IoT Based Smart Home Automation System Using Arduino Uno R3 Microcontroller

PROJECT REPORT

Submitted in fulfilment for the J Component of ITA6010 - Internet of Things

CAL COURSE

in

Master of Computer Applications

by

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ABSTRACT

In recent years everything is getting automatized and digitalized, Human life is getting easier day by day as the things which were time consuming and requires human efforts are no more there in our life. Now Old manual systems are getting replaced by IoT systems which are reducing human efforts. Internet of things (IoT) provides us a Platform that makes connection of devices, which are used for sensing, controlling and which can be accessed from anywhere we want that is we can access IoT devices remotely. In this paper We are Proposing a smart home automation system where different sensors are used such as PIR sensor, gas sensor, piezoelectric sensor, ultrasonic distance sensor and gas sensor is connected with Arduino board and it is automatically controlling the functioning of the actuators such as Fans, Lights, Doors, and alarms. The Arduino board have microcontroller to control all the process occurred in home and it can be sensed by the various sensor and it can be alert to the owner by different mechanisms or some automated action is performed.

INTRODUCTION

In this project an IoT based smart home automation system is build using IoT simulation hardware available in Tinkercad. We simulated a home automation system using the Arduino Uno R3 microcontroller features such as gas leak detection, smart door lock, smart light and fan are implemented using sensors such as Ultrasonic Distance Sensor which measures the distance of the target object which is used for building smart door unlock system, PIR Sensor is used for implementing the smart fan controls that is the fan is automatically turned on if a presence of a human is detected, Photoresistors are used to implement smart light system, and gas sensor detects the quality of air inside the house so that potential gas leak can be prevented. Finally, all the data generated by the sensors are send to ThingSpeak where all the values are monitored and further processed for analysis and visualization. The smart home automation system will take benefit of its environment and allow flawless control whether the user is present or absent. Home automation system maintains the home activities by particular user and know the energy performance in home. The system can be defined as sensible home technology and the devices can manage the components in home environment.

LITERATURE SURVEY

[1]. This research proposal showcases safety solutions for a house. This system warns the user concerning various segments in the house, such as warning about a probable intruder, fire safety, identifying AC gas leakage, LPG gas leakage, break-in. Moreover, the system works as home automation as well by turning on the lights fans and also ensuring two-way protection for the user to enter the house. Consequently, if there is any nature of the hazardous situation, then the user shall be notified, and the safety measures or steps were taken by the user depends upon the user because there are both automated and manual modes to take proper steps during the disastrous incident. For the automation mode, the user can set trusted contacts to send them notifications for a period of time that the user was predefined. Again, camera modules are set in different corners of the room to monitor the situation inside the house during any possible catastrophic incident. This system notifies potential hazardous incidents that will help reduce casualties not only for the house but also may become the reason that can save lives from tragic incidents.

[2]. The proposed system is easily accessible by the web and also by the manual switches system. It gave the flexibility and reliability to the home appliances. The proposed system is working approximately in the real-time domain. In this proposed system a person can operate his home appliances through the internet and in cases, internet access is not available, manual switching could also be used. In both cases, the database will be updated. Working on the prototype has been demonstrated with the eight switches, though the number of switches could be increased by adding the number of microcontroller modules with the I2 C communication bus.

[3]. The main objective of this system is to make human life easy and comfortable by using IoT. In this proposed system users can change the load number according to their requirement through the web portal. And if the server is hosted on a public IP then the user can control this server and monitor this server from anywhere in this world. Though many future updates can further improve this proposed system. The server can be made more user friendly. More than one house can be connected into the server from there is possibility to monitor power consumption of an area. Further work is still going on. We believe that by using this Internet of Things we can create a difference between normal life and smart life.

[4]. Paper represents developments of smart home system with enhance security and comfort. Proposed system will enhance automation service and security. It reduces computation

overhead. In future system will updated to provide more secure mechanism and enhanced smart home services. Proposed system has reduces the need of gateway by using cloud for intermediate data storage and processing so it reduces cost also. As compare to Bluetooth, voice, Zigbee based systems our system provides more secure and automated IoT enabled smart home.

[5]. In this project, they proposed a simple solution for home automation based on ESP8266 chips and Raspberry Pi boards. Both choices are cost effective, small, and easy to work with. Moreover, the proposed qToggle system uses a very basic core API, allowing for a more flexible network design. qToggle is aimed to be a complete smart home prototype, with a lot of functionalities—automation, control, monitoring, and security and it is a system that could be continuously developed and improved.

One contribution of this paper involves the reviewing of the recent (last 10 years) papers published in the literature, commercial solutions, and open source home automation systems , so that the paper could be considered a survey. As compared to other papers in the literature, the proposed paper details the implementation of the solution (both hardware and software). Most smart home systems presented in the literature have been made with fewer functionalities, using different technologies, controllers, type of communication, user interface, etc

[6]. In this paper, they reviewed different IoT based smart home technologies. They classified smart home techniques into two categories namely, IoT based smart home automation and IoT based smart home security systems. Different IoT sensors, actuators and communication technologies of IoT based smart home automation systems are discussed. Limitations and future direction of IoT based smart home techniques are discussed. They believed that this survey work will help researchers to understand the architecture, current trends, challenges, and future scopes of an IoT based smart home automation.

[7]. An IoT-based interactive smart home automation system is designed and implemented. The system used compact, low power and low-cost single board computing platforms. Using mobile phones, users can activate virtual buttons and virtual sliding switches as well as type text and voice commands to monitor and control home appliances from anywhere anytime.

[8]. In this paper, a SHAS prototype along with its Android App has been successfully implemented. Features like remote status observation and actuating of devices, data communication through cloud infrastructure as well as an operational and physically employed prototype has been developed. This proposed prototype has been implemented with 6 loads, 4

of which are used for the status monitoring purpose and the remaining two has been used for demonstration of controlling action. The design uses ATmega16 as its master controller because of its cost-effective feature as well as the number of pins available with Atmega16 is more when compared with Arduino Uno in the context of home automation application. For the control of speed of fan or intensity of light, three timers are required, two for generating firing pulse and one to read the command from the dashboard, which is provided in the ATmega16 micro-controller. The scheme, discussed above in the context of small-scale domestic application which uses an open-source dashboard, can be scaled up for commercial application by designing a customized dashboard application. In the future work, it can control the status of the fan or AC, according to the humidity and temperature of the room.

[9]. This paper proposed secured IoT-based home automation applications using WSNs. In WSNs, because of the limited computational power of sensor nodes, an efficient security mechanism based on effective key generation mechanism which could accomplish all major data security requirements and consumes less processing time for data encryption is well needed. In this study a security algorithm, namely TBSA, based on a simple and efficient key generation procedure is developed. The proposed IoT integrates low power Wi-Fi and the proposed TBSA in WSNs with internet to provide additional benefits of increased coverage range and capability of supporting large number of sensor nodes due to usage of low power Wi-Fi module; it also consumes less processing time for data encryption because of the utilization of the proposed TBSA algorithm. The experimental results obtained from the hardware implementation have elaborated that the proposed algorithm TBSA is more energy-efficient for data encryption than all compared approaches. Furthermore, it has been verified in this study that developed IoT platform fulfills all major security requirements including network security (secure localization, non-repudiation, availability, access control, trustworthiness and authentication) and data security (confidentiality, privacy, integrity, and data freshness).

[10]. The IoT can be describing as collection of large numbers of interconnected devices, objects, services with the ability to connect, share and communicate with each other. IOT is used and implemented in different domains like health care, agriculture, smart homes, smart cities, transportation, energy production and distribution. One of the most important domains of IOT is smart home system. Smart homes bring comfort and ease in our lives. Smart home operations are usually control through the mobile devices. A user-friendly interface allows users to control the home appliance more effectively as compared to complex one. If the system

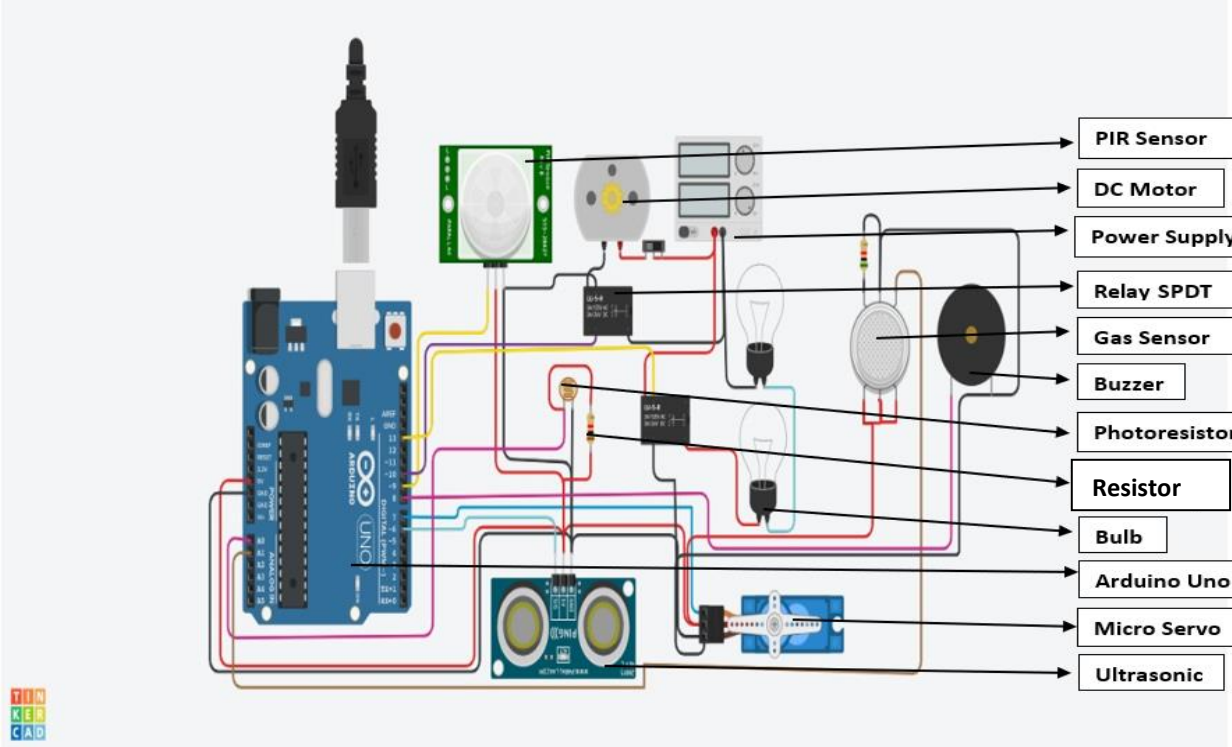
is complex, then numbers of interactive smart home items are misused because they are quite difficult to operate and understand. The smart home system that are available in the market are expensive and are not affordable for families of middle and lower middle class. Therefore, there is need that users of smart home system should be clearly identified and develop a system that is flexible, cost effective, adaptable and easy to use by users of all age group. In this project a cost-effective smart home system is presented by using Arduino microcontroller, ESP8266 Wi-Fi module, different sensors (flame sensor, PIR sensor). Three different potential experiments are successfully performed (remotely control lights, fans and appliances, safety system and security system). Home appliance can be control remotely without putting any extra effort. Security system, safety system is successfully implemented and used in this presented smart home model. The smart home user can detect unwanted or suspicious activity and enhance security of their home, they also increase safety of their homes by installing the safety system which detects Fire and timely intimates the smart home user. The presented system is low cost, user friendly and brings comfort in our life.

