جامعة الإسكندرية
ALEXANDRIA
UNIVERSITY

IOT Project Presentation

Smart Home

جامعة الإسكندرية
ALEXANDRIA UNIVERSITY

By hands of:

ENG. AHMED HESHAM

ENG. YOUSEF RAGAB

ENG. ALI SOLIMAN

ENG. AMR FAYAD

ENG. MOHAMED IBRAHEM

Smart Home
LET'S GET STARTED!

HARDWARE :-

In the hardware, we use many sensors, and we implemented all these sensors in the wooden maquette after we went to Elwarsha to buy it. We thought of a new idea to implement it everywhere ourselves, handling all the hardware and designing the maquette based on our own concept. Ali was with the man in the atelier and instructed him to apply all our project ideas, including making holes and spaces to accommodate the sensors, as well as a place underneath to put the ESP, breadboard, and all the connections.

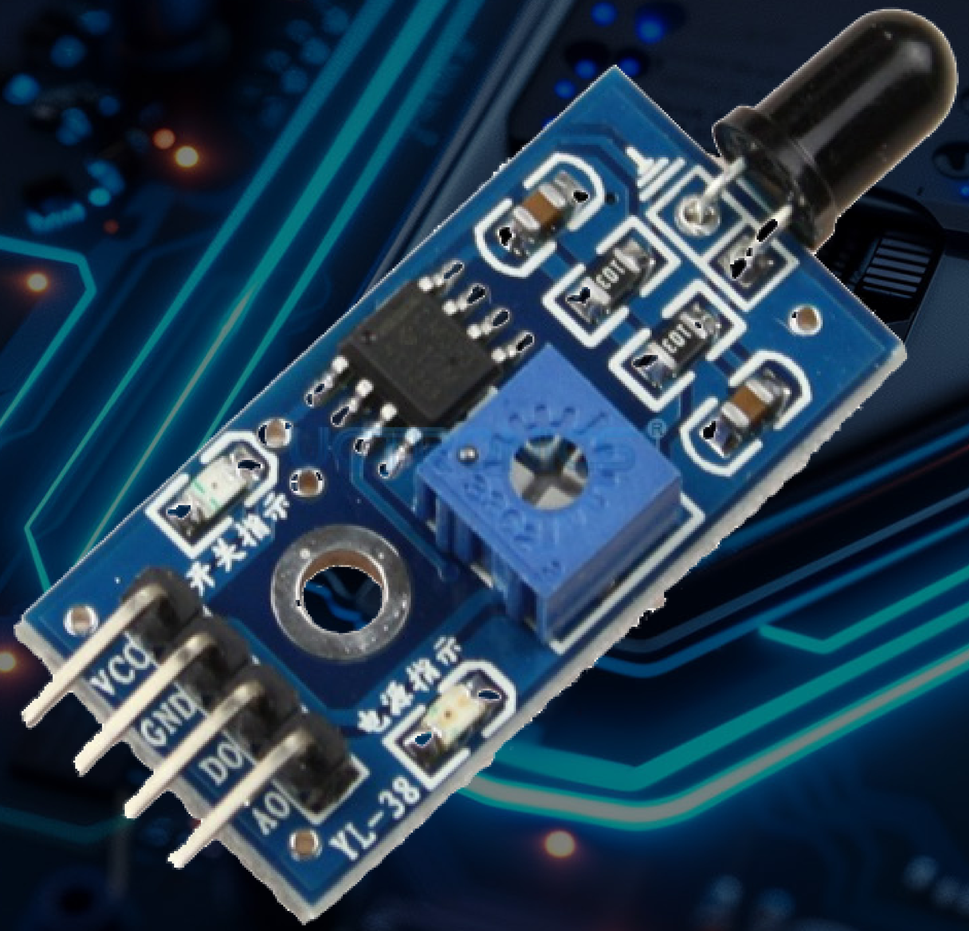
LDR sensor (analog) as it sense light

Rain sensor(digital) as it sense if it is rainy

MQ4(analog)

we use it analog as It sense the gas percentage if it increase over specific percentage it prints as it’s a gas detected and if we use digital it detects all time the gas percentage because the existence of gas in the atmosphere.

Flame sensor:(digital) as it detect the fire.

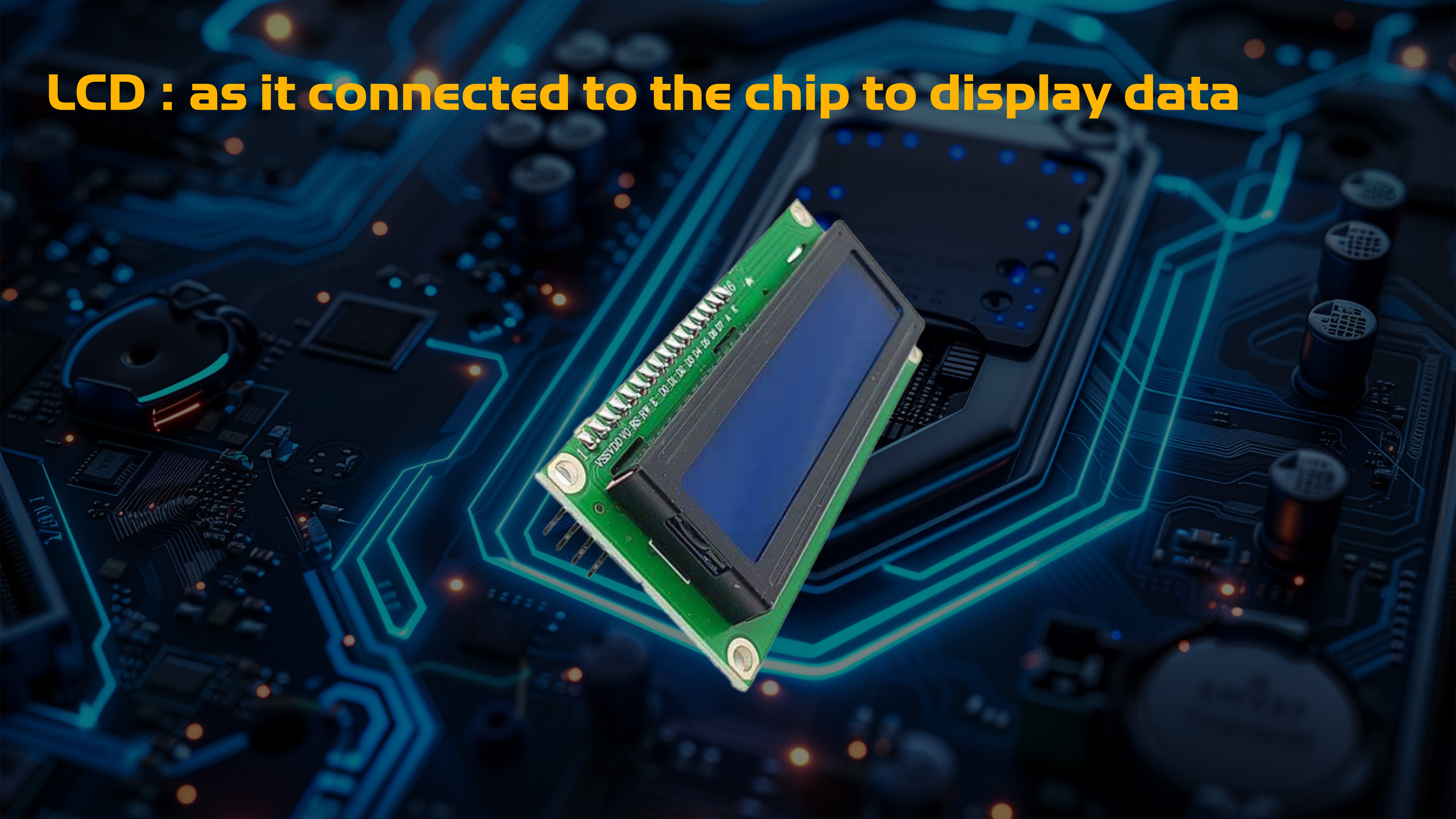


RFID sensor(digital):as it read the card as a key as the elevator

Buzzer(digital):

