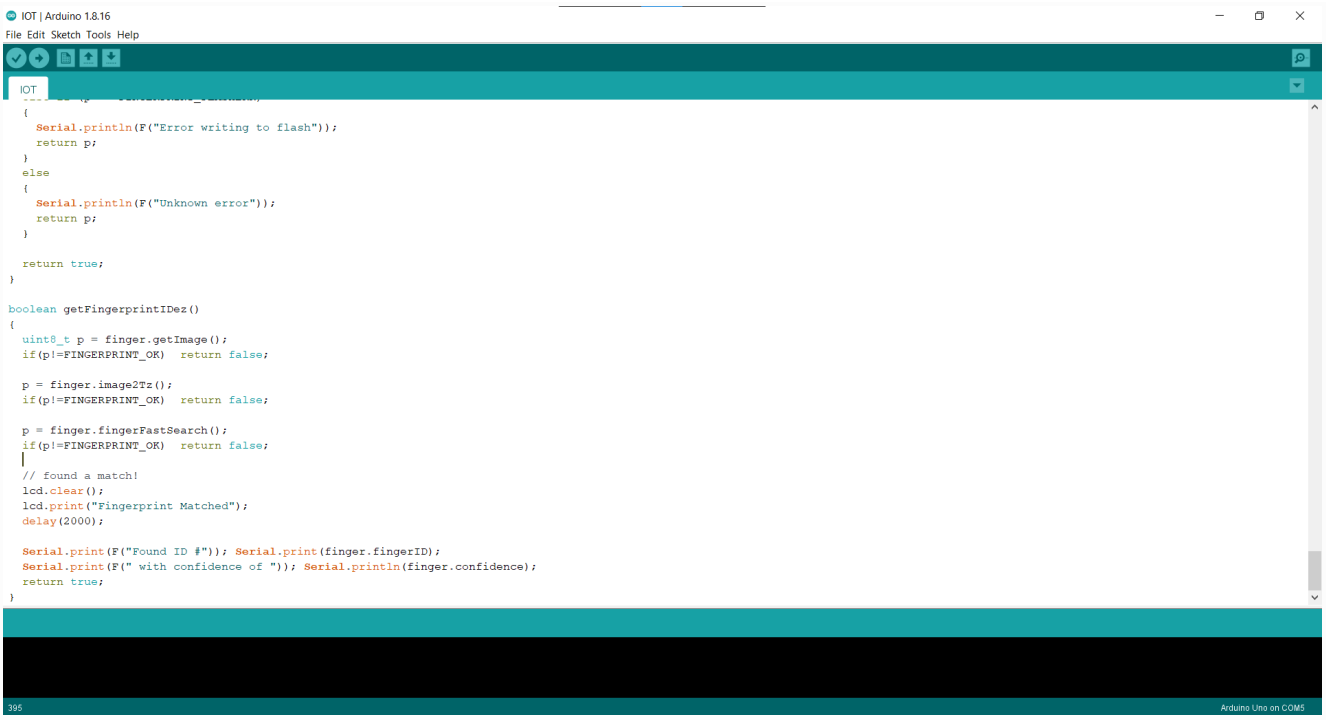
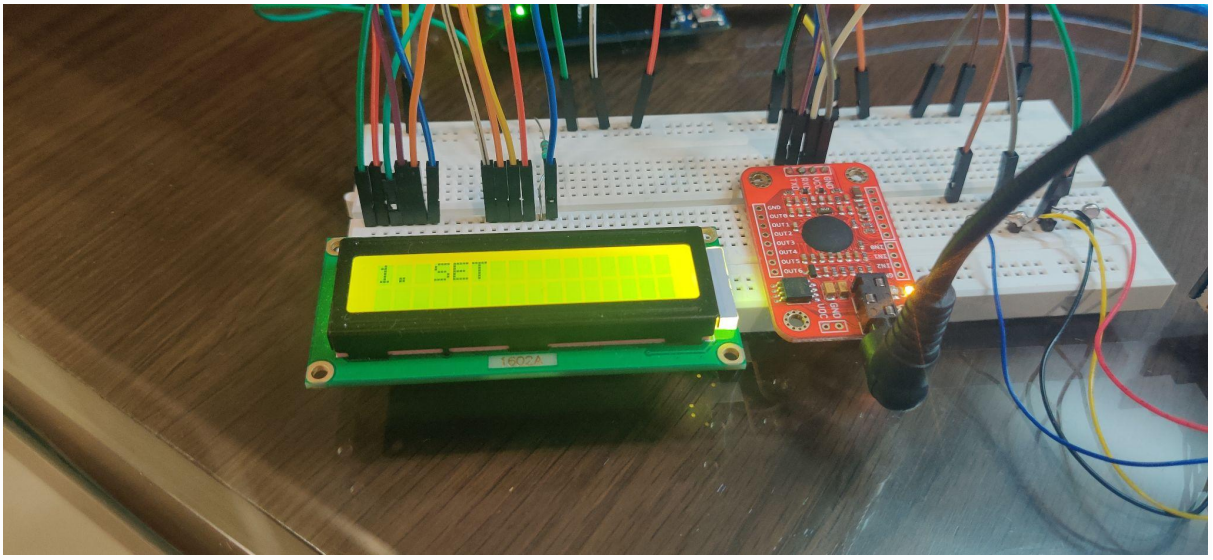
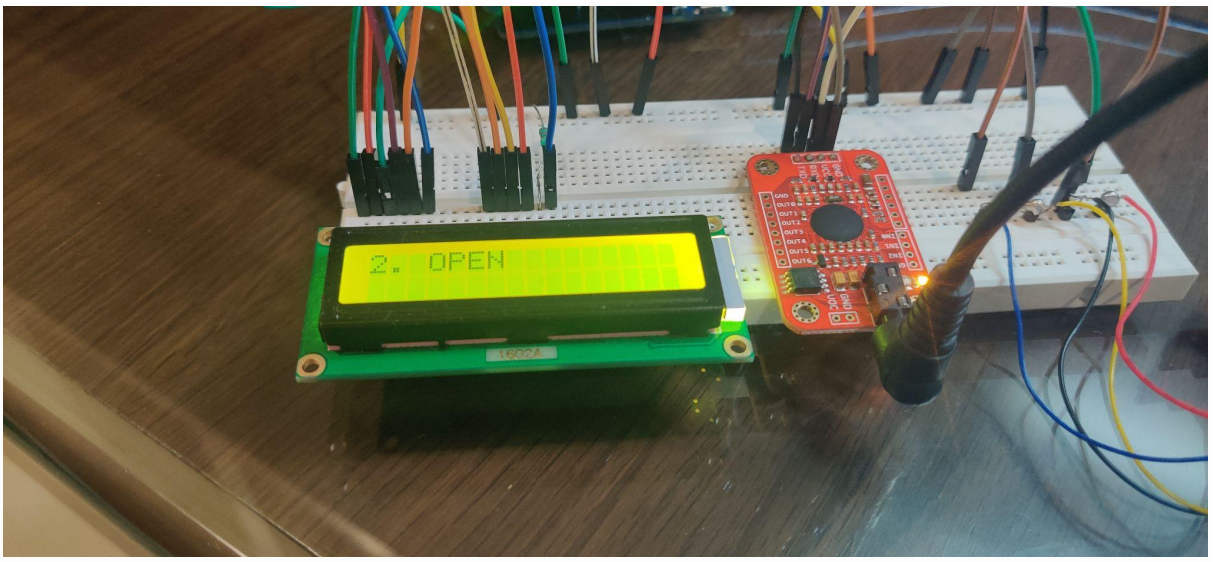
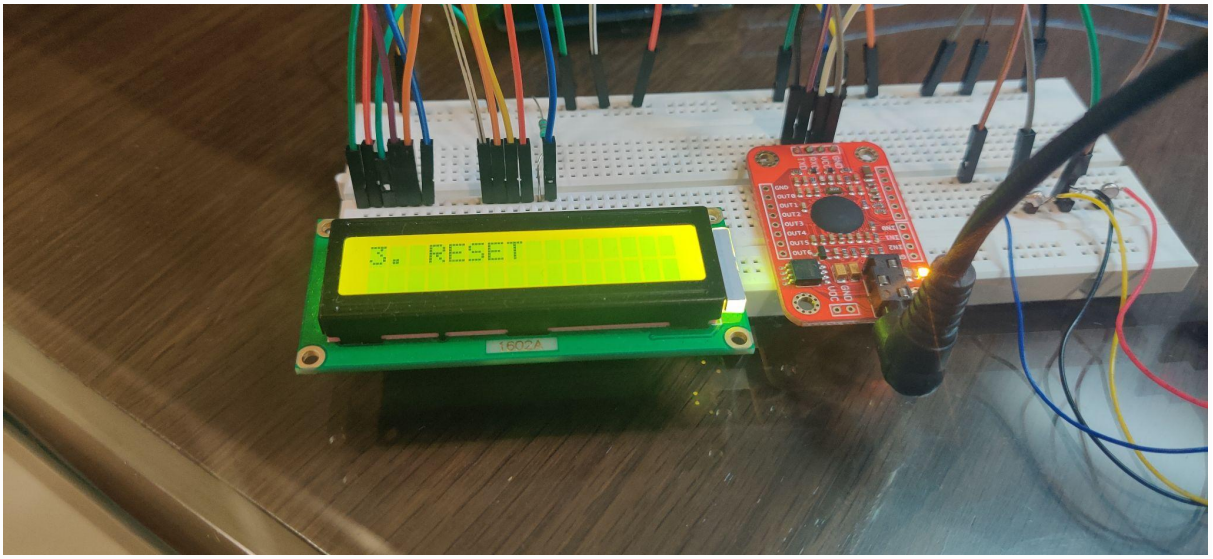
File Edit Sketch Tools Help
IOT
'
Serial.println(F("Communication error"));
return p;
}
else if (p == FINGERPRINT_BADLOCATION)
{
Serial.println(F("Could not store in that location"));
return p;
}
else if (p == FINGERPRINT_FLASHERR)
{
Serial.println(F("Error writing to flash"));
return p;
}
else
{
Serial.println(F("Unknown error"));
return p;
}
return true;
}
boolean getFingerprintIDez()
{
uint8_t p = finger.getImage();
if(p!=FINGERPRINT_OK) return false;
p = finger.image2Tz();
if(p!=FINGERPRINT_OK) return false;
p = finger.fingerFastSearch();
if(p!=FINGERPRINT_OK) return false;
362
Arduino Uno on COM5