PROBLEM STATEMENT

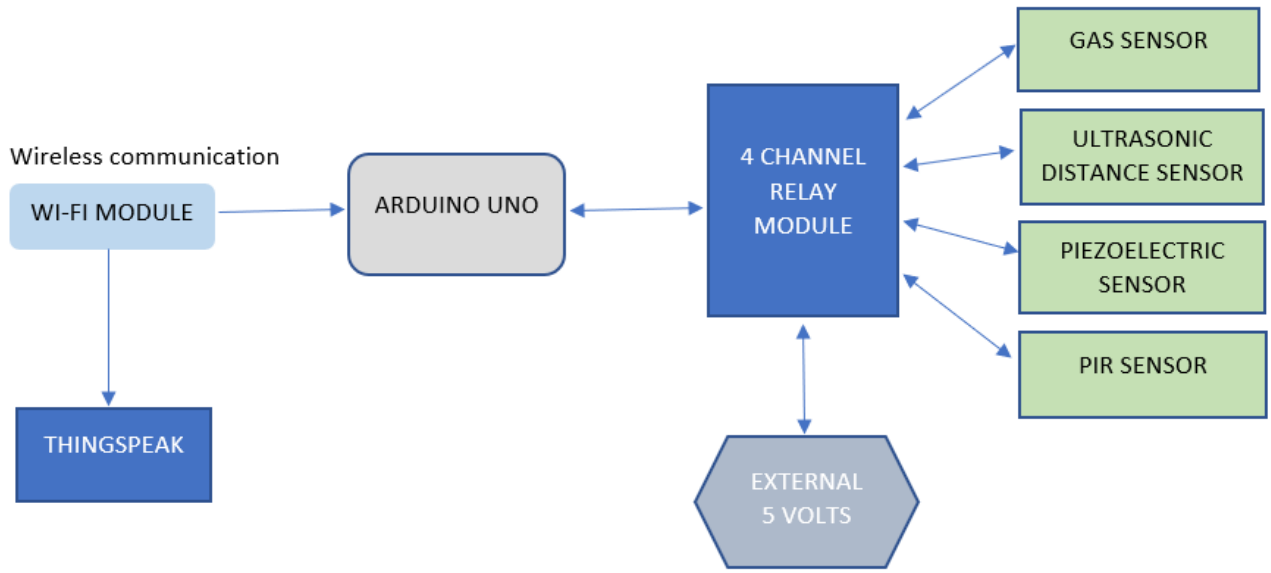
Creating a robust framework for smart home automation that can control the home appliances according to the environment and presence of humans. The appliances or alarms should run automatically when a specific action is triggered due to some critical values or break point values. The system should also provide user an efficient way of controlling the devices within the house and also provide security, ease of access and reliability.

SYSTEM DESIGN

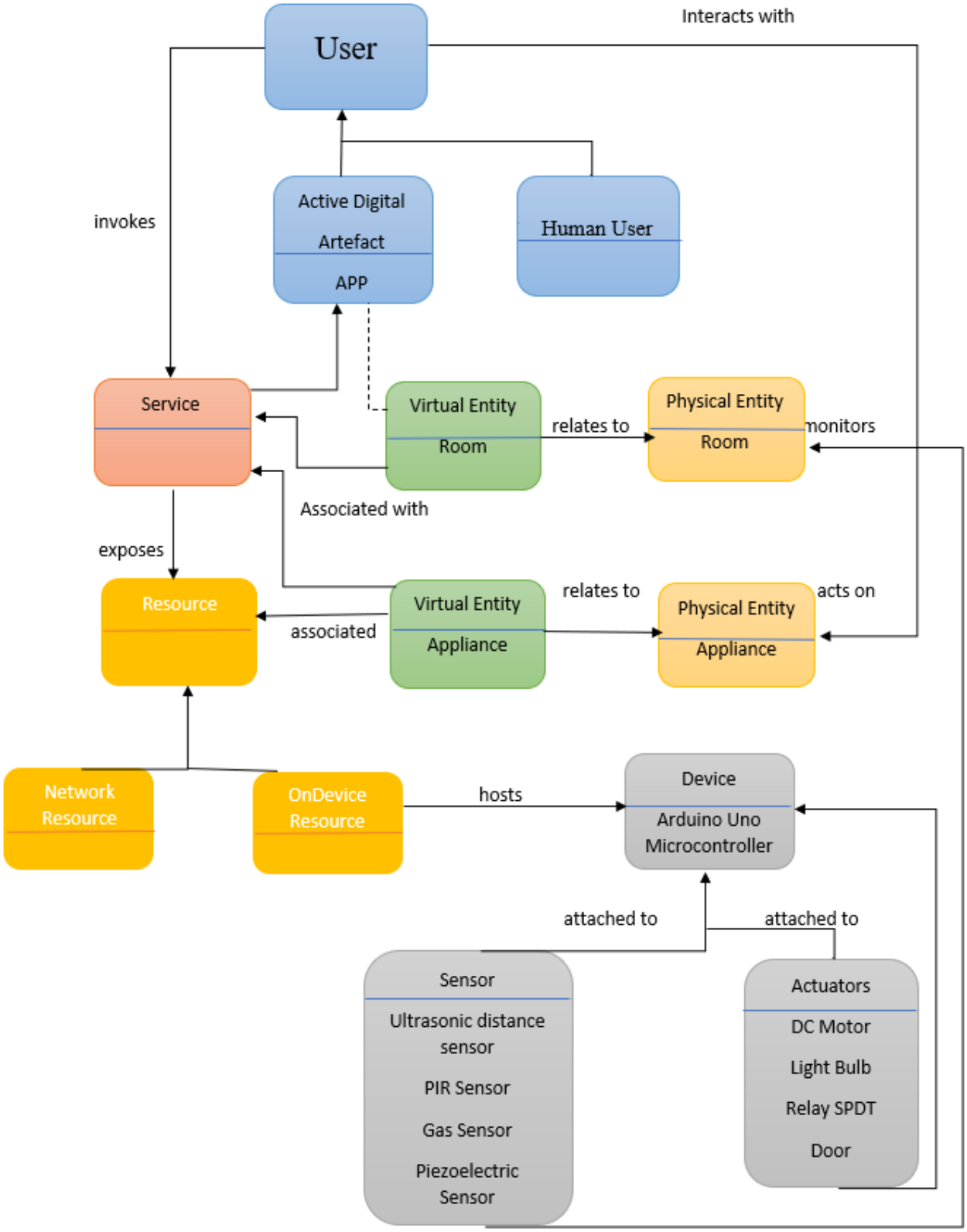
PHYSICAL DIAGRAM:



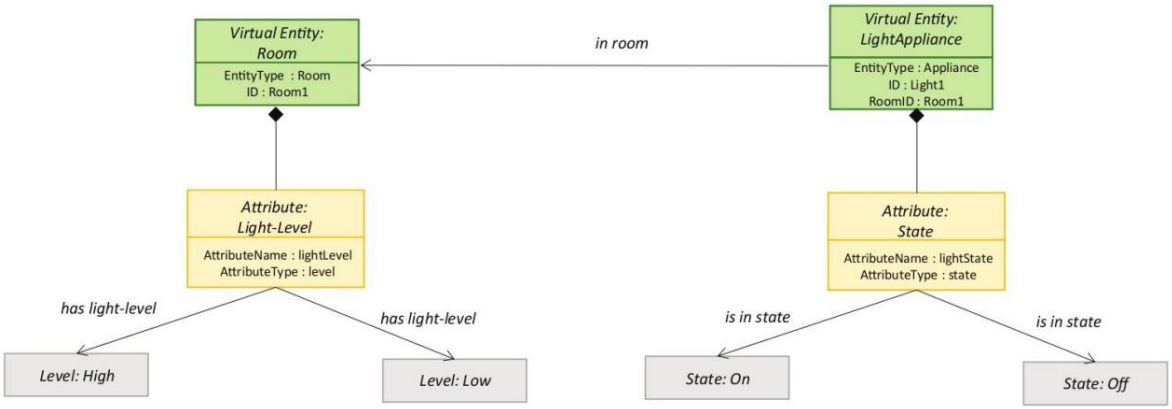
LOGICAL DIAGRAM:



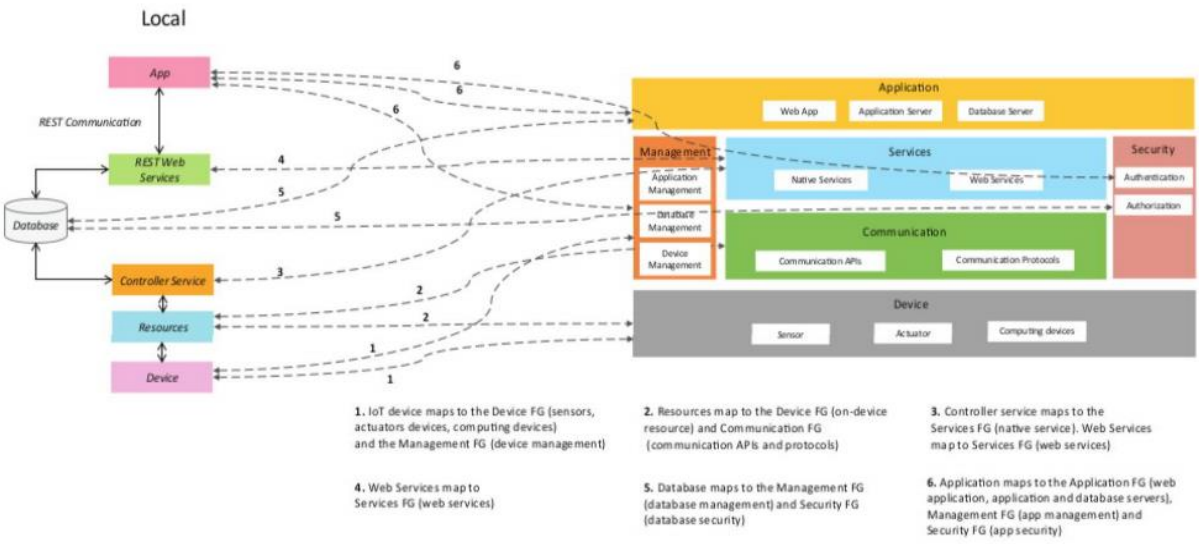
DOMAIN MODEL SPECIFICATION:



INFORMATION MODEL SPECIFICATION:



FUNCTIONAL VIEW SPECIFICATION:



WORKING MODEL AND HARDWARE INTEGRATION:

Arduino Uno R3:

Arduino Uno is a microcontroller board based on the ATmega328P. 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.

Ultrasonic Distance Sensor:

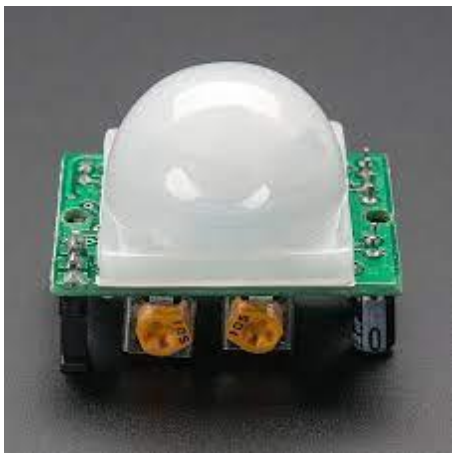
An ultrasonic sensor is **an electronic device that measures the distance of a target object by emitting ultrasonic sound waves**, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound. Its 5v and GND pins are connected to 5v and GND of Arduino and micro servo, then the trigger pin or the SIG is connected to Arduino D6 pin.

Positional Micro Servo:

Servo motors (or servos) are self-contained electric devices that rotate or push parts of a machine with great precision. Here in our project, it is used to simulate the properties of a door as its levers moving back and forth can be used to control doors. We connect the 5v of micro servo to 5v of ultrasonic distance sensor then connect it to 5v of Arduino, then connect GND of micro serve to GND of ultrasonic distance sensor which is then connected to GND of Arduino. Then servo signal pin is connected to Arduino D7.

PIR Sensor:

The PIR sensor has two slots in it, each opening is made of an sensitive material that is responsive to IR. The lens utilized here isn't actually doing a lot thus we see that the two openings can 'see' out past some distance (essentially the affectability of the sensor). At the point when the sensor is inactive, the two spaces distinguish a similar measure of IR, the surrounding sum emanated from the room or dividers or outside. At the point when a warm body like a human or creature cruises by, it first blocks one portion of the PIR sensor, which causes a positive differential change between the two parts. At the point when the warm body leaves the detecting region, the opposite occurs, whereby the sensor produces a negative differential change. These change beats are what is identified. PIR's signal pin is connected to D9 of Arduino, 5v and GND are connected to the Ultrasonic Distance sensor which is in turn connected to the Arduino 5v and GND, In our project it is used to sense the presence of a living entity when it senses the presence the DC motor is turned on that is used to simulate a fan and light bulbs are turned on.

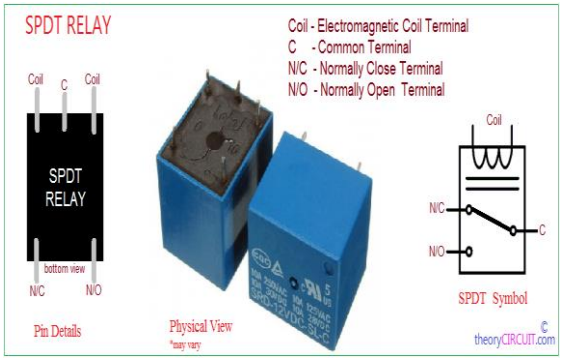


DC Motor

A direct current (DC) motor is a type of electric machine that converts electrical energy into mechanical energy. DC motors take electrical power through direct current, and convert this energy into mechanical rotation. In out Project it is used to simulate the working of a fan on detecting a human presence and automatically switching off when person leaves.

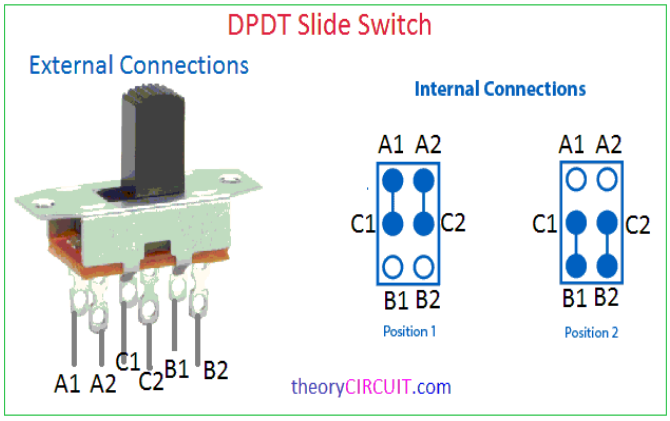
SPDT Relay

The SPDT Relay(30A) is a high quality Single Pole Double Throw Relay(SPDT).The Relay consists of a coil, 1 common terminal, 1 normally closed terminal, and one normally open terminal. When the coil of the relay is at rest (not energized), the common terminal and the normally closed terminal have continuity. When the coil is energized, the common terminal and the normally open terminal have continuity. This relay's coil is rated up to 5V and the contact is rated up to 30A (@250VAC, 30VDC). It is used to control high current devices. Anytime you want to switch on/off a device which draws more current or works with a high voltage, you'll need to use a relay. That is to say, the relay is "a high voltage or current switch controlled by low voltage". The coil of an SPDT relay that we most commonly use draws very little current. Now, with this 30A relay, you can control much more high-current switch devices such as headlights, parking lights, horns, etc.



Slide Switches

Switches are used to turn ON/OFF devices and to connect different parts of a circuit. The slide-switch in Arduino moves the slider of the switch from the open position (ON) to the closed position (OFF). It allows the flow of current in the circuit without the need for splice wire. The slide switches are widely used in small circuits applications.

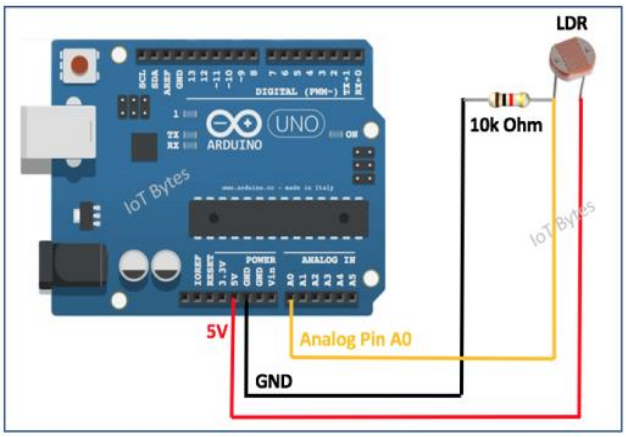


Power supply

All Arduino boards need electric power to function. A power supply is what is used to provide electric power to the boards and typically can be a battery, USB cable, AC adapter or a regulated power source device. There are different ways to power your Arduino board. The most common way is through the USB connector available on every board, but there are also a few other possibilities to power your board. USB is one of them. USB-Arduino board can operate satisfactorily on power that is available from the USB port. It provides 5V DC voltage and can be sourced from the port from a PC, wall socket adapter or portable power bank.

Photoresistor

Photoresistor or light-dependent resistor (abbreviated as LDR) or photoconductor is a special resistor made of semiconductor materials such as cadmium sulphide or cadmium selenide. Its working principle is based on the internal photoelectric effect. The stronger the light, the lower the resistance value. With the increase of the light intensity, the resistance value decreases rapidly, and the bright resistance value can be as small as 1KΩ or less. The photoresistor is very sensitive to light, and it shows a high resistance state when there is no light, and the dark resistance can generally reach 1.5MΩ. It is used to control the dimming of the lights or automatically switching it ON or OFF.



1kilo ohm resistor:

We have connected 1k ohm resistor between Terminal 1 and VCC to make it work as a resistor divider because it divides down the input voltage.

Light bulb:

We have connected light bulb along with relay in series with power supply. Light Bulbs are ON when environment light intensity is LOW and Light Bulbs turn OFF when environment light intensity is HIGH

Gas Sensor and 5 kilo ohm resistor:

We have connected a gas sensor with the system which is used to detect the gas in home environment. For gas sensor, the MQ-2 sensor has two signals like analog and digital outputs,

ground and VCC. We have provided 5 kilo ohm resistance in between A1 and H1 of the gas sensor using the resistor. And A2 has been connected to Arduino A1.

Piezoelectric Sensor:

We have connected a piezoelectric sensor representing a buzzer here. Buzzer is connected in GND and D8. It converts applied stress from the sensor into electrical energy to produce a vibration or a buzz sound.