as it connected to any sensor to detect if the senser work and make a sound

LCD : as it connected to the chip to display data



Keypad: as it used to enter the password the allow the motor open the door

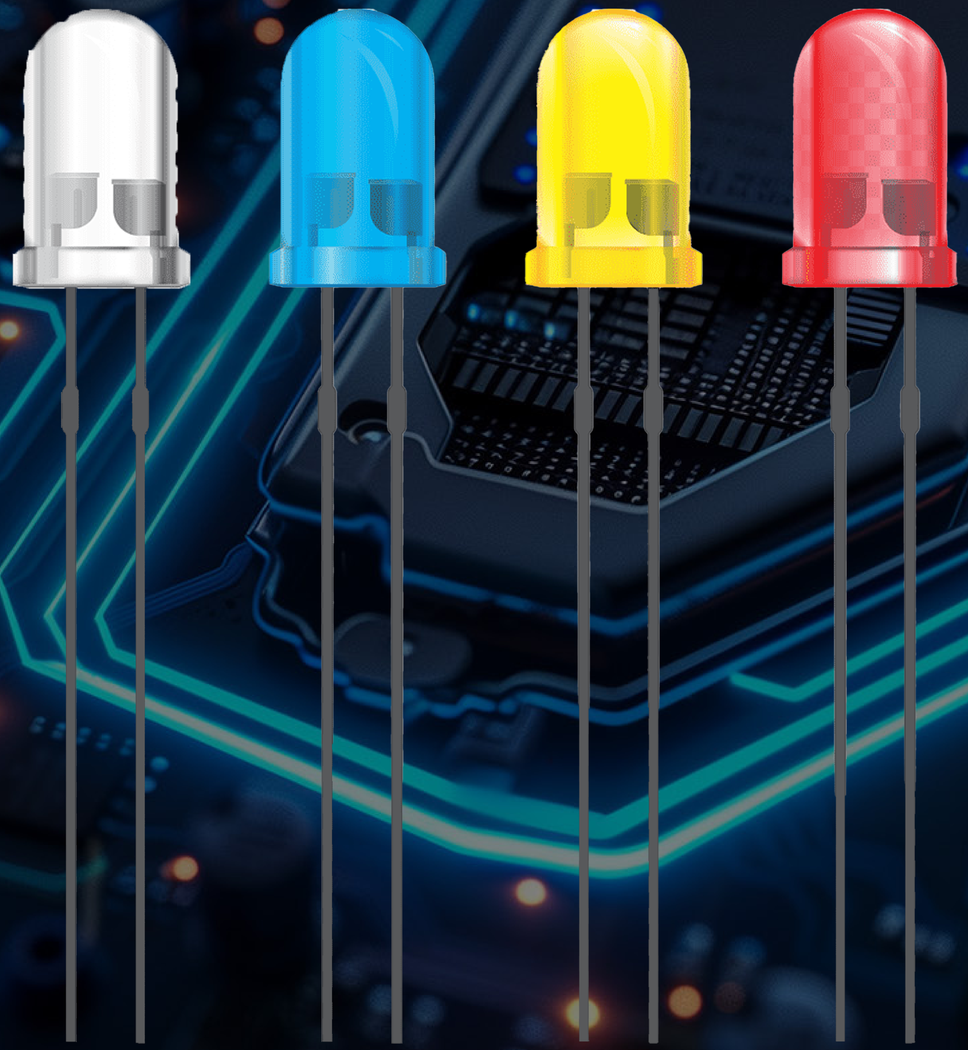
Servo motor(ADC):as it uses for motion like opening door and window.

IR sensor (digital):

as it detect specific characteristics in its surroundings through emitting or detecting IR radiation.

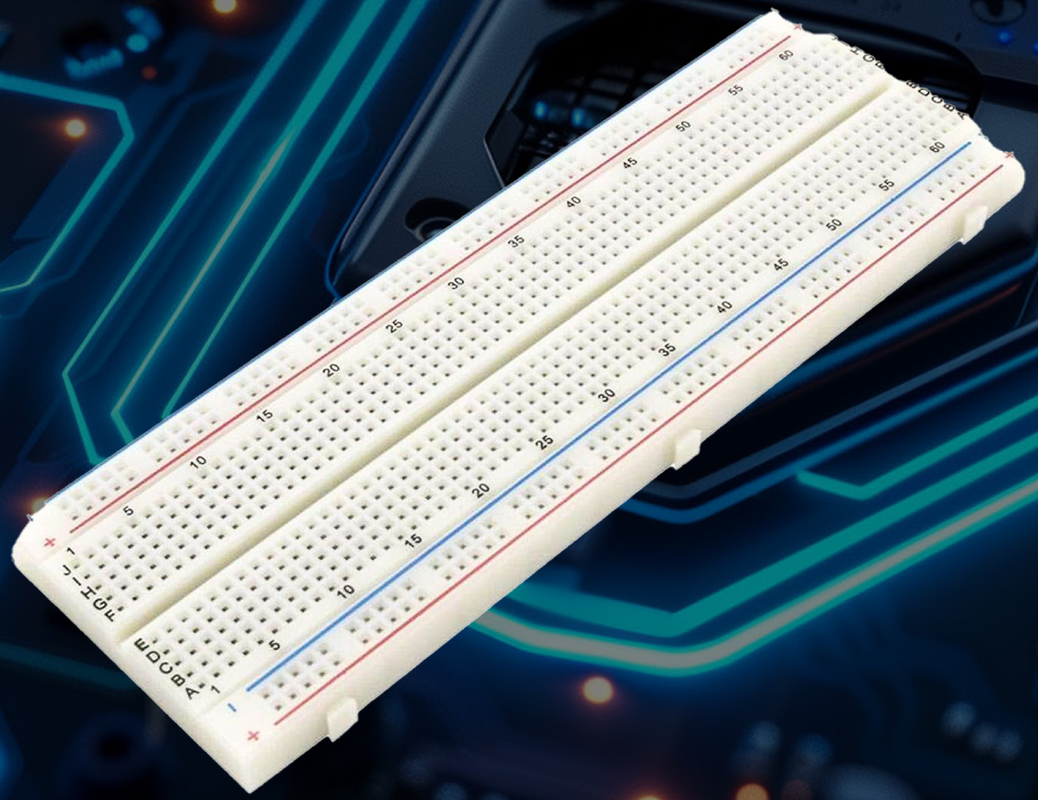
PIR sensor(analog): as it sensetive to the motion.