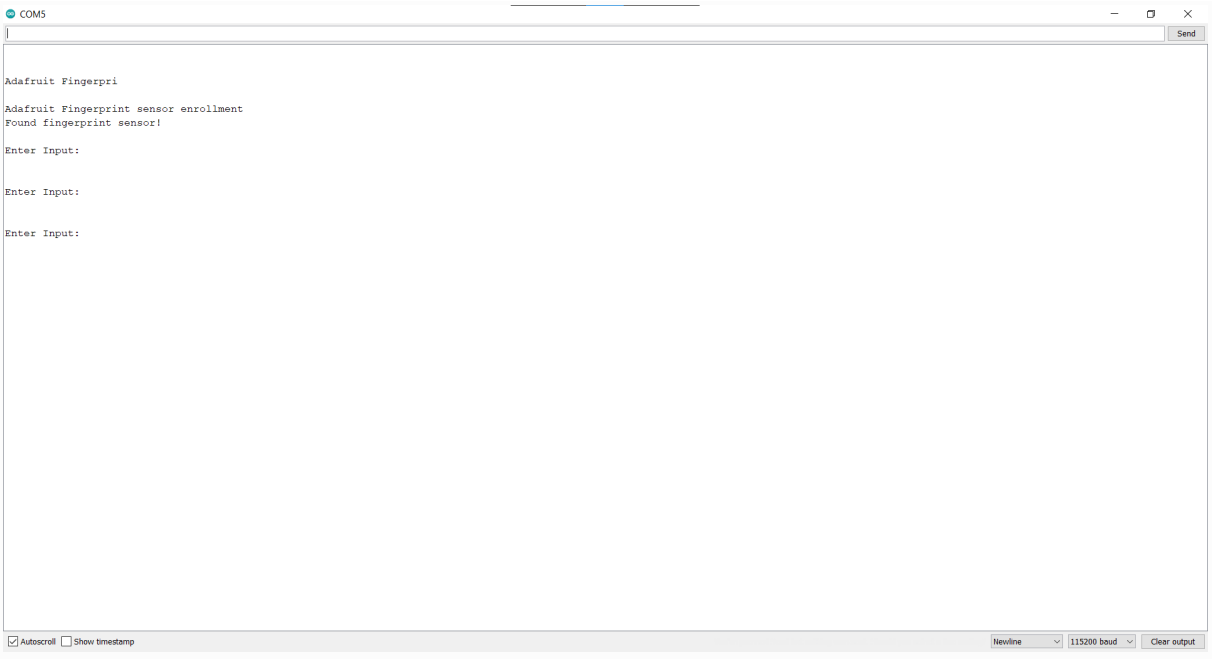


6.2 OUTPUT/RESULTS

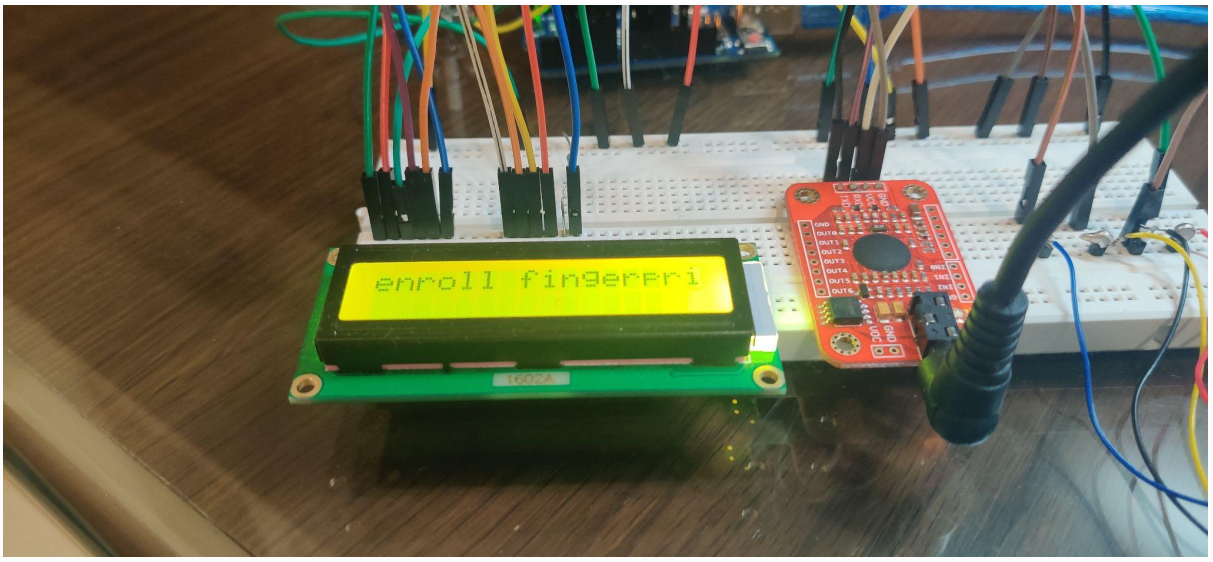


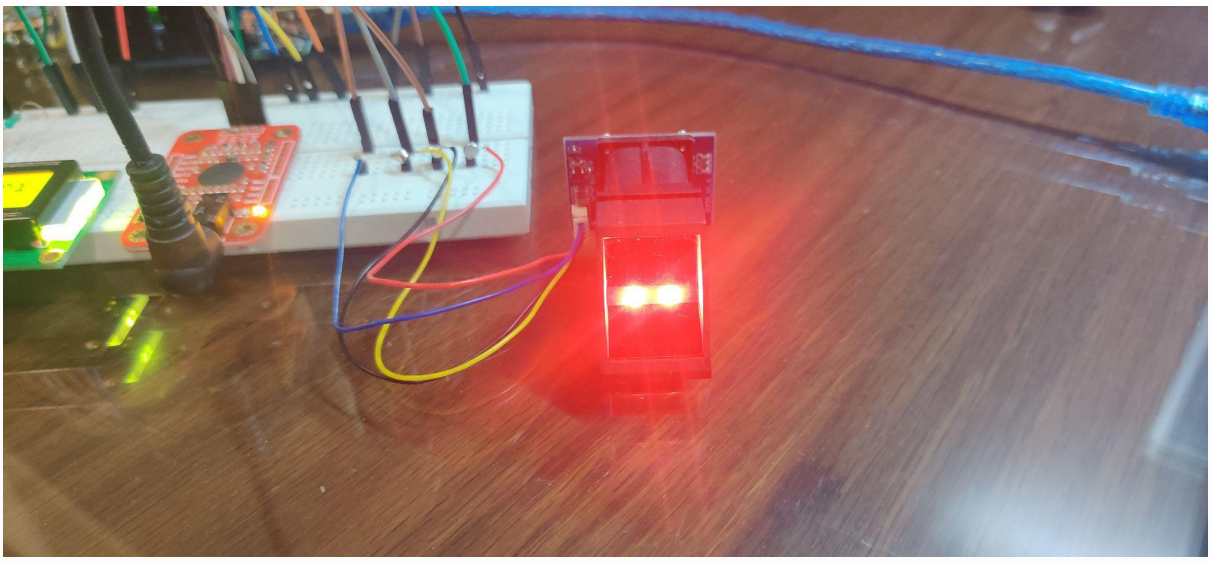

2. OPEN
1602A

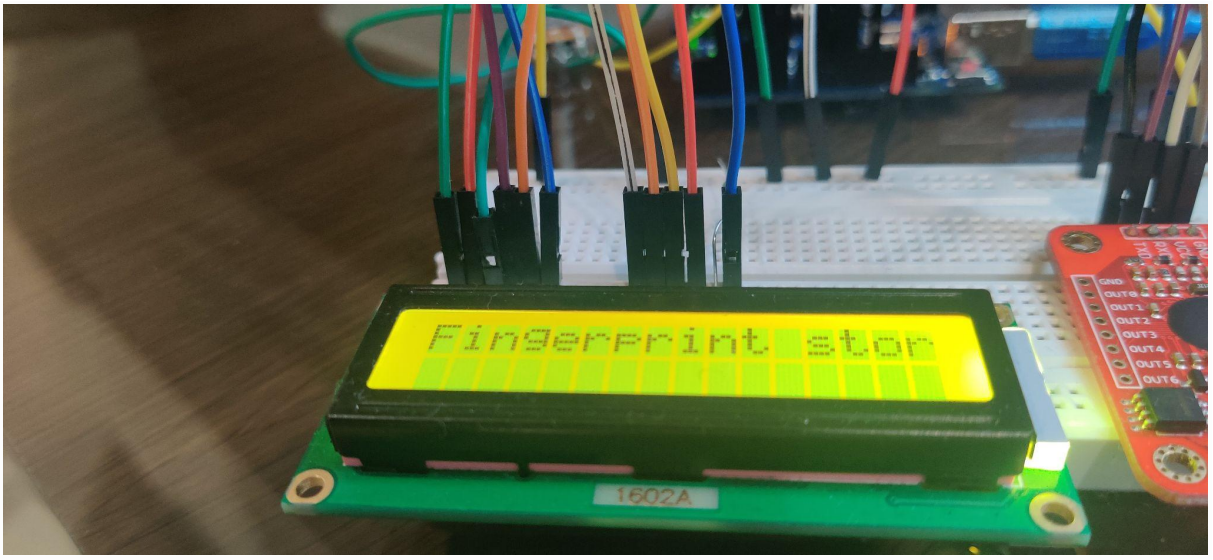

3. RESET
1602A


COM5
Send
Adafruit Fingerpri
Adafruit Fingerprint sensor enrollment
Found fingerprint sensor!
Enter Input:
Enter Input:
Enter Input:
Autoscroll
Show timestamp
Newline
115200 baud
Clear output