ARDUINO SOURCE CODE:

Code for controlling different actions on different sensor inputs:

```
#include <Servo.h>


int output1Value = 0;

int sen1Value = 0;
```

```
int sen2Value = 0;
int const gas_sensor = A1;
int const LDR = A0;
int limit = 400;

long readUltrasonicDistance(int triggerPin, int echoPin)
{
  pinMode(triggerPin, OUTPUT);  // Clear the trigger
  digitalWrite(triggerPin, LOW);
  delayMicroseconds(2);
// Sets the trigger pin to HIGH state for 10 microseconds
  digitalWrite(triggerPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(triggerPin, LOW);
  pinMode(echoPin, INPUT);
  // Reads the echo pin, and returns the sound wave travel time in microseconds
  return pulseIn(echoPin, HIGH);
}

Servo servo_7;

void setup()
{
   Serial.begin(9600);              //initialize serial communication
```

```
  pinMode(A0, INPUT);                   //LDR
  pinMode(A1,INPUT);          //gas sensor
  pinMode(13, OUTPUT);                  //connected to relay
  servo_7.attach(7, 500, 2500); //servo motor

  pinMode(8,OUTPUT);          //signal to piezo buzzer
  pinMode(9, INPUT);          //signal to PIR
  pinMode(10, OUTPUT);                  //signal to npn as switch
  pinMode(4, OUTPUT);                   //Red LED
  pinMode(3, OUTPUT);                   //Green LED

}

void loop()
{

    //------light intensity control------//
//-------------------------------------------------------------
   int val1 = analogRead(LDR);
  if (val1 > 500)
          {
          digitalWrite(13, LOW);
   Serial.print("Bulb ON = ");
   Serial.print(val1);
```

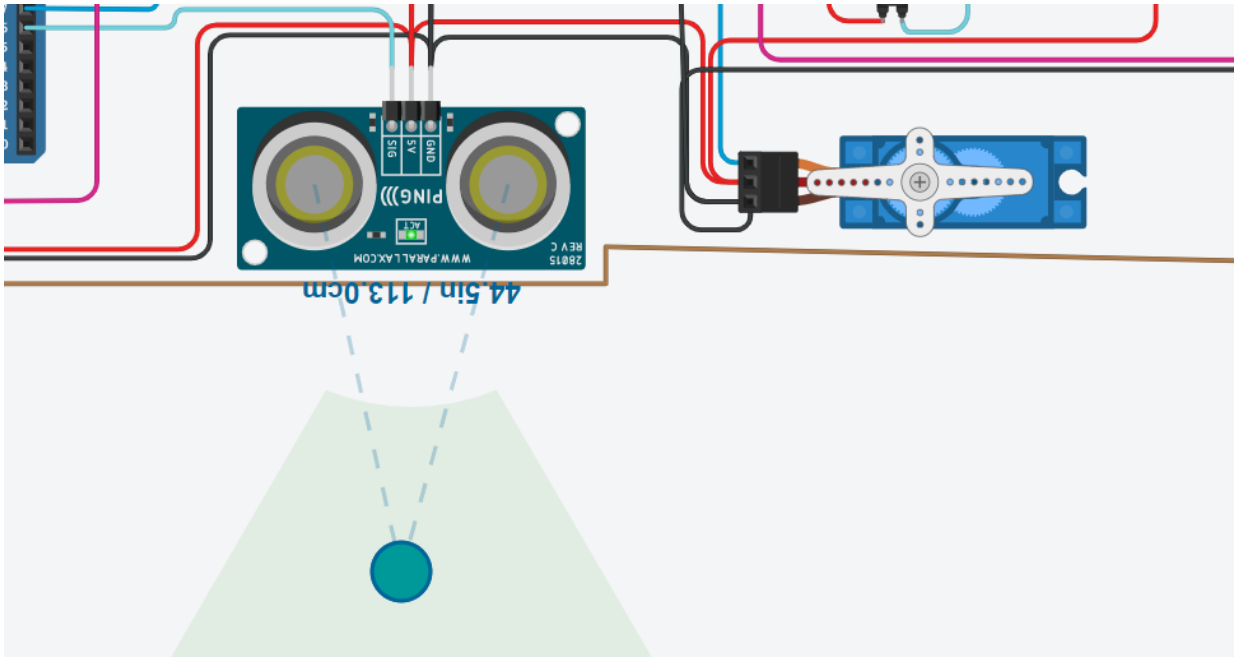
```
        }
  else
        {
        digitalWrite(13, HIGH);
     Serial.print("Bulb OFF = ");
    Serial.print(val1);
        }

//-------------------------------------------------------------
      //------ light & fan control --------//
//-------------------------------------------------------------
  sen2Value = digitalRead(9);
  if (sen2Value == 0)
        {
        digitalWrite(10, LOW); //npn as switch OFF
        digitalWrite(4, HIGH); // Red LED ON,indicating no motion
        digitalWrite(3, LOW); //Green LED OFF, since no Motion detected
    Serial.print("     || NO Motion Detected    " );
        }

  if (sen2Value == 1)
        {
        digitalWrite(10, HIGH);//npn as switch ON
    delay(5000);
```

```
        digitalWrite(4, LOW); // RED LED OFF
        digitalWrite(3, HIGH);//GREEN LED ON , indicating motion detected
    Serial.print("            || Motion Detected!      " );
        }


//-------------------------------------------------------------
      // ------- Gas Sensor --------//
//-------------------------------------------------------------
int val = analogRead(gas_sensor);      //read sensor value
  Serial.print("|| Gas Sensor Value = ");
  Serial.print(val);                                  //Printing in serial monitor
//val = map(val, 300, 750, 0, 100);
  if (val > limit)
        {
        tone(8, 650);
        }
        delay(300);
        noTone(8);


 //-------------------------------------------------------------
     //-------  servo motor  ---------//
 //-------------------------------------------------------------
  sen1Value = 0.01723 * readUltrasonicDistance(6, 6);
```

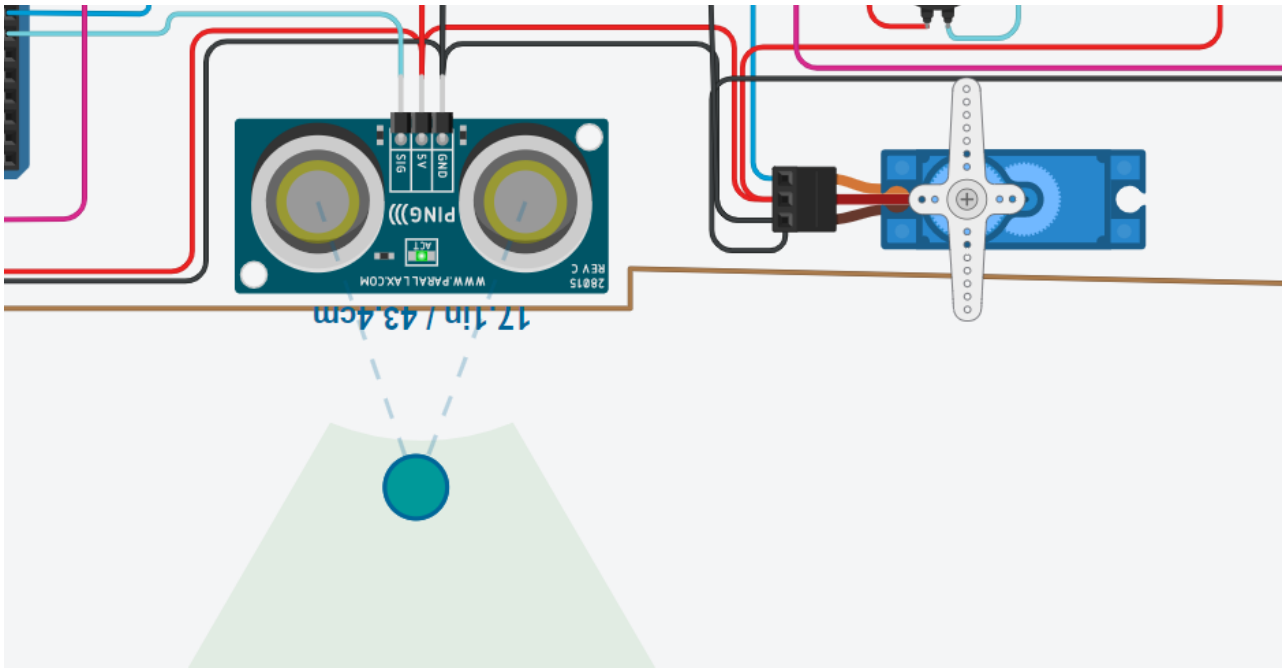
```
 if (sen1Value < 100)
        {
        servo_7.write(90);
   Serial.print("            || Door Open!  ; Distance = ");
   Serial.print(sen1Value);
  Serial.print("\n");


        }
 else
        {
        servo_7.write(0);
   Serial.print("            || Door Closed! ; Distance =  ");
   Serial.print(sen1Value);
   Serial.print("\n");
 }
 delay(10); // Delay a little bit to improve simulation performance
}
```