LEDs :- as it is the light of the smart home



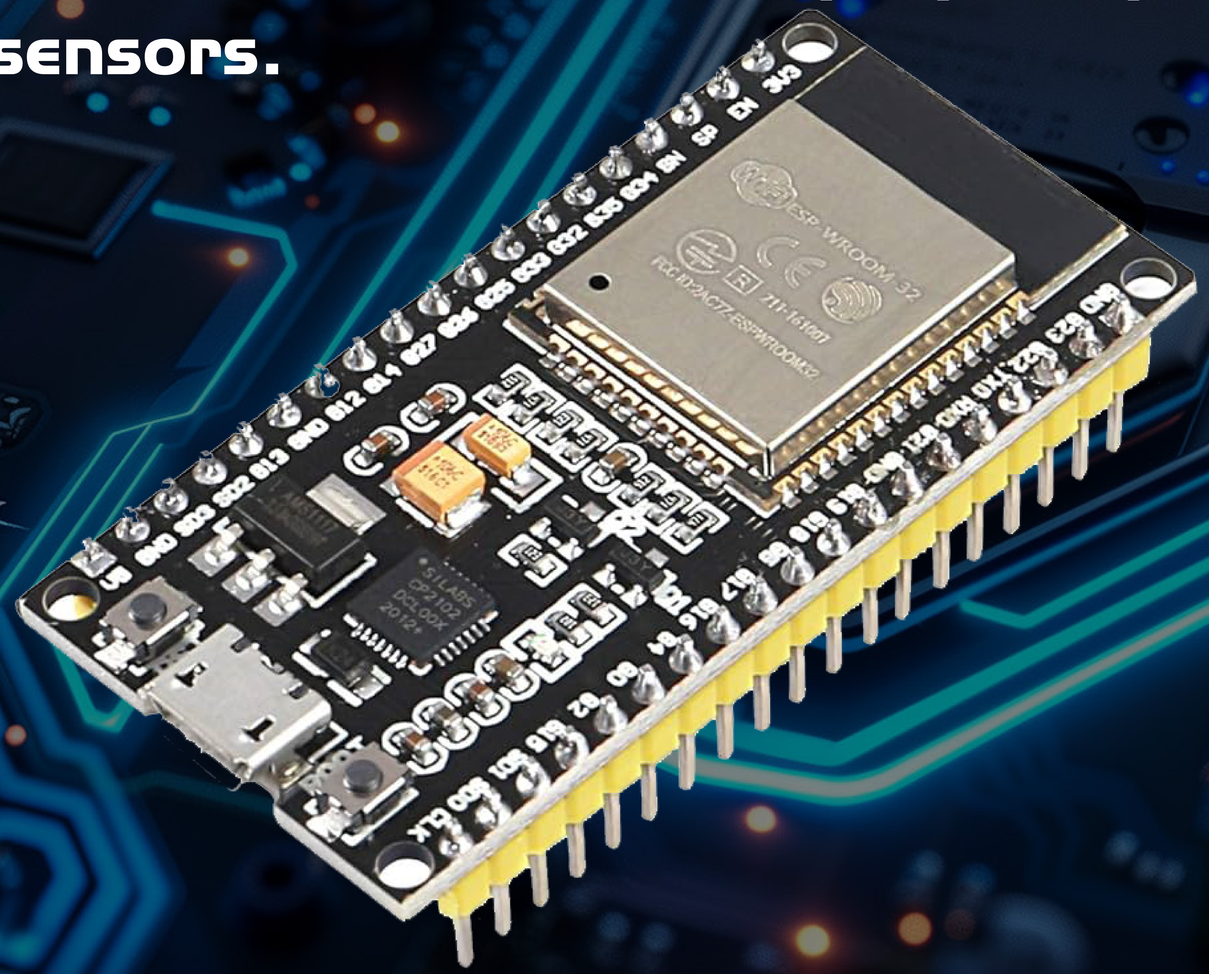
Breadbord :-

as in resposible for all of the wire connection as esp has a limeted number of pins so we use it to connect all sensors and servomotors to it for the energy.



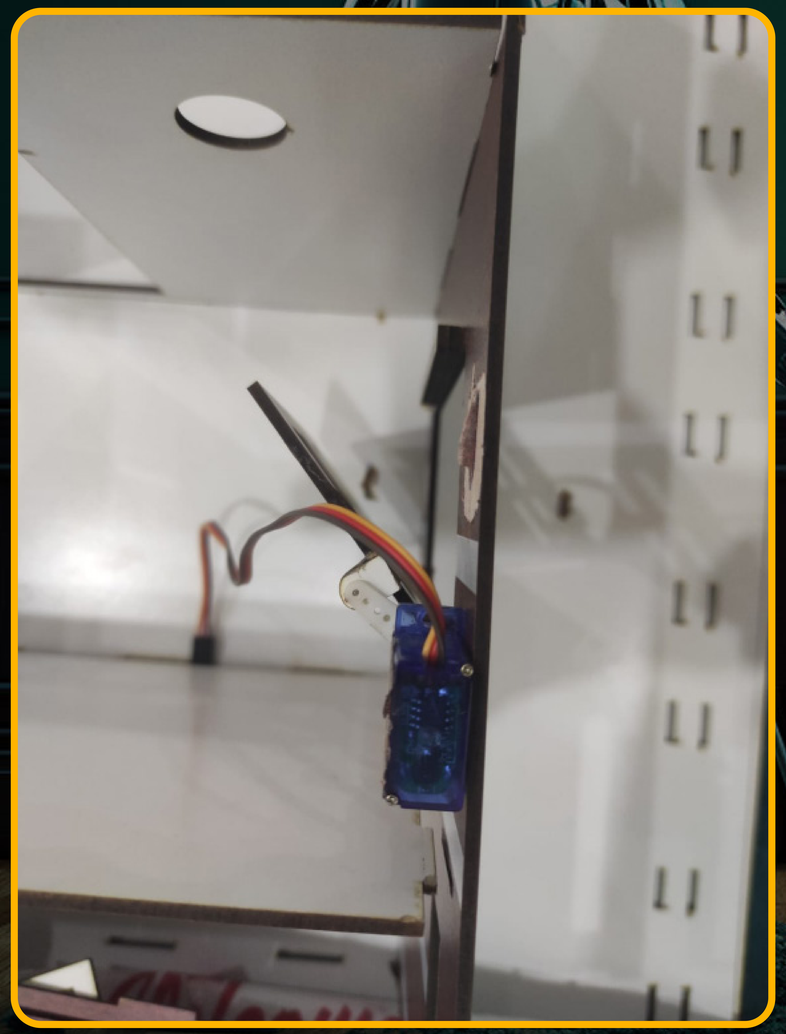
ESP32 :-

It is the brain of the project that all of sensors are connected to it as it has the power and it connected to the laptop to upload the code on it so it works all the sensors.



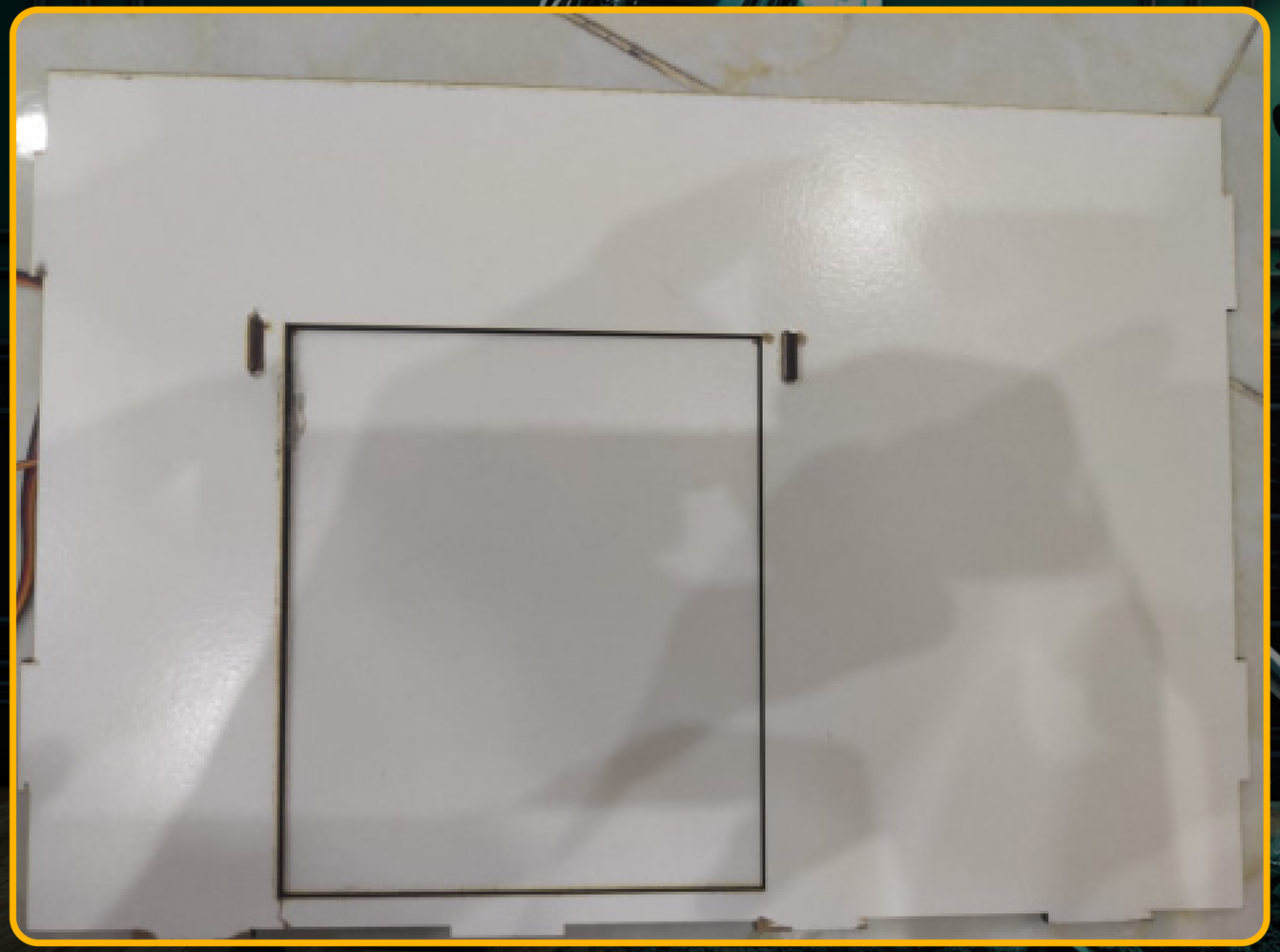
Smart Home
THE MAQUETTE

We implement servomotors in the door as it open and close by the code



We make the ground consists of 2 layers as there is a distance between them to enter the wires , ESP32 and the breadboard.

we implement a servo motor to the garage door as it control the motion of the door



We implement a servo motor to the window to control its motion.

we make it to enter ESP32 and wires through it.

We make the two holes to implement the two sensors of flame and gas in the kitchen.