LCD showing the menu and serial monitor waiting for user input







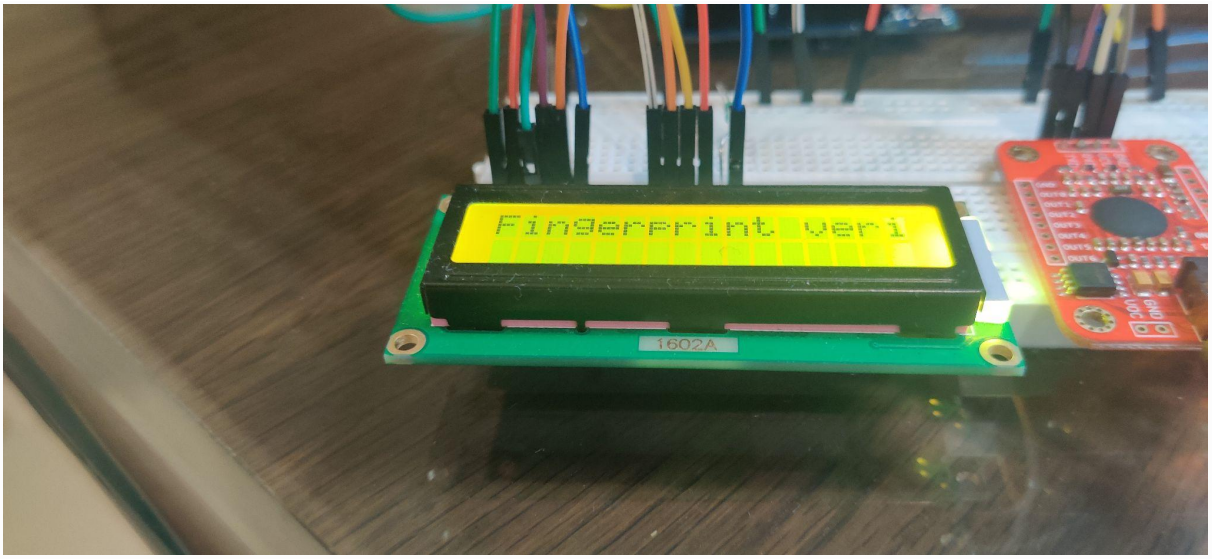
COM5

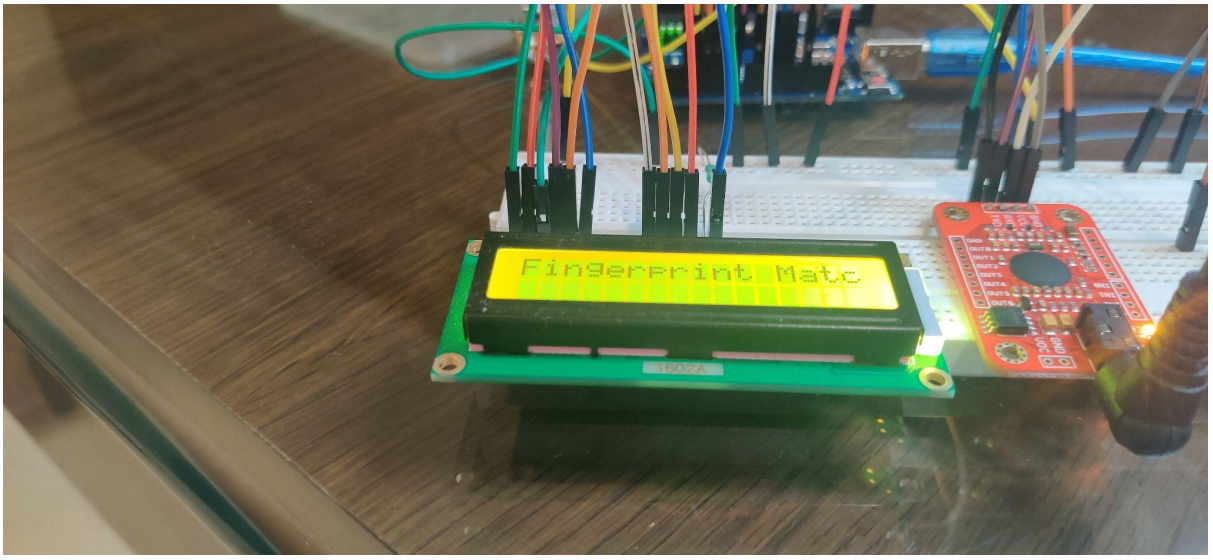
Send

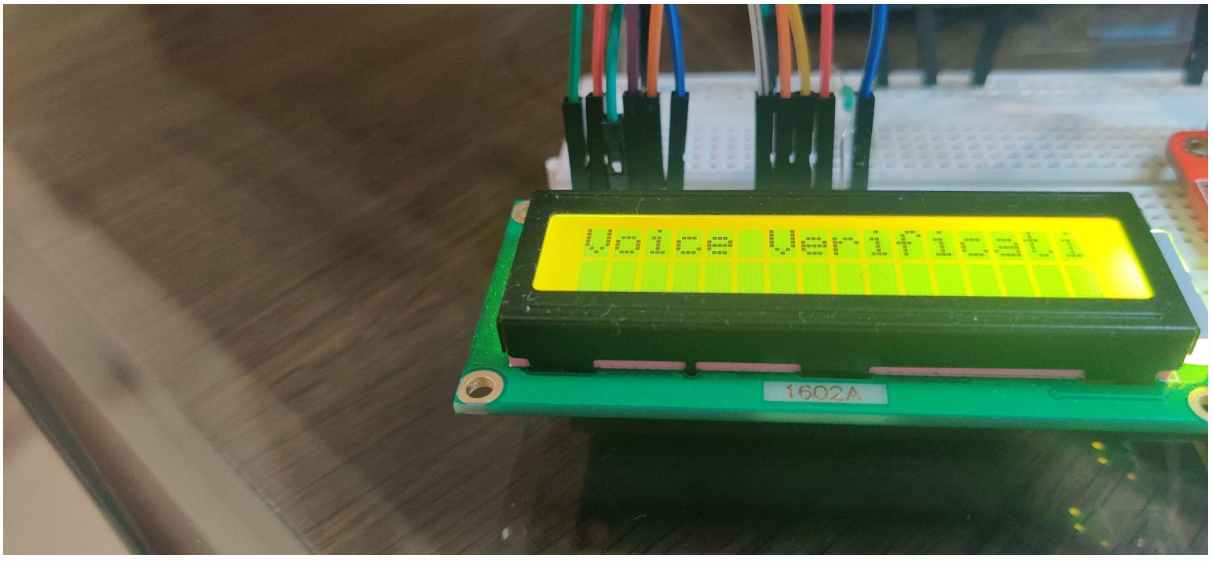
```
.
.
.
.
.
Image taken
Image converted
Remove finger
ID 5
Place same finger again
.....................Image taken
Image converted
Creating model for #5
Fingerprints did not match