SYSTEM DEMONSTRATION

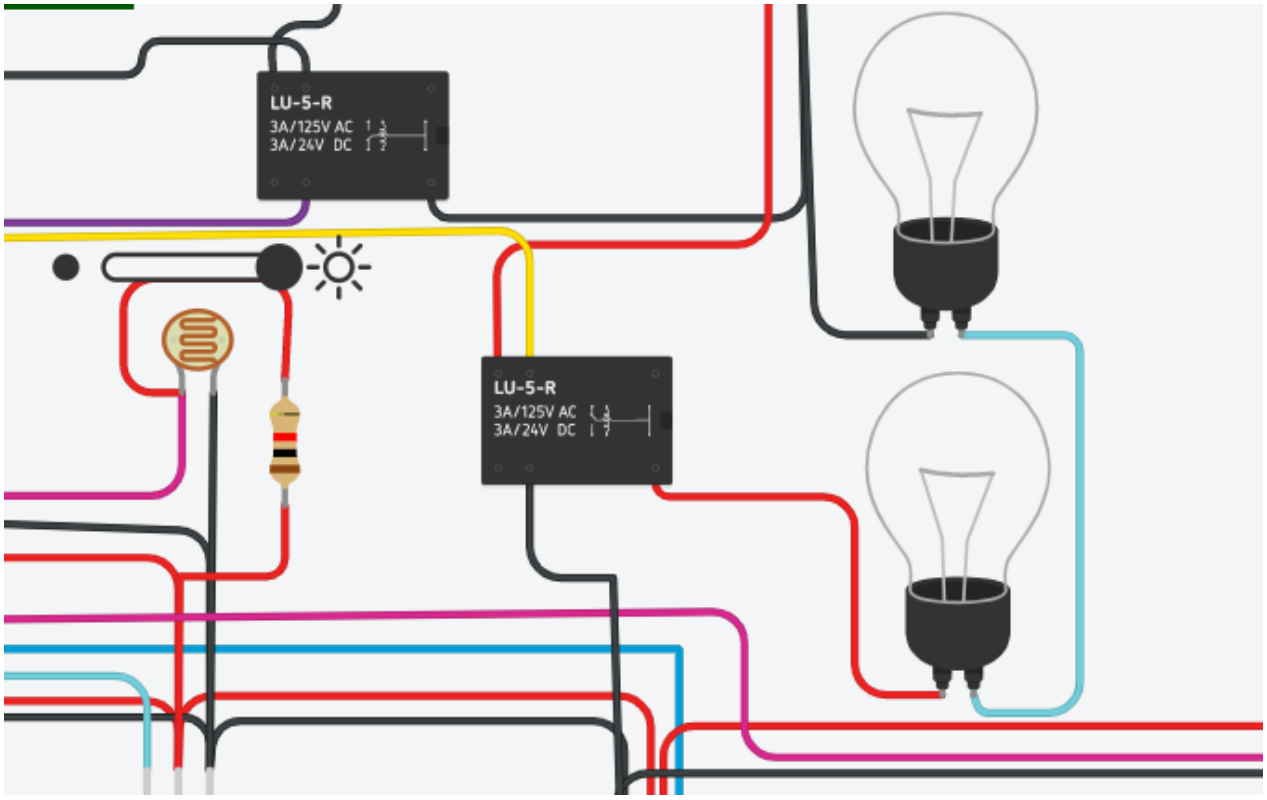
Door closed when user is far:



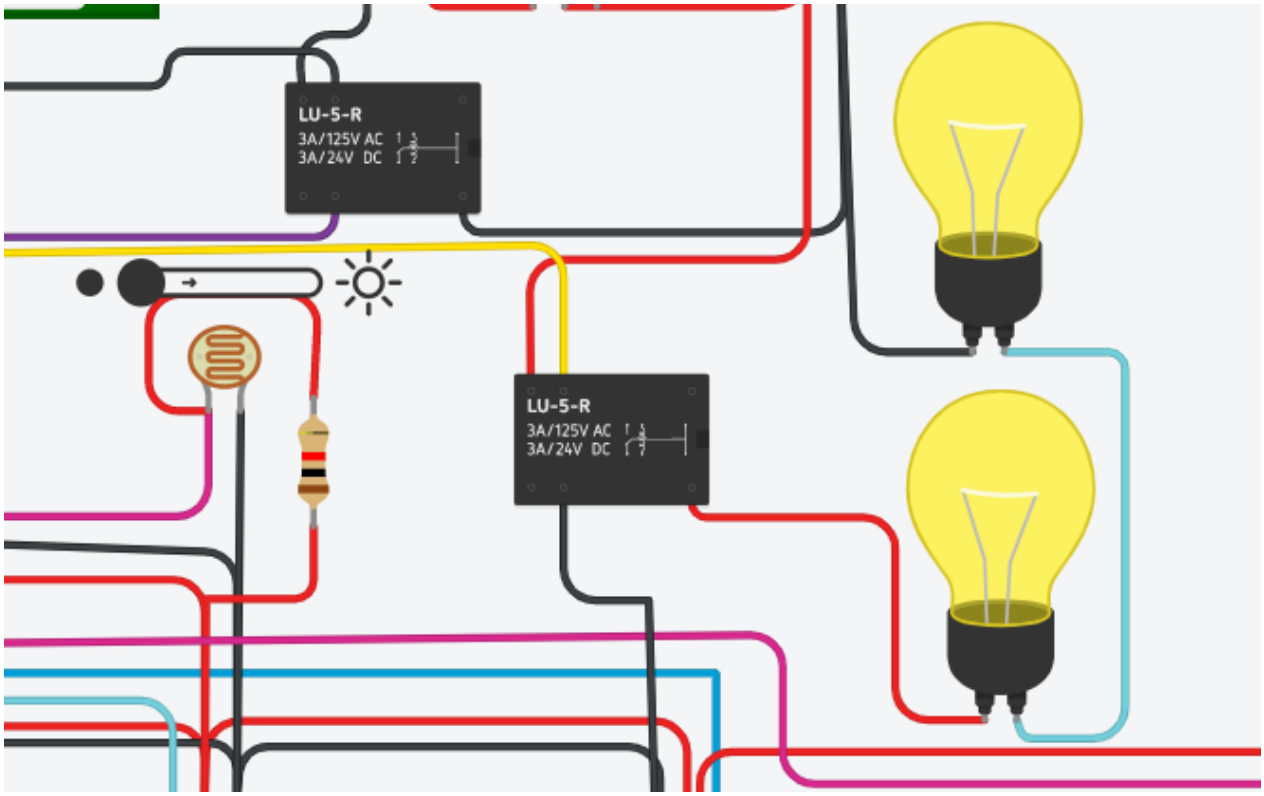
Door open when user is nearby:



Light bulbs are OFF when environment light intensity is HIGH:

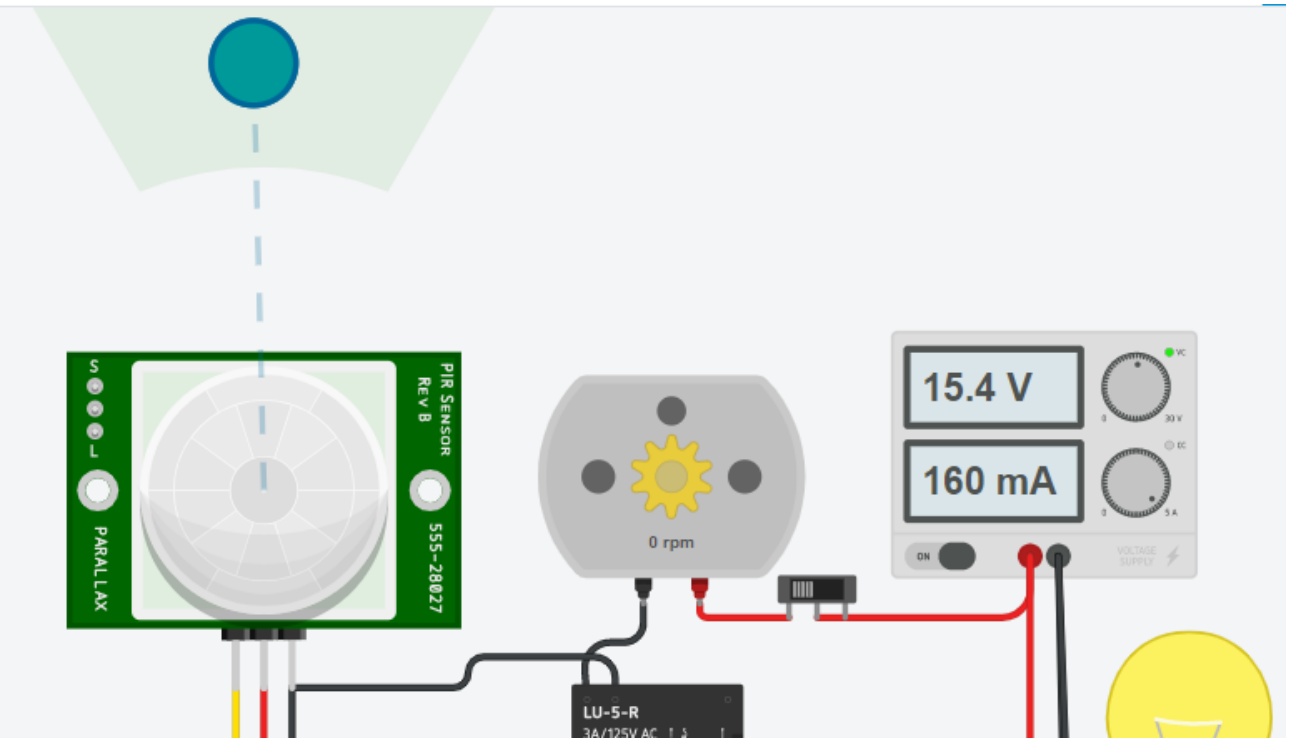


Light bulbs turn automatically ON when the environment light intensity is LOW:

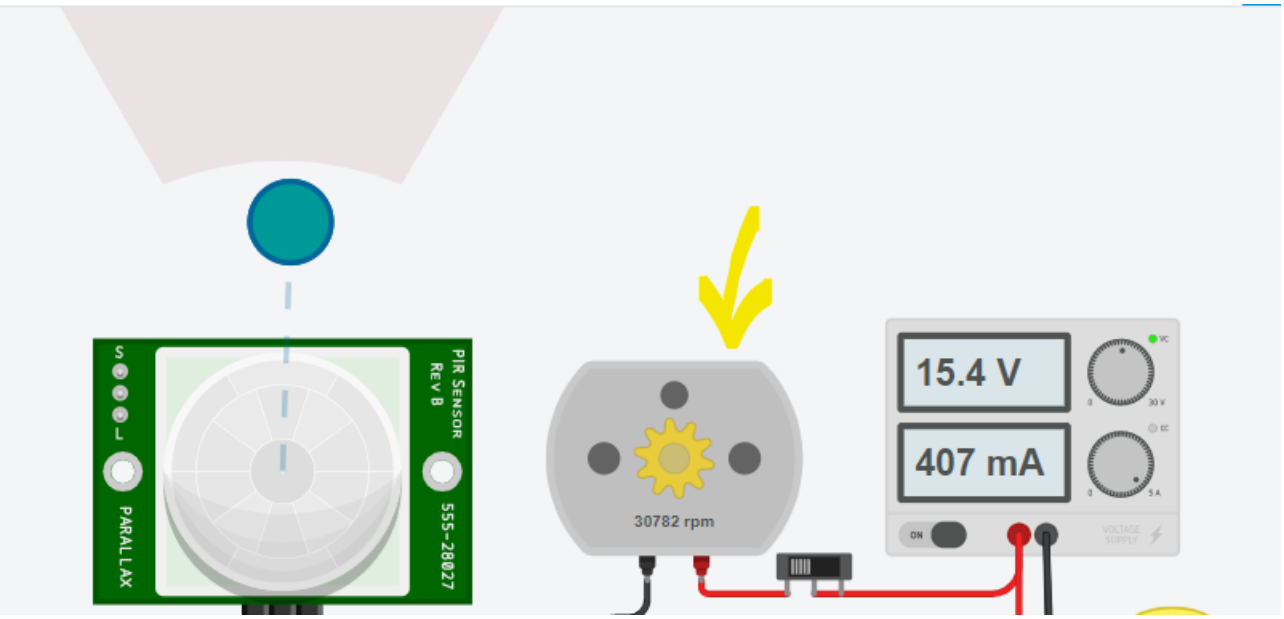


Presence is detected by PIR Sensor to control DC Motor (Fan).