ESP32/MQTT CODE

In this code we handled all smart home sensors to act together and connect all sensors to Esp32 to make every sensor do efficiently As we used many sensors and tools to do it as we used:-

1- ESP32 (brain)
2- breadboard (for connections)
3- a lot of jumpers 20cm (wires)
4- LEDs
5- PIR sensor (motion sensor)
6- IR sensor
7- There servomotors (for door and window and garage)
8- keypad
9- buzzer
10- LCD
11- RFID sensor
12- flame sensor
13- MQ4 sensor (gas sensor)
14- Rain sensor
15- LDR

That’s all sensors that we used so, what is the Idea of the project that is the smart home project ? . And the small photo to imagin all the idea of the project.

The image of the project :-

The IDEA of the project.

- We first make a wooden Marquette of the smart home and it has a garden. At the garden when you enter the garden there is a PIR sensor to detect the motion if someone enters and there are six LEDs as three on the left and three on the right.

-As when the PIR sensor detect someone enters the garden the six LEDs lights up.

And when arrives to the door there is an IR sensor over the door when it detect someone one behind the door it turns on the LCD and it prints Hello enter the password as there is a keypad to enter the password.

And if he enters correct password, the door open and the LCD prints welcome.

And if he enters the wrong password the LCD prints wrong password and he has three trials if he enters the third one wrong, the buzzer makes a sound.

And in the kitchen there are two sensors of fire and MQ4 for the gas detection if the fire sensor detects as there is a fire there buzzer makes a sound and same in a MQ4.

And in the kitchen there is the window open and closed.

And next to the home there is a garage as it has an servomotor to open and closed the door of it and it has RFID sensor as if it detacts the card of it the door of the garage opened.

And there is a rain sensor at the garden behind the garage as it when it feels that there is a rain, The window in the kitchen closed up.

And there are many jumbers to connect the all sensors to the breadboard and esp32 that found under the home.

As we understands the idea of the project. We will see the code that we made to implement that idea on the real ground and on the smart home.

First we import all functions that we need In the project.

```
#include <WiFi.h>
#include <PubSubClient.h>
#include <WiFiClientSecure.h>
#include <Servo.h>
#include <Keypad.h>
#include <LiquidCrystal.h>
```

And I make a char variables to enters the name and the password of the WiFi and a char variables to conncet to mqtt server of hiveMQ and I make account on it and and takes the client link and the username and password and write the in the code here

```
// WiFi credentials
const char* ssid = "YOUR_SSID";
const char* password = "YOUR_PASSWORD";

// MQTT Broker settings
const char* mqtt_server = "YOUR_HIVE_MQ_CLUSTER_ID";
const char* mqtt_username = "YOUR_USERNAME";
const char* mqtt_password = "YOUR_PASSWORD";
const int mqtt_port = 8883;
```

And there is a CA Certificate of the hive mQ serve that responsible for the security of it .

```
// HiveMQ Cloud Let's Encrypt CA certificate
static const char *root_ca PROGMEM = R"EOF(
-----BEGIN CERTIFICATE-----
MIIFazCCA1OgAwIBAgIRAIIQz7DSQONZRGPgu2OCiwAwDQYJKoZIhvcNAQELBQAw
TzELMAkGA1UEBhMCVVMxKTAnBgNVBAoTIEludGVybmV0IFNlY3VyaXR5IFJlc2Vh
cmNoIEdyb3VwMRUwEwYDVQQDEwxJU1JHIFJvb3QgWDEwHhcNMTUwNjA0MTEwNDM4
WhcNMzUwNjA0MTEwNDM4WjBPMQswCQYDVQQGEwJVUzEpMCcGA1UEChMgSW50ZXJu
ZXQgU2VjdXJpdHkgUmVzZWFyY2ggR3JvdXAxFTATBgNVBAMTDElTUkcgUm9vdCBY
MTCCAiIwDQYJKoZIhvcNAQEBBQADggIPADCCAgoCggIBAK3oJHP0FDfzm54rVygc
h77ct984kIxuPOZXoHj3dcKi/vVqbvYATyjb3miGbESTtrFj/RQSa78f0uoxmyF+
0TM8ukj13Xnfs7j/EvEhmkvBioZxaUpmZmyPfjxwv60pIgbz5MDmgK7iS4+3mX6U
A5/TR5d8mUgjU+g4rk8Kb4Mu0UlXjIB0ttov0DiNewNwIRt18jA8+o+u3dpjq+sW
T8KOEUt+zwvo/7V3LvSye0rgTBIlDHCNAymg4VMk7BPZ7hm/ELNKjD+Jo2FR3qyH
B5T0Y3HsLuJvW5iB4YlcNHlsdu87kGJ55tukmi8mxdAQ4Q7e2RCOFvu396j3x+UC
B5iPNgiV5+I3lg02dZ77DnKxHZu8A/lJBdiB3QW0KtZB6awBdpUKD9jf1b0SHzUv
KBds0pjBqAlkd25HN7rOrFleaJ1/ctaJxQZBKT5ZPt0m9STJEadao0xAH0ahmbWn
OlFuhjuefXKnEgV4We0+UXgVCwOPjdAvBbI+e0ocS3MFEvzG6uBQE3xDk3SzynTn
jh8BCNAw1FtxNrQHusEwMFxIt4I7mKZ9YIqioymCzLq9gwQbooMDQaHWBfEbwrbw
qHyGO0aoSCqI3Haadr8faqU9GY/rOPNk3sgrDQoo//fb4hVC1CLQJ13hef4Y53CI
rU7m2Ys6xt0nUW7/vGT1M0NPAgMBAAGjQjBAMA4GA1UdDwEB/wQEAwIBBjAPBgNV
HRMBAf8EBTADAQH/MB0GA1UdDgQWBBR5tFnme7bl5AFzgAiIyBpY9umbbjANBgkq
hkiG9w0BAQsFAAOCAgEAVR9YqbyyqFDQDLHYGmkgJykIrGF1XIpu+ILlaS/V9lZL
ubhzEFnTIZd+50xx+7LSYK05qAvqFyFWhfFQDlnrzuBZ6brJFe+GnY+EgPbk6ZGQ
3BebYhtF8GaV0nxvwuo77x/Py9auJ/GpsMiu/X1+mvoiBOv/2X/qkSsisRcOj/KK
NFtY2PwByVS5uCbMiogziUwthDyC3+6WVwW6LLv3xLfHTjuCvjHIInNzktHCgKQ5
ORAzI4JMPJ+GslWYHb4phowim57iaztXOoJwTdwJx4nLCgdNbOhdjsnvzqvHu7Ur
TkXWStAmzOVyyghqpZXjFaH3pO3JLF+l+/+sKAIuvtd7u+Nxe5AW0wdeRlN8NwdC
jNPElpzVmbUq4JUagEiuTDkHzsxHpFKVK7q4+63SM1N95R1NbdWhscdCb+ZAJzVc
oyi3B43njTOQ5yOf+1CceWxG1bQVs5ZufpsMljq4Ui0/1lvh+wjChP4kqKOJ2qxq
4RgqsahDYVvTH9w7jXbyLeiNdd8XM2w9U/t7y0Ff/9yi0GE44Za4rF2LN9d11TPA
mRGunUHBcnWEvgJBQl9nJEiU0Zsnvgc/ubhPgXRR4Xq37Z0j4r7g1SgEEzwxA57d
emyPxgcYxn/eR44/KJ4EBs+lVDR3veyJm+kXQ99b21/+jh5Xos1AnX5iItreGCc=
-----END CERTIFICATE-----
)EOF";
```

And I make a setup for the keypad,s buttons that are responsible for write the password of the door of the home and the pins of it in the esp32 colume and rows pins.

```
// WiFi and MQTT clients
WiFiClientSecure espClient;
PubSubClient client(espClient);
```

```
// Keypad setup
const byte ROWS = 4;
const byte COLS = 4;
char keys[ROWS][COLS] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};
byte rowPins[ROWS] = {13, 12, 14, 27};
byte colPins[COLS] = {26, 25, 33, 32};
Keypad keypad = Keypad(makeKeymap(keys), rowPins, colPins, ROWS, COLS);
```

There are the definition of the pins to some of sensors and leds and there are pins thatconnected to the ground GND and other to 3.3 V or to 5V and there are ather sensors defined in other place of the code as we see keypad and there are three servometers needs to connect as they connect to 5V not 3.3V.

```
// Sensor and actuator pins
#define PIR_PIN 15
#define IR_DOOR_PIN 34
#define FLAME_PIN 35
#define GAS_PIN 36
#define RAIN_PIN 39
#define BUZZER_PIN 22
#define LED1_PIN 23
#define LED2_PIN 19
#define LED3_PIN 18
#define LED4_PIN 17
#define LED5_PIN 16
#define LED6_PIN 4
```