Enter Input:

Please type in the ID # (from 1 to 127) you want to save this finger as...
Enrolling ID #5
.
.
.
.
.
.
.
.
.
.
.
Image taken
Image converted
Remove finger
ID 5
Place same finger again
.........Image taken
Image converted
Creating model for #5
Prints matched!
ID 5
Stored!
```

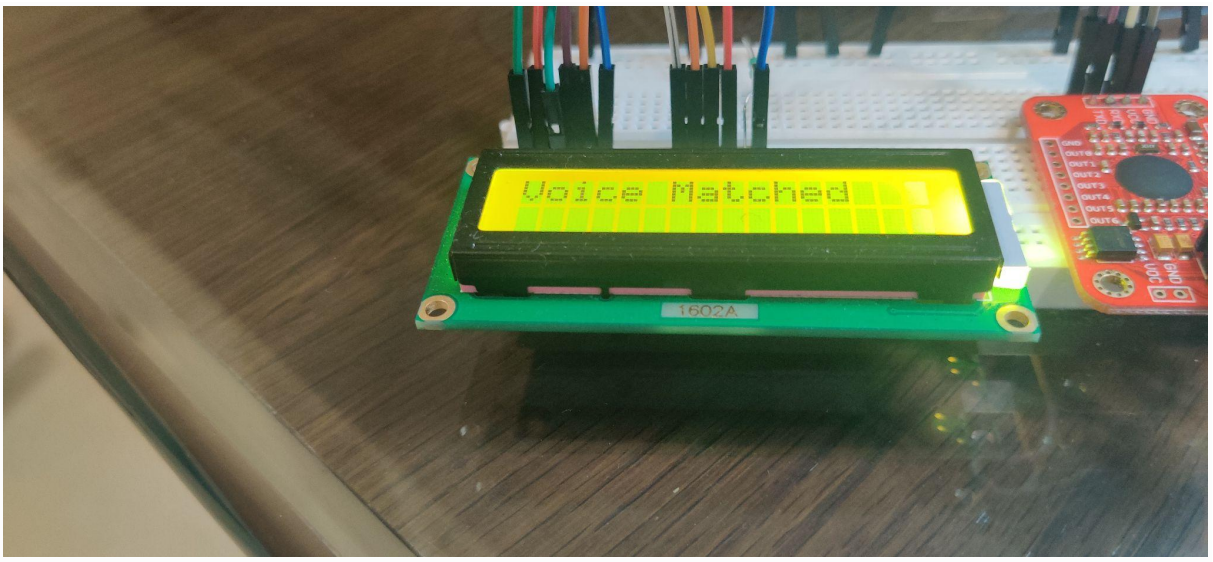
Autoscroll Show timestamp Newline 115200 baud Clear output