Fans are OFF when user is far



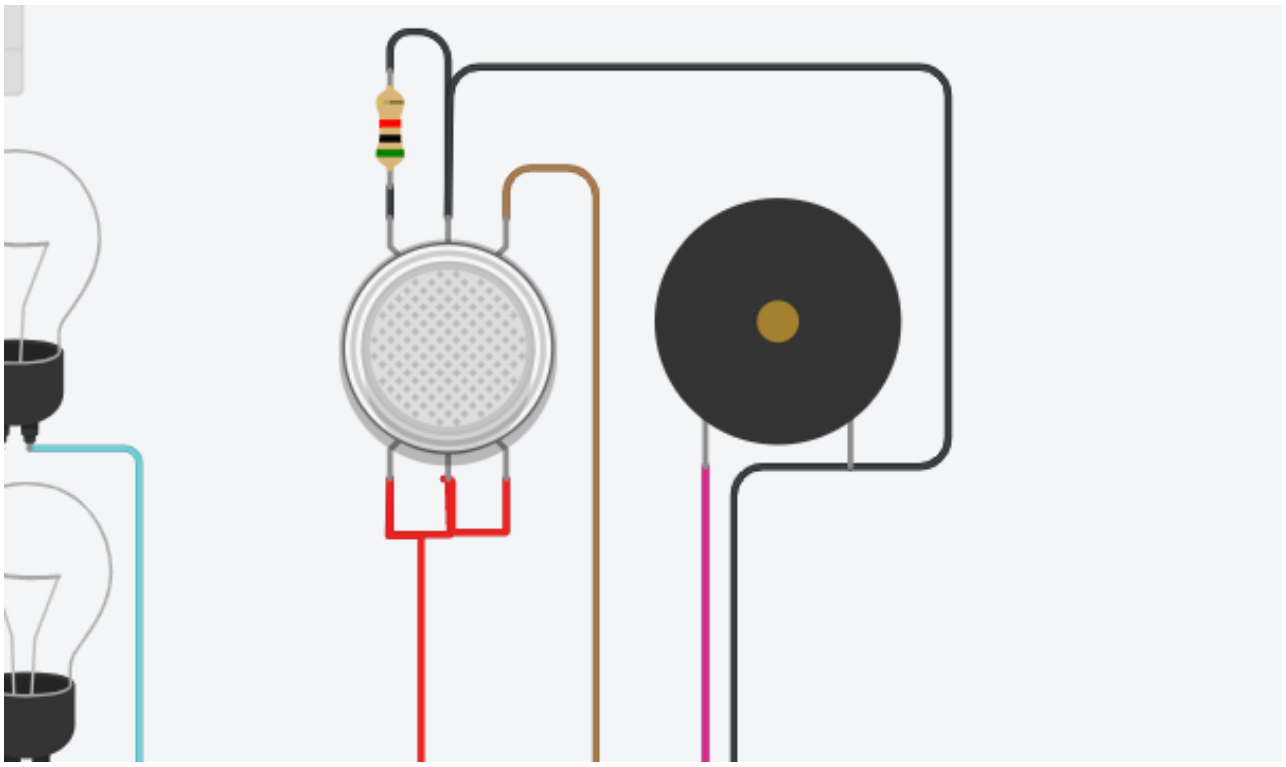
Fans turn on Automatically when user is nearby:



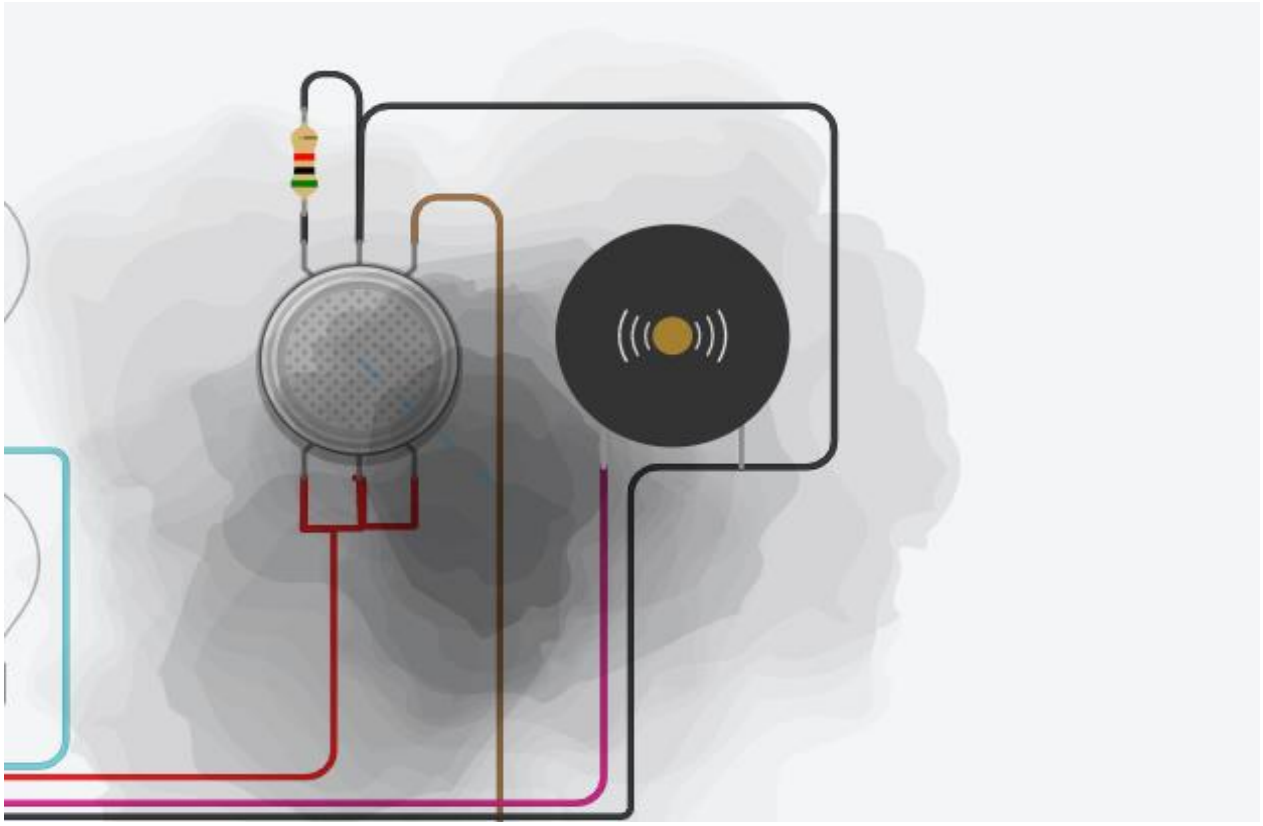
We can see that the RPM increased in the DC Motor

Working of Gas Sensor:

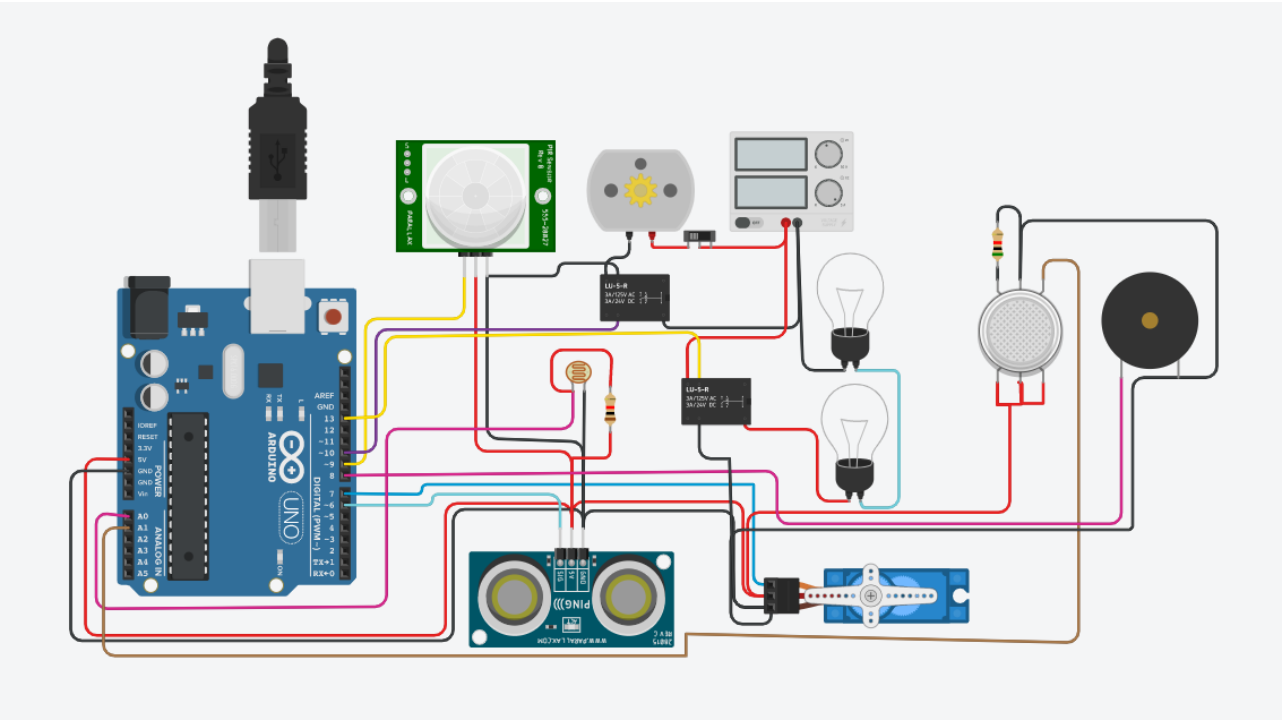
The alarm is OFF when no Gas is detected in the Air