And there is the password of that the input password and the correct password to compare them and number of trials to counts them to three after three the buzzer make sound

```
unsigned long lastMsg = 0;
char msg[50];
int trial_count = 0;
String inputPassword = "";
String correctPassword = "5555";
bool personDetected = false;
```

And there are the topics of every sensor to can published and subscribe data from and to hiveMQ server and by that we can control that by flutter application that we will do it, to access data from the sensors by that.

```
// Topics for MQTT
const char* topic_pir = "smartHome/garden/pir";
const char* topic_flame = "smartHome/kitchen/flame";
const char* topic_gas = "smartHome/kitchen/gas";
const char* topic_rain = "smartHome/garden/rain";
const char* topic_led_control = "smartHome/garden/ledControl";
const char* topic_door_control = "smartHome/door/control";
const char* topic_window_control = "smartHome/kitchen/windowControl";
const char* topic_garage_control = "smartHome/garage/control";
```

And it is the function that responsible for the WIFI connection.

```
// Function to connect to WiFi
void setup_wifi() {
  delay(10);
  Serial.print("Connecting to ");
  Serial.println(ssid);

  WiFi.mode(WIFI_STA);
  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }

  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}
```

And it is function of callback

```
// MQTT callback function to handle incoming messages
void callback(char* topic, byte* payload, unsigned int length) {
  String receivedMsg = "";
  for (int i = 0; i < length; i++) {
    receivedMsg += (char)payload[i];
  }
```

This code to handel the led control as when it resive massage from hiveMQ server as on massege it turn on the six leds that found on the garden and if massage are off it turns off six LEDS.

```
// Handle LED control
if (strcmp(topic, topic_led_control) == 0) {
  if (receivedMsg == "on") {
    digitalWrite(LED1_PIN, HIGH);
    digitalWrite(LED2_PIN, HIGH);
    digitalWrite(LED3_PIN, HIGH);
    digitalWrite(LED4_PIN, HIGH);
    digitalWrite(LED5_PIN, HIGH);
    digitalWrite(LED6_PIN, HIGH);
  } else if (receivedMsg == "off") {
    digitalWrite(LED1_PIN, LOW);
    digitalWrite(LED2_PIN, LOW);
    digitalWrite(LED3_PIN, LOW);
    digitalWrite(LED4_PIN, LOW);
    digitalWrite(LED5_PIN, LOW);
    digitalWrite(LED6_PIN, LOW);
  }
}
```

This code to control the door servo as it opened and close by receiving massages from hiveMQ server as when the massage is open the door open and if the massage is close the door closed.

```
// Handle door control
if (strcmp(topic, topic_door_control) == 0) {
  if (receivedMsg == "open") {
    doorServo.write(90);  // Open door
  } else if (receivedMsg == "close") {
    doorServo.write(0);   // Close door
  }
}
```

This code to control the door servo as it opened and close by receiving massages from hiveMQ server as when the massage is open the door open and if the massage is close the door closed.

```
// Handle window control
if (strcmp(topic, topic_window_control) == 0) {
  if (receivedMsg == "open") {
    windowServo.write(90);  // Open window
  } else if (receivedMsg == "close") {
    windowServo.write(0);   // Close window
  }
}
```

```
// Handle garage control
if (strcmp(topic, topic_garage_control) == 0) {
  if (receivedMsg == "open") {
    garageServo.write(90);  // Open garage
  } else if (receivedMsg == "close") {
    garageServo.write(0);   // Close garage
  }
}
```

And in this part of code the function of reconnect as if it connected to hiveMQ server subscribes massages from the server and if the connection is lost it prints that as you should check to the connection.

```
// Function to reconnect to MQTT broker
void reconnect() {
  while (!client.connected()) {
    Serial.print("Attempting MQTT connection...");
    if (client.connect("ESP32Client", mqtt_username, mqtt_password)) {
      Serial.println("connected!");

      // Subscribe to all control topics
      client.subscribe(topic_led_control);
      client.subscribe(topic_door_control);
      client.subscribe(topic_window_control);
      client.subscribe(topic_garage_control);
    } else {
      Serial.print("failed, rc=");
      Serial.print(client.state());
      Serial.println(" try again in 5 seconds");
      delay(5000);
    }
  }
}
```

This part is responsible for define of the pins as it needs input to work as gas, rain and flame pins. And the output only as the leds.And I setup the serial begin as my laptop need ever 9600 or 115200. And I start wifi and mqtt connection and I initialize LCD.

```
// Initial setup function
void setup() {
  Serial.begin(9600);

  // Attach servos
  doorServo.attach(16);
  windowServo.attach(17);
  garageServo.attach(18);

  // Initialize pins
  pinMode(PIR_PIN, INPUT);
  pinMode(IR_DOOR_PIN, INPUT);
  pinMode(FLAME_PIN, INPUT);
  pinMode(GAS_PIN, INPUT);
  pinMode(RAIN_PIN, INPUT);
  pinMode(BUZZER_PIN, OUTPUT);
  pinMode(LED1_PIN, OUTPUT);
  pinMode(LED2_PIN, OUTPUT);
  pinMode(LED3_PIN, OUTPUT);
  pinMode(LED4_PIN, OUTPUT);
  pinMode(LED5_PIN, OUTPUT);
  pinMode(LED6_PIN, OUTPUT);

  // Start WiFi and MQTT connection
  setup_wifi();
  espClient.setCACert(root_ca);
  client.setServer(mqtt_server, mqtt_port);
  client.setCallback(callback);

  // Initialize LCD
  lcd.begin(16, 2);
}
```

And it is the loop function that responsible for all the project as it is an important function to execute the smart home and work of all sensors togather in the project.
And there is that handle the pir sensor as when it detect the motion in the garden that is in front of the door the six leds opens and lights up and if the motion disappear it turns off the six leds that found as three leds at the right and three leds at the left.

```
// Main loop function
void loop() {
  if (!client.connected()) {
    reconnect();
  }
  client.loop();

  // Handle PIR sensor (Garden entrance)
  if (digitalRead(PIR_PIN) == HIGH) {
    client.publish(topic_pir, "Motion detected in garden");
    digitalWrite(LED1_PIN, HIGH);
    digitalWrite(LED2_PIN, HIGH);
    digitalWrite(LED3_PIN, HIGH);
    digitalWrite(LED4_PIN, HIGH);
    digitalWrite(LED5_PIN, HIGH);
    digitalWrite(LED6_PIN, HIGH);
    delay(10000); // Keep LEDs on for 10 seconds
    digitalWrite(LED1_PIN, LOW);
    digitalWrite(LED2_PIN, LOW);
    digitalWrite(LED3_PIN, LOW);
    digitalWrite(LED4_PIN, LOW);
    digitalWrite(LED5_PIN, LOW);
    digitalWrite(LED6_PIN, LOW);
  }
```

In this part of the loop function is responsible for when IR sensor detect that someone behind the door it prints on the LCD that hello and demands for the password and if the is no one behind the door the door closed after 5 seconds

```
// Handle IR sensor (Door)
if (digitalRead(IR_DOOR_PIN) == HIGH && !personDetected) {
  personDetected = true;
  lcd.clear();
  lcd.print("Hello, enter");
  lcd.setCursor(0, 1);
  lcd.print("the password");
}else{delay(5000);          // Wait 5 seconds
      doorServo.write(0);   // Close door
      }
```

In this part of the loop function is responsible forManage the open and closed the door by input the password on the keypad as if the password is correct the lcd prints the password is correct and prints welcome and it opens the door And if the password is not correct it prints that on the LCD and the number of the trials increases by one and if the number of trials is more than or equal to 3 the buzzer turned on and it makes a sound.

```
// Keypad input for door password
char key = keypad.getKey();
if (key) {
  if (key == '#') {
    if (inputPassword == correctPassword) {
      client.publish(topic_door_control, "open");
      lcd.clear();
      lcd.print("Password correct");
      lcd.setCursor(0, 1);
      lcd.print("Welcome!");
      doorServo.write(90);  // Open door
      personDetected = false;
    } else {
      lcd.clear();
      lcd.print("Password incorrect");
      trial_count++;
      if (trial_count >= 3) {
        digitalWrite(BUZZER_PIN, HIGH);
      }
      inputPassword = "";
    }
  } else {
    inputPassword += key;
  }
```

In this part of the loop function is responsible for Manage the flame and MQ4 sensor (gas sensor) as when it detect the fire or gas emission it turns on the buzzer and it sends a message to the server of hiveMQ that it is fire or it is a gas.