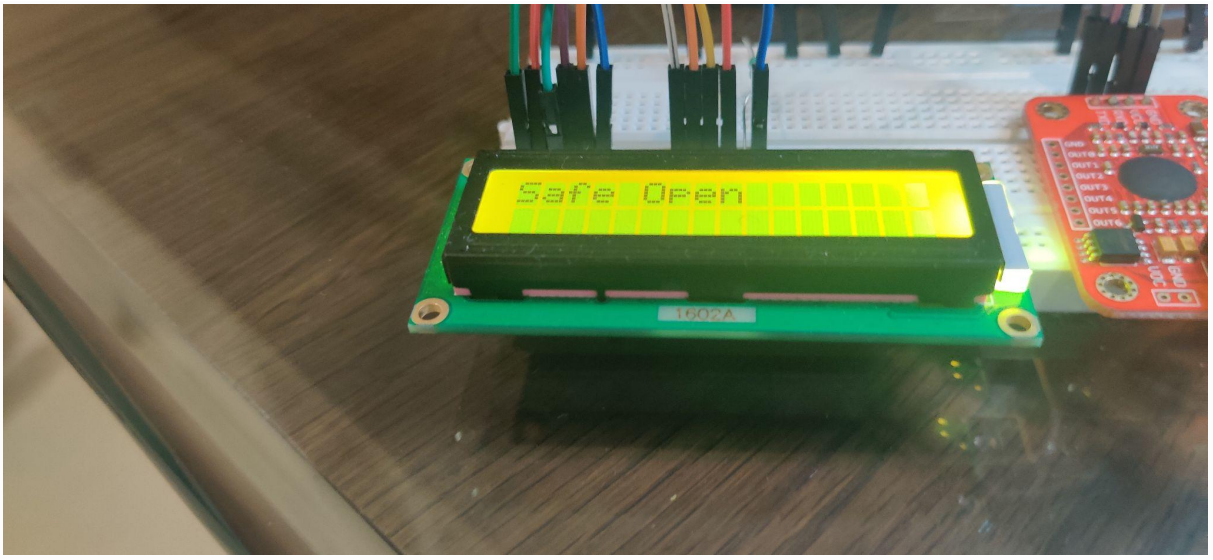
SET: Fingerprint is set and stored at id 5 and in built voice train code used to store the codeword on address 20 and train Voice Recognition V3 with codeword