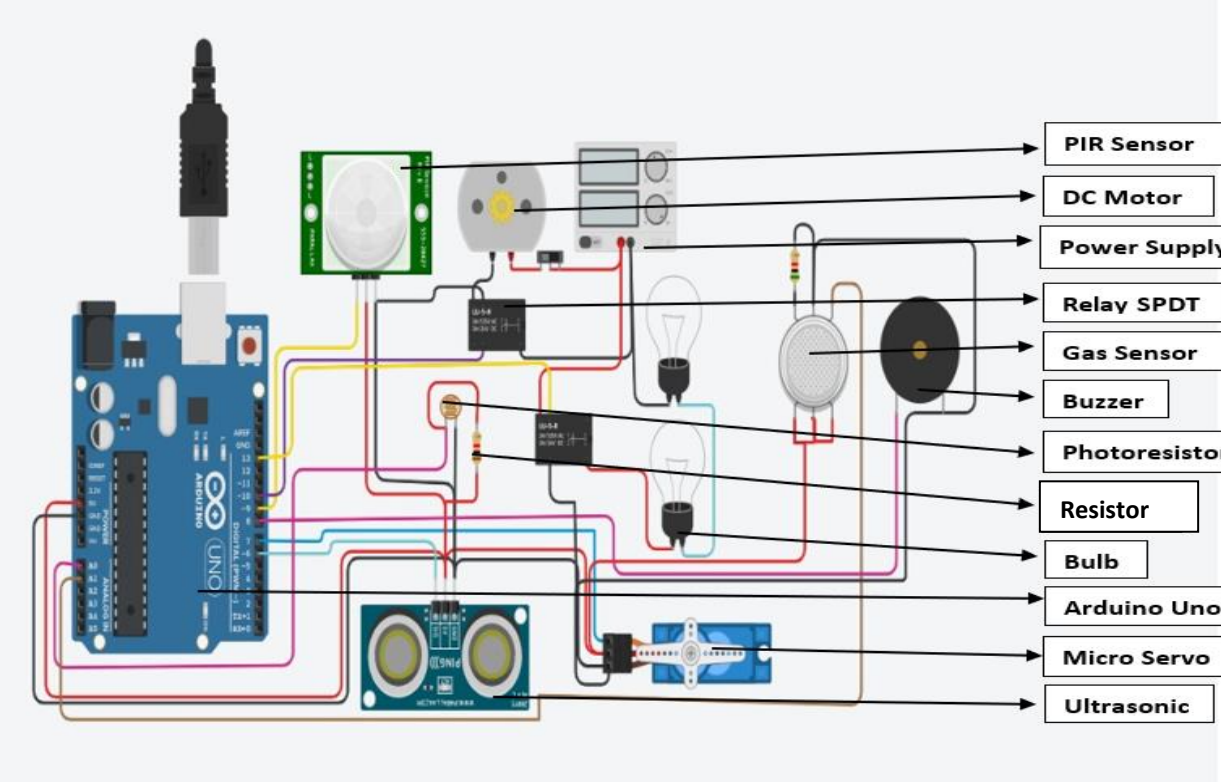


Alarm turn ON automatically when presence of Gas is Detected:



Complete System:

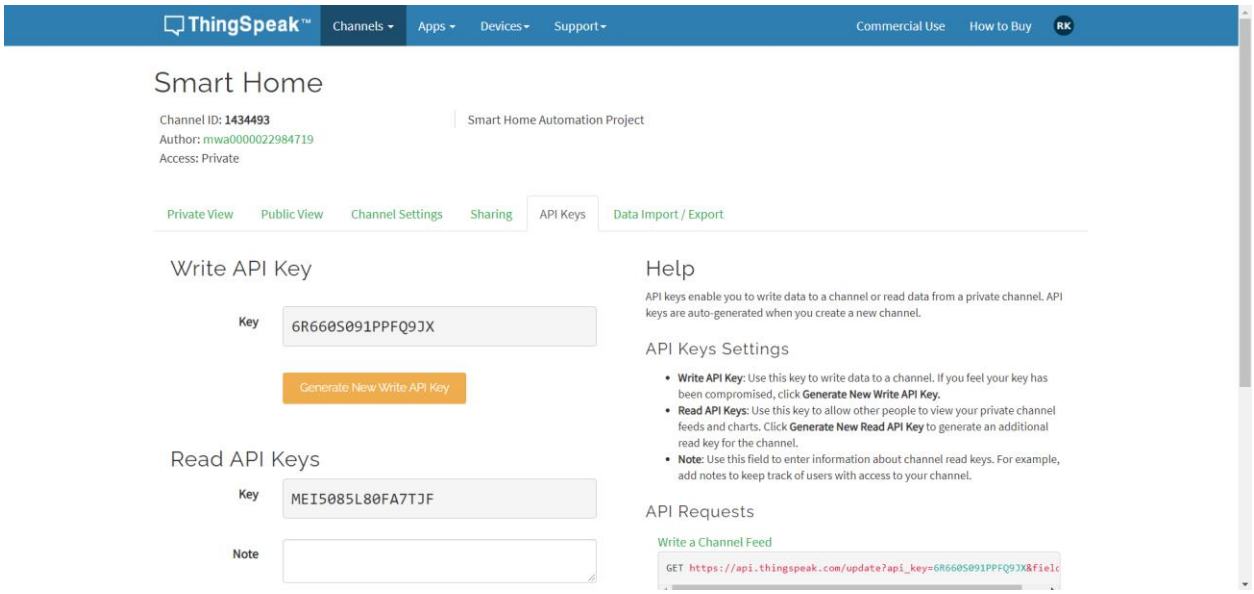




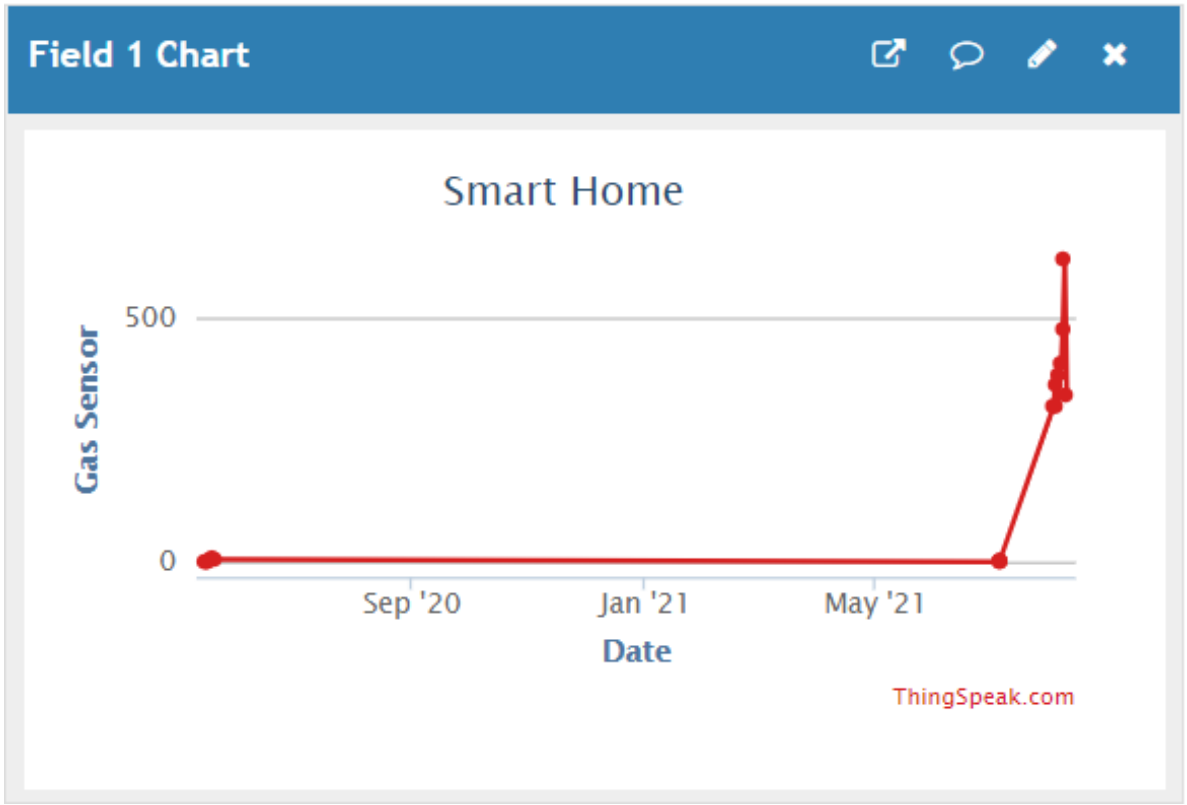
RESULTS

ThinkSpeak Visualization of Sensor data

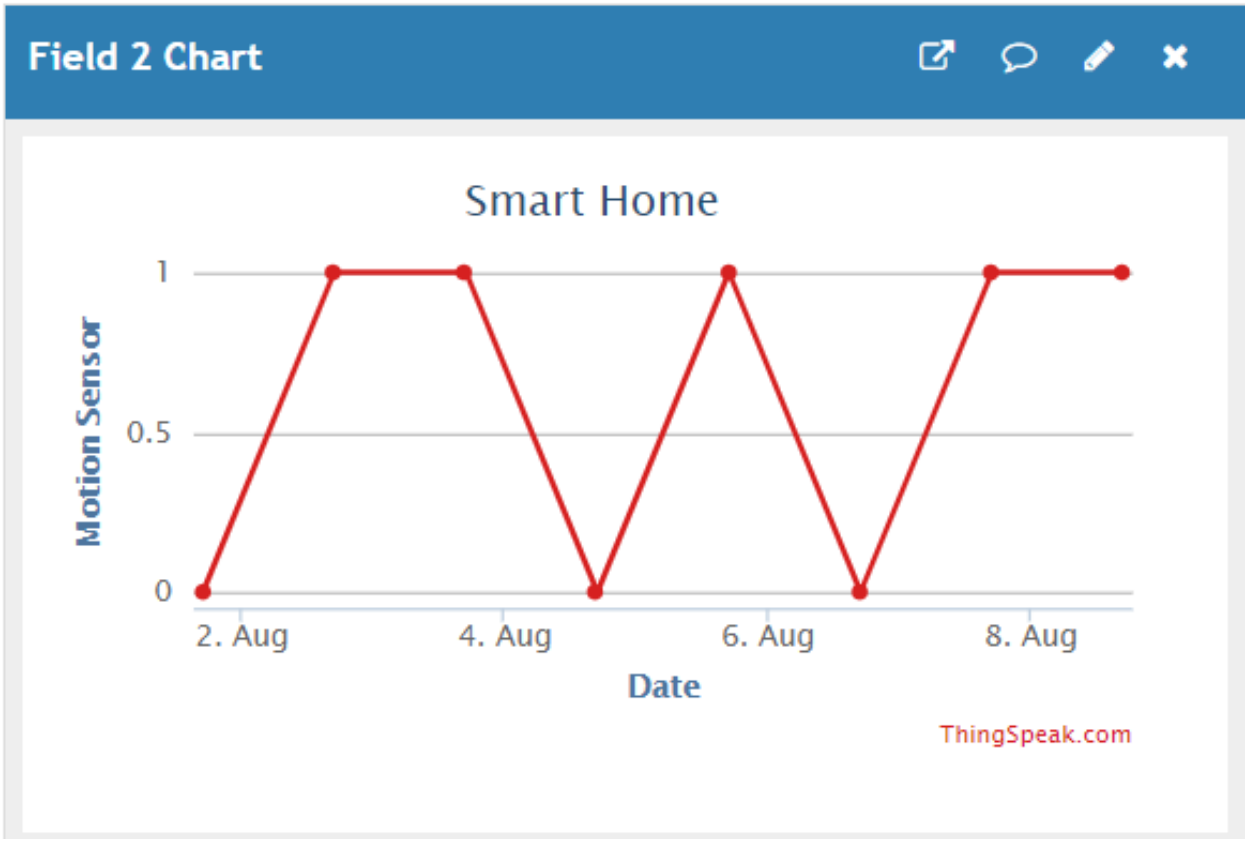
Connect API to Tinkercad



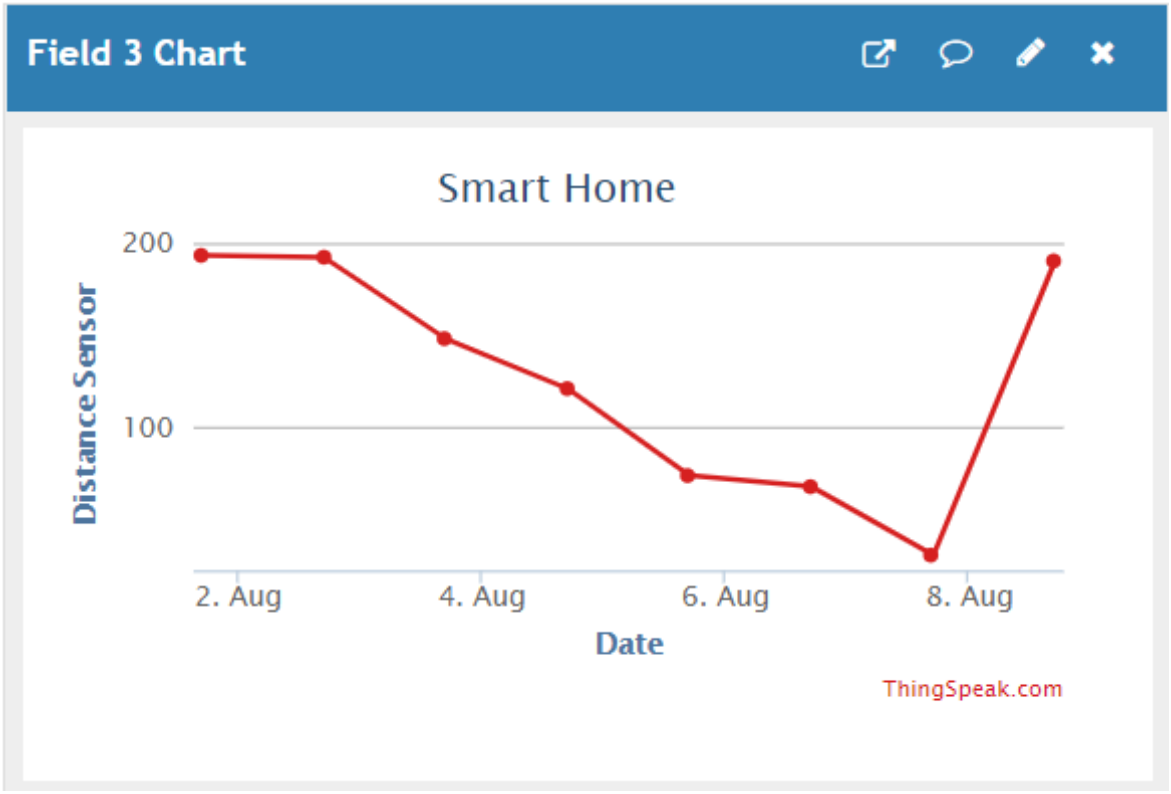
Gas Sensor Values



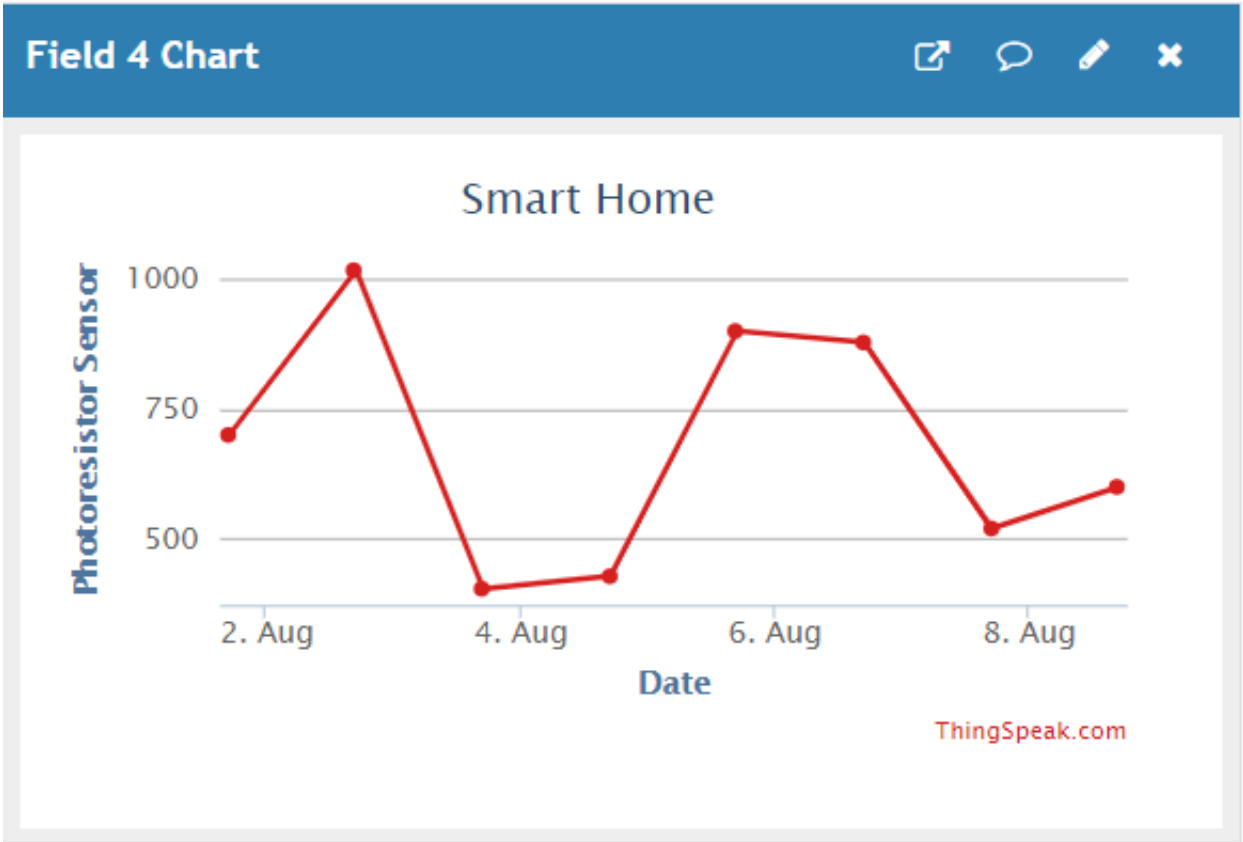
Motion Sensor



Distance Sensor



Photoresister Sensor



CONCLUSION AND FUTURE WORK

After implementing the system and thoroughly examining the functionality we can conclude that the Smart Home Automation system proposed by us successfully controls all the appliances in home and provides security and ease of access. The gas sensor and buzzer provide a good mechanism to alert user of potential gas leak. The servo motors and Ultrasonic Distance sensor is used effectively implemented to control doors and provides ease of access. Photoresistor and Light sensor is used to automatically control the light bulbs depending upon the intensity of environmental light. Also, the Fans can be controlled using the PIR sensor to detect the presence of a human in the room. The proposed system is fully functional on its own but further features can be added like smart ac controller, smart grocery restocking alert, automated bill payment and health monitoring can be integrated with smart home automation.

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