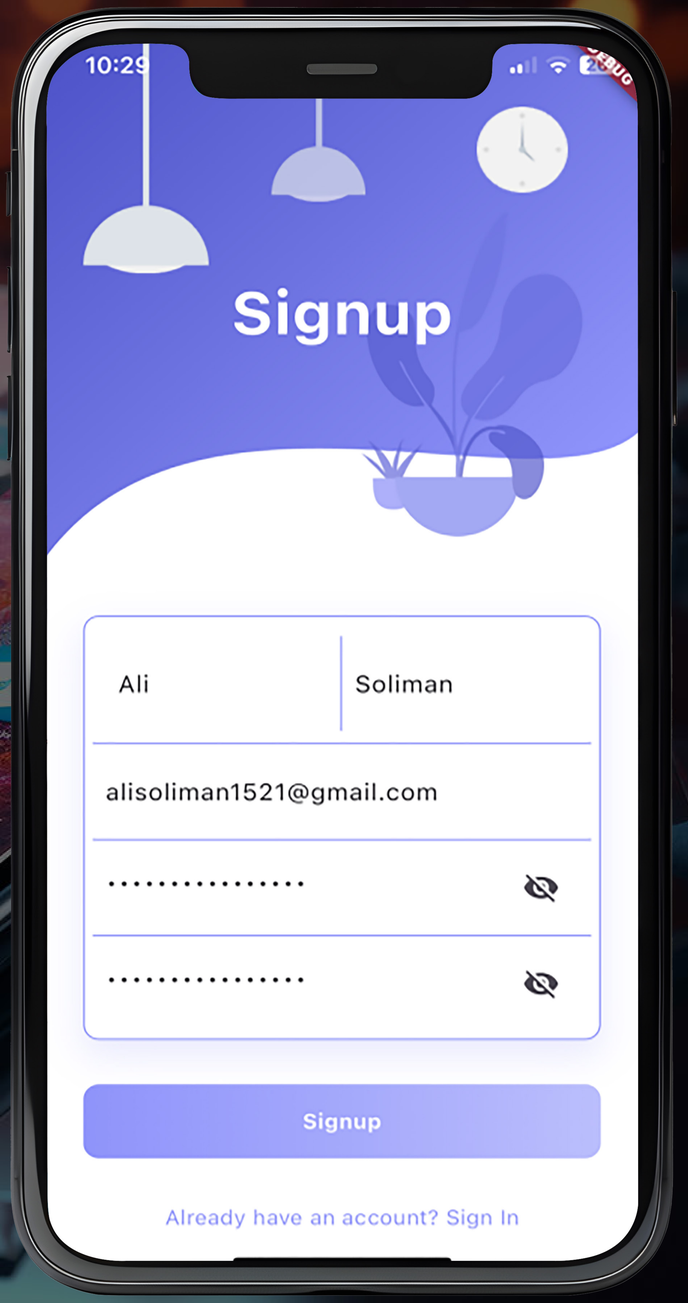
```
    // Handle flame sensor (Fire detection)
    if (digitalRead(FLAME_PIN) == HIGH) {
      client.publish(topic_flame, "Fire detected in kitchen");
      digitalWrite(BUZZER_PIN, HIGH);
    }
  // Handle gas sensor (Gas leak detection)
  if (digitalRead(GAS_PIN) == HIGH) {
      client.publish(topic_gas, "Gas leak detected in kitchen");
       digitalWrite(BUZZER_PIN, HIGH);
        }
```

In this part of the loop function is responsible for manage rain sensor as if it is rainy it sends a massage to the server of hiveMQ that it is rainy and close the window of the kitchen and when its not rainy it open the window.

```
// Handle rain sensor (Window control)
if (digitalRead(RAIN_PIN) == HIGH)
{   client.publish(topic_rain, "Rain detected in garden");
    windowServo.write(0);// Close window
}
else { windowServo.write(90); // Open window
    }
}
```

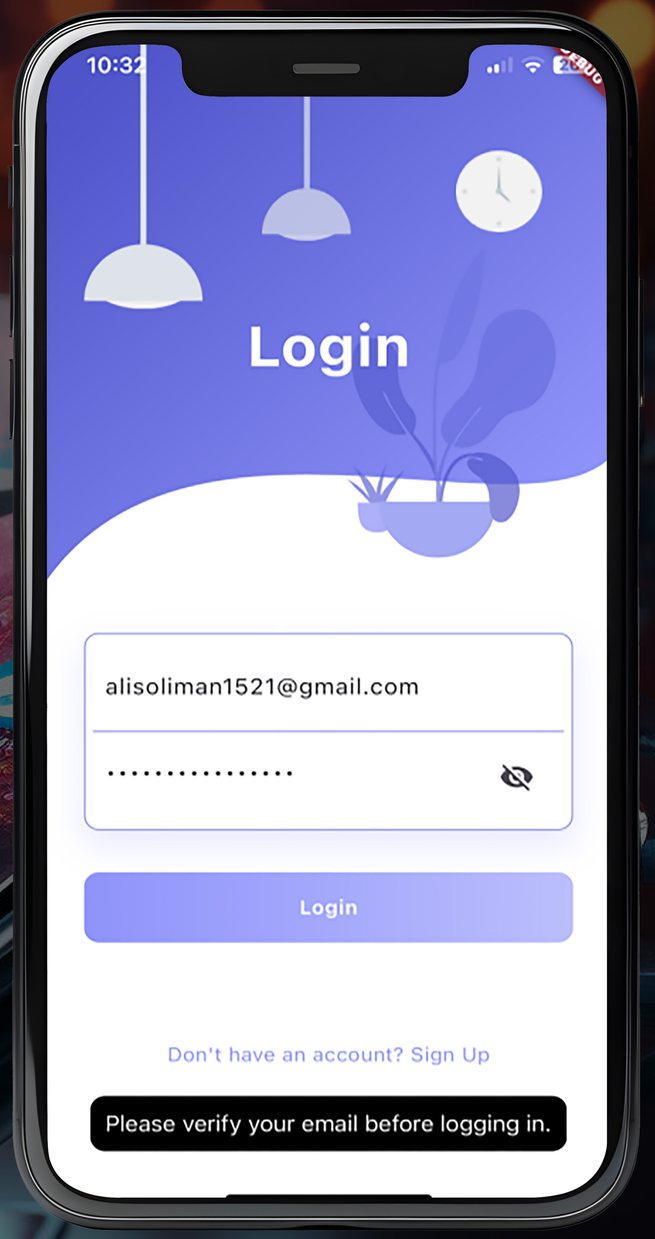
Flutter and firebase app :-

First I started off by researching the UI of flutter application (To make visual feed) to help me imagine and land on a design for my application that would be both good looking User interface and efficient as user experience to handle and use and when I got the idea of it and landed on a design for it I started using figma to see how it goes how it looks and how to handle the navigation between pages and then I started coding to create what I have imagined for it an it looks something like that :