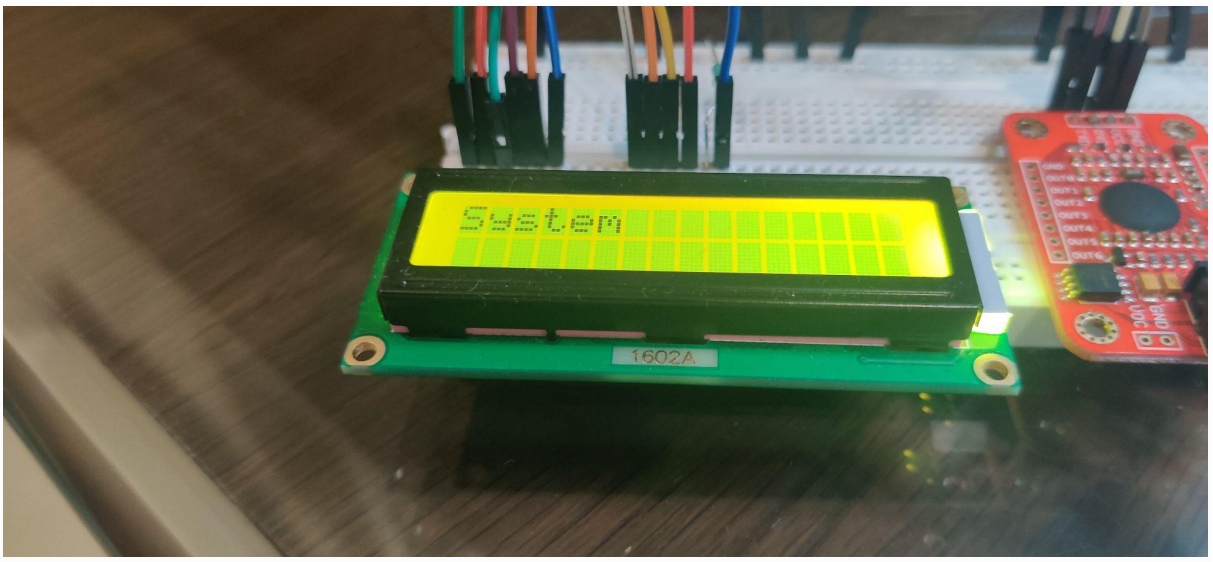


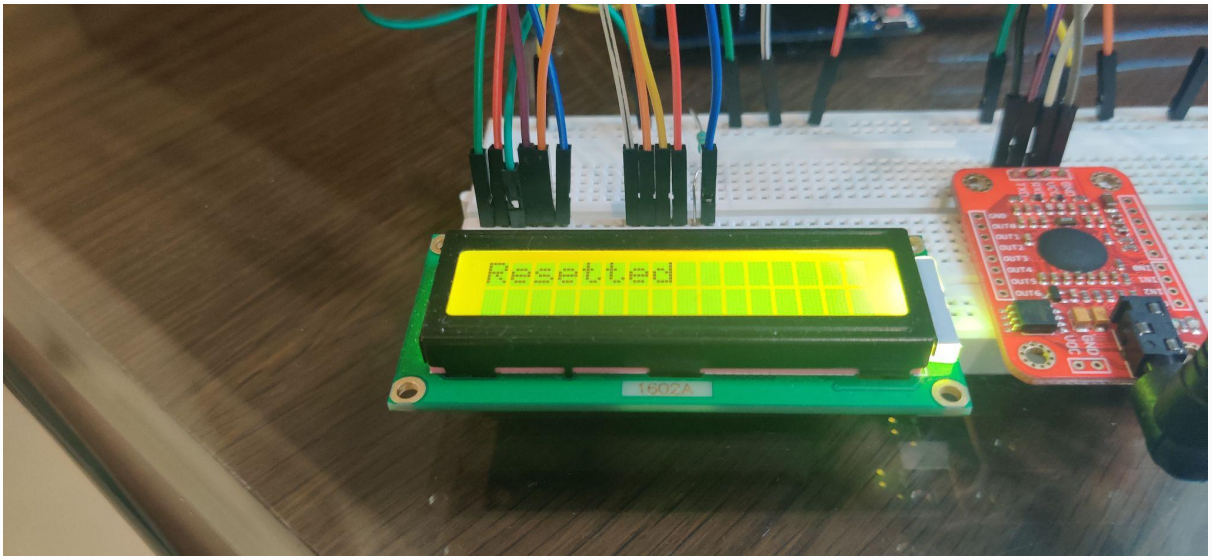





```
Enter Input:

Sensor contains 3 templates
Waiting for valid finger...
Found ID #8 with confidence of 127

Elechouse Voice Recognition V3 Module
IOT Safe System Project
Recognizer cleared.
Codeword Loaded

Waiting for valid voice command...
Voice Matched
VR Index        Group   RecordNum       Signature
0               NONE    20              codeword
```

OPEN: First fingerprint is verified and if matched, voice verification is done otherwise error shown, in voice verification if codeword matches to stored one, then voice is matched and also the safe open message is shown on LCD and if it does not match error is shown.



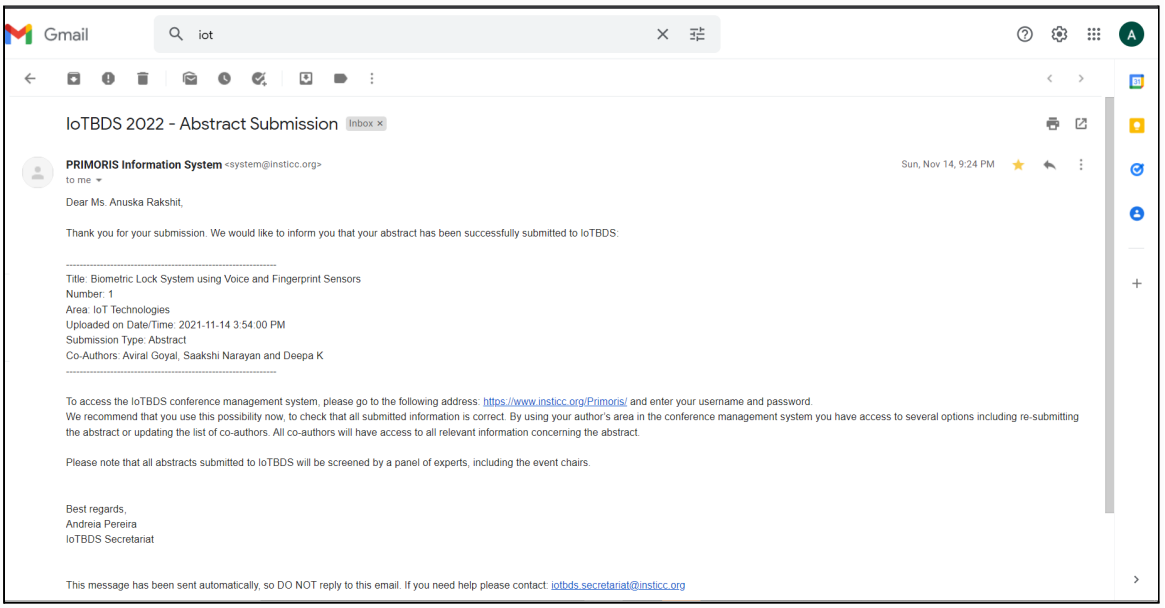


RESET: System resetted message is shown on LCD and then new fingerprint and voice codeword can be stored in the same addresses as previous one

7. CONCLUSION

We have been successful in the actualization of our prototype. The device was successfully manufactured and yielded the anticipated results. This device is low-cost, low-maintenance, and simple to set up as a safe system using IoT.

8. PAPER STATUS



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