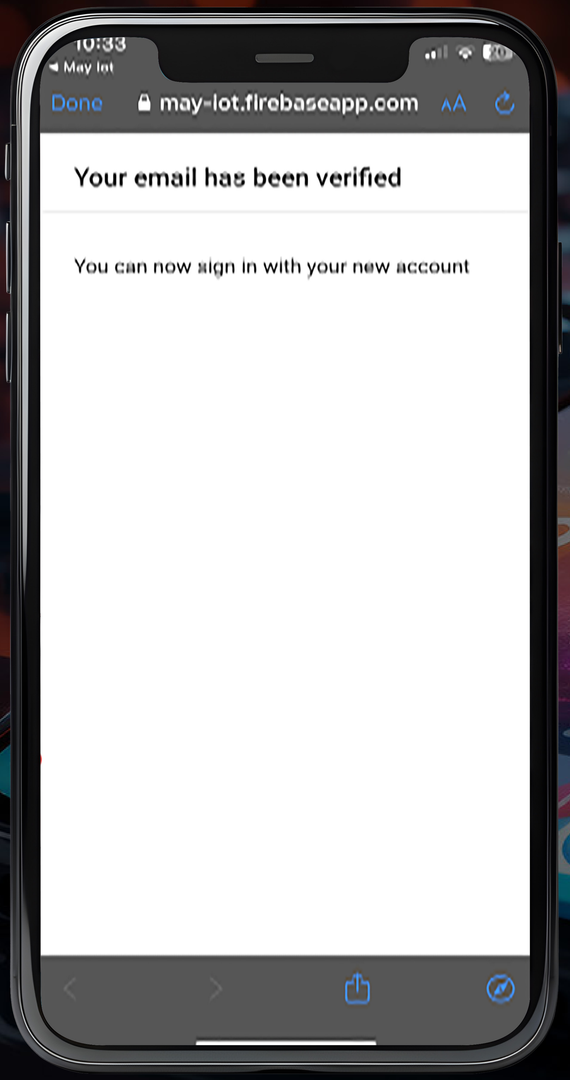


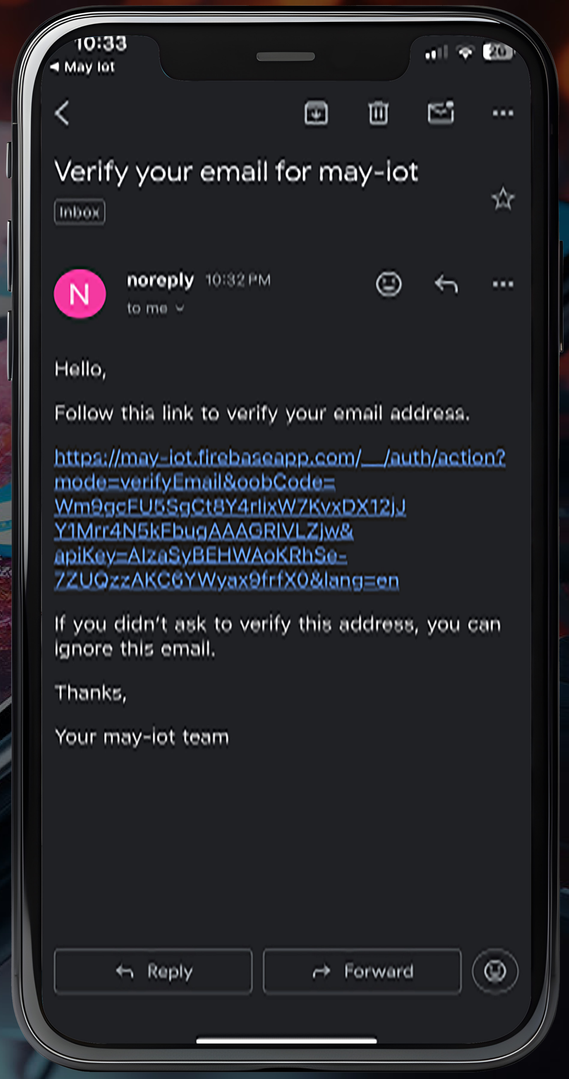
And that took me quit a while to handle and then I started with the backend of it to connect it to the firebase so you get to signup login for real and your data would be stored in the firestore database of the firebase as one of the accounts who get to use and login to the application

And then I started using the authentication in the firebase so I can verify your email and send you a verification email to check if it's yours and that everything is right your name email and password and you cannot login until you're verified as it shows in the screen here



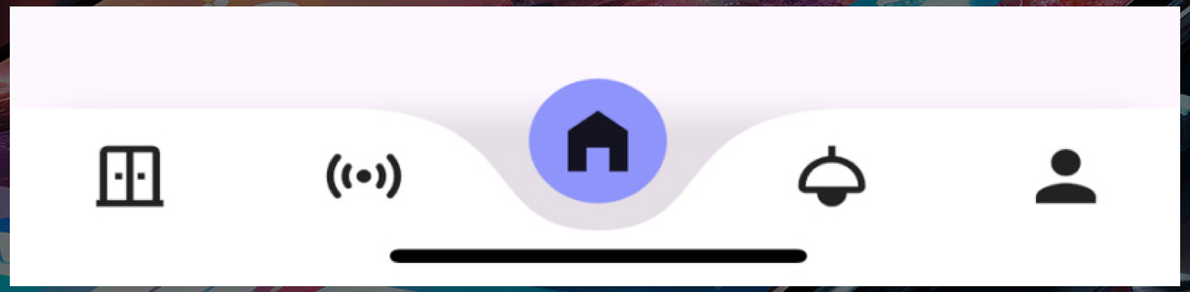
But if you do get the email and verify yourself you can



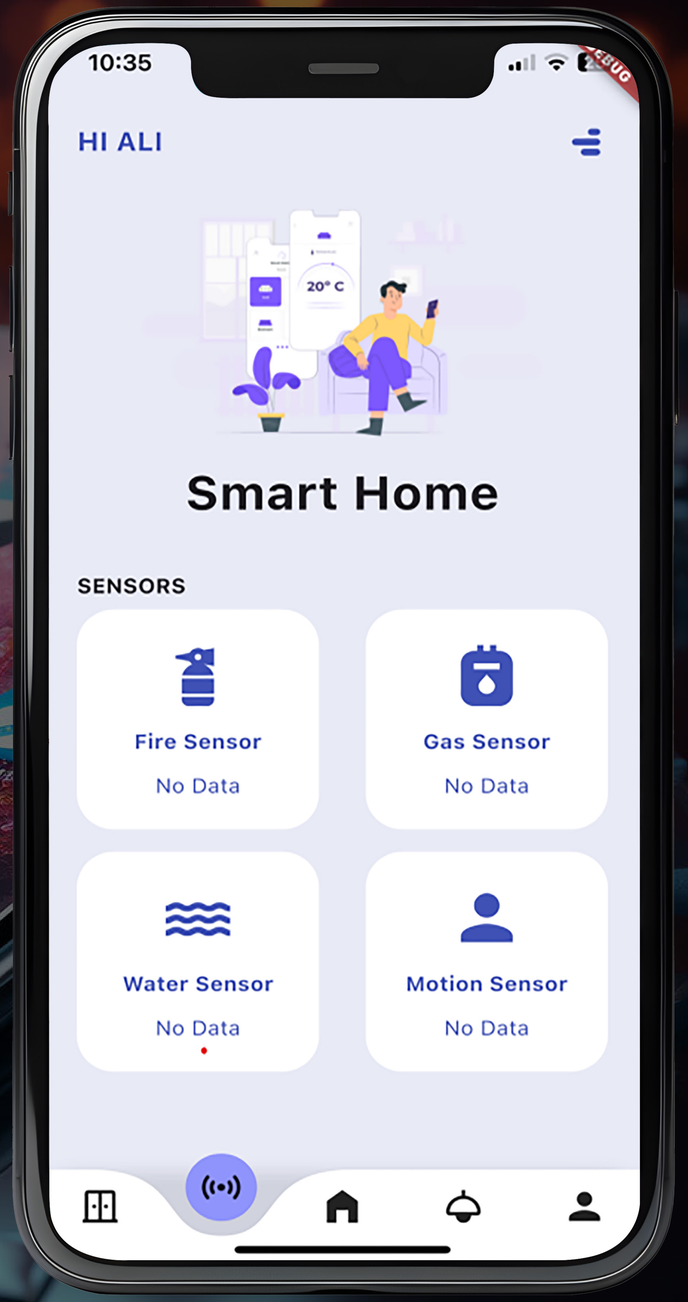


And now that you've verified your email you can login and get to the home page where a pop up message appears and greets you using the first and last name you've entered in your signup process and get to the home page where you would find a brief about our team I have not yet decided what to write down but by the time you read this and see the video you'd find everything included in it ISA

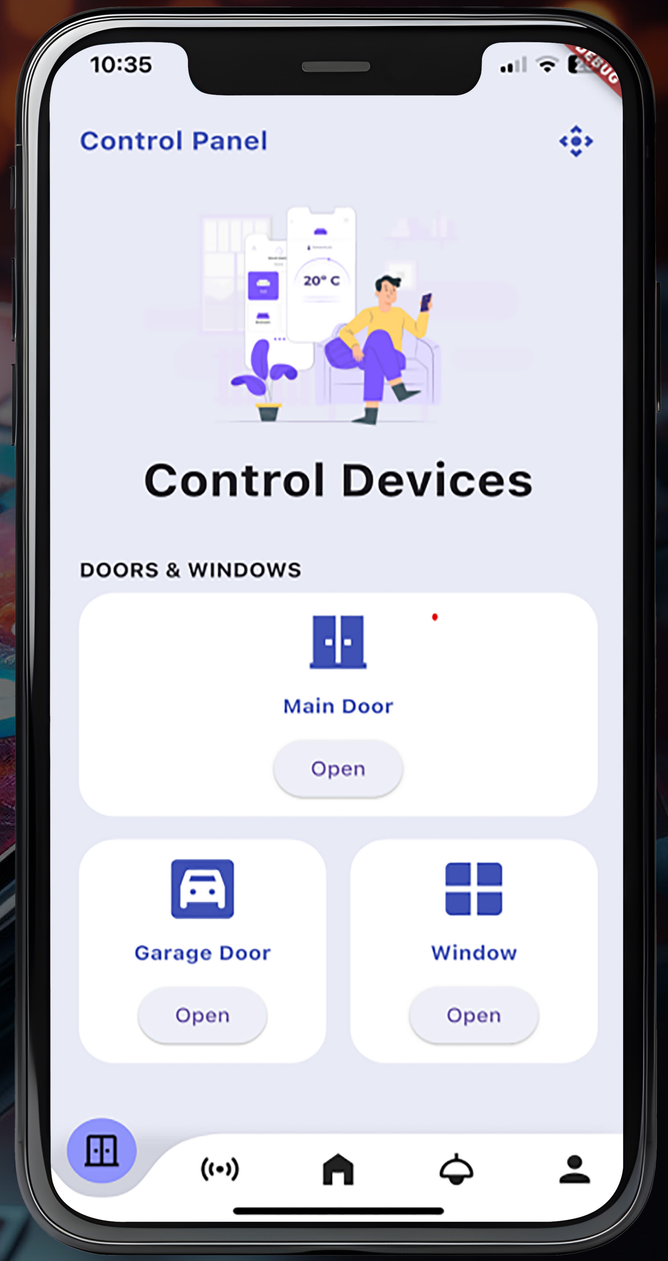
You'd find in the home screen the UI we landed on and the curved navigation bar I used and implemented to give the user a more joyful experience when he navigates through the pages I've made for him Also included in the **navigation bar 5 pages** one to control the door , one to control the LEDs , one to show the sensor implemented readings and changes in real time as it's showing in the screen below



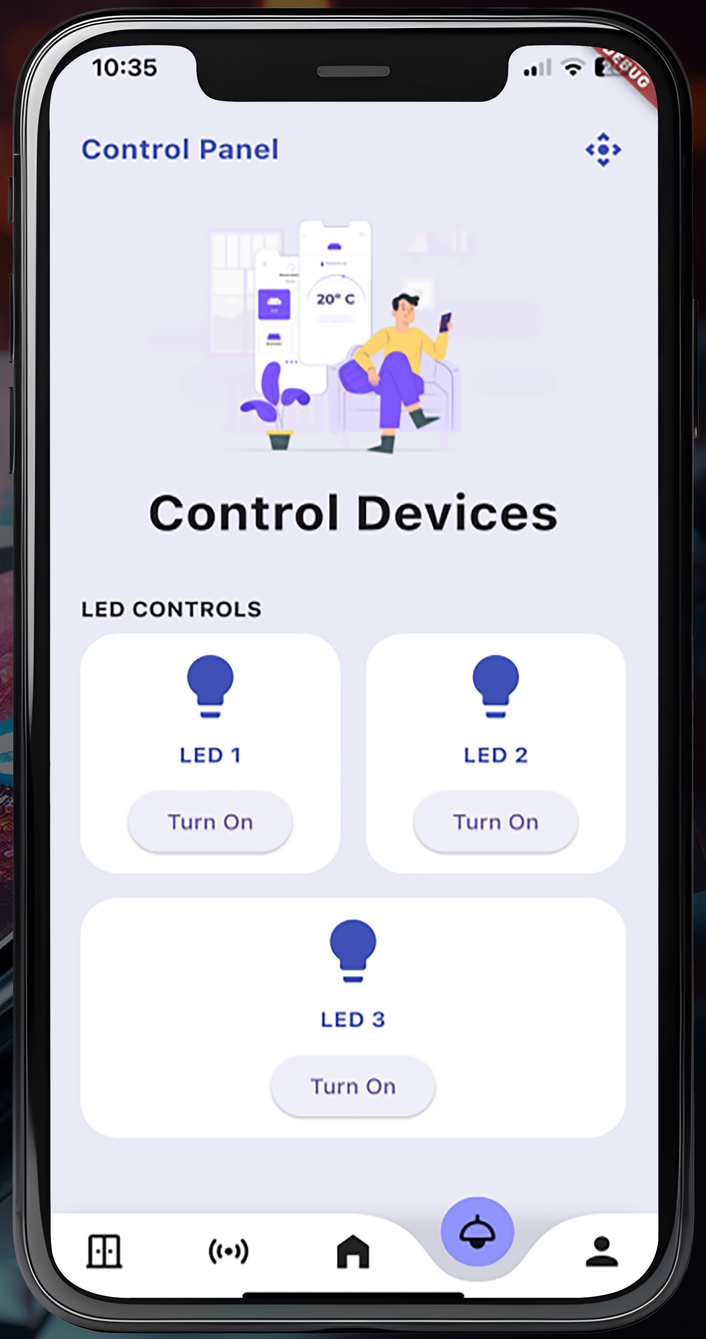
Also when the readings of each sensor reach a certain point you'd find the color of the widgets changed to red as a sign of danger fire or increase of the gas around you and all this implemented using MQTT to show real time changes



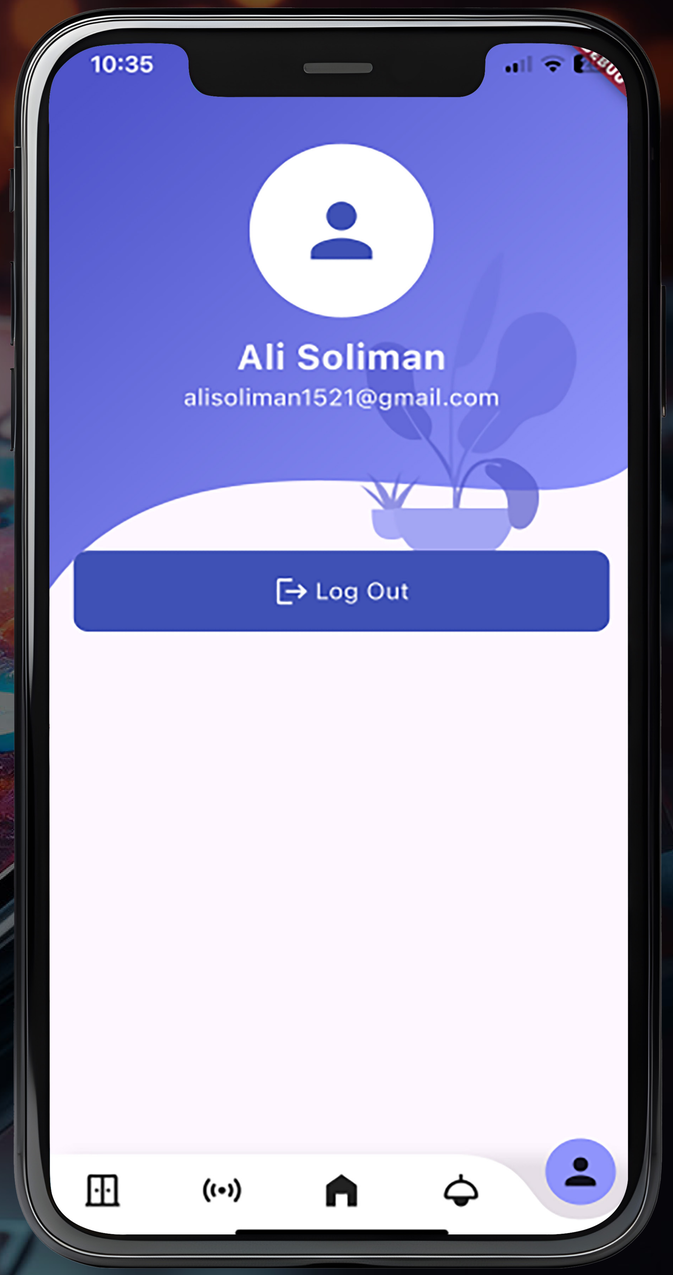
Ad in this page you get to control the servo's implemented in each of the doors to open or close them and also the window I used toggled elevated button where you get to press and they change from open to close showing the state of the door in the house



And the same with the LEDs we've implemented to light on and off as you press the buttons



And finally the profile page where you get to see the data you've entered in your signup process which is first , last name and the email that you've verifies directly from the firestore and you also get to logout of your account if you wanted to but still your data is kept safe in the firestore of the firebase I'm using.



Thank You For Watching

The Rest of the project in the link drive **Here:**