RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY

ETE 2200: Electronic Project Design and Development

Project : Android Based Home Automation & Security System

Submitted By

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Android Based Home Automation & Security System

Chapter 1

1.1 Abstract

The present age is the age of information and technology. Bangladesh has recently joined in this era of technology. Home automation is one of the major contributions of technology in the modern world . Smart home Automation technology, lifetime is getting easier and simpler on all side in life . This android based home automation system is specially designed for Bangladesh focusing to solve the basic problems in people's regular lives. This system includes controlling the fan, light, and door lock using Bluetooth. This system also includes an environmental security system for gas leakage and fire and also an automated light that turns on when the house is dark. The whole process is controlled with a user-friendly application of android. Its environmental security system adds a different level to home automation. One of the biggest problems in Bangladesh is accidents due to gas leakage. Most of the time it happens when someone forgets to turn off the cooker and the flammable gas spreads all over the house and a devastating accident occurs. This system brings a solution to stop this kind of accidents and save natural resources. The solution is when the flammable gas spreads the room , an alarm will turn on and a security message with an alarm will be appeared in the user's android app as well as an exhaust fan will automatically turned on . This exhaust fan will remain on until the gas is completely erased. This security system is made with three MQ-2 gas sensors with a buzzer and an exhaust fan. Bluetooth system is made with HC-05 Bluetooth module and automated light is controlled by an LDR. The whole process is controlled by a microcontroller ATMega328 . This project uses a microcontroller module Arduino Nano which uses ATMega328 as its core controller.

1.2 Components Needed :

No	Name	Rating	Quantity
1	Arduino Nano	5V	1
2	Bluetooth Module(HC-05)	5V	3
3	BC547		3
4	LM35	5V	1
5	Relay	5V	3
6	Gas Sensor (MQ-2)	5V	3
7	LDR		1
8	Resistor	50K	1
9	Resistor	10K	1
10	Resistor	1K	2
11	1N4007		3
12	LED		5
13	16x2 LCD Display		1
14	I2C Module		1
15	Buzzer		1
16	L298N Motor Driver		1
17	Exhaust Fan	5V	1
18	Bulb	5V	1
19	Fan	5V	1
20	Electric Lock	5V	1
21	Power Adapter	5V	1

1.3 Software :

No.	Name	Reason
1	Arduino IDE	To program the microcontroller
2	Proteus 8.10	To design the circuit
3	MIT App Inventor 2	To design the app
4	TinkerCad	To simulate the circuit

1.4 Circuit Diagram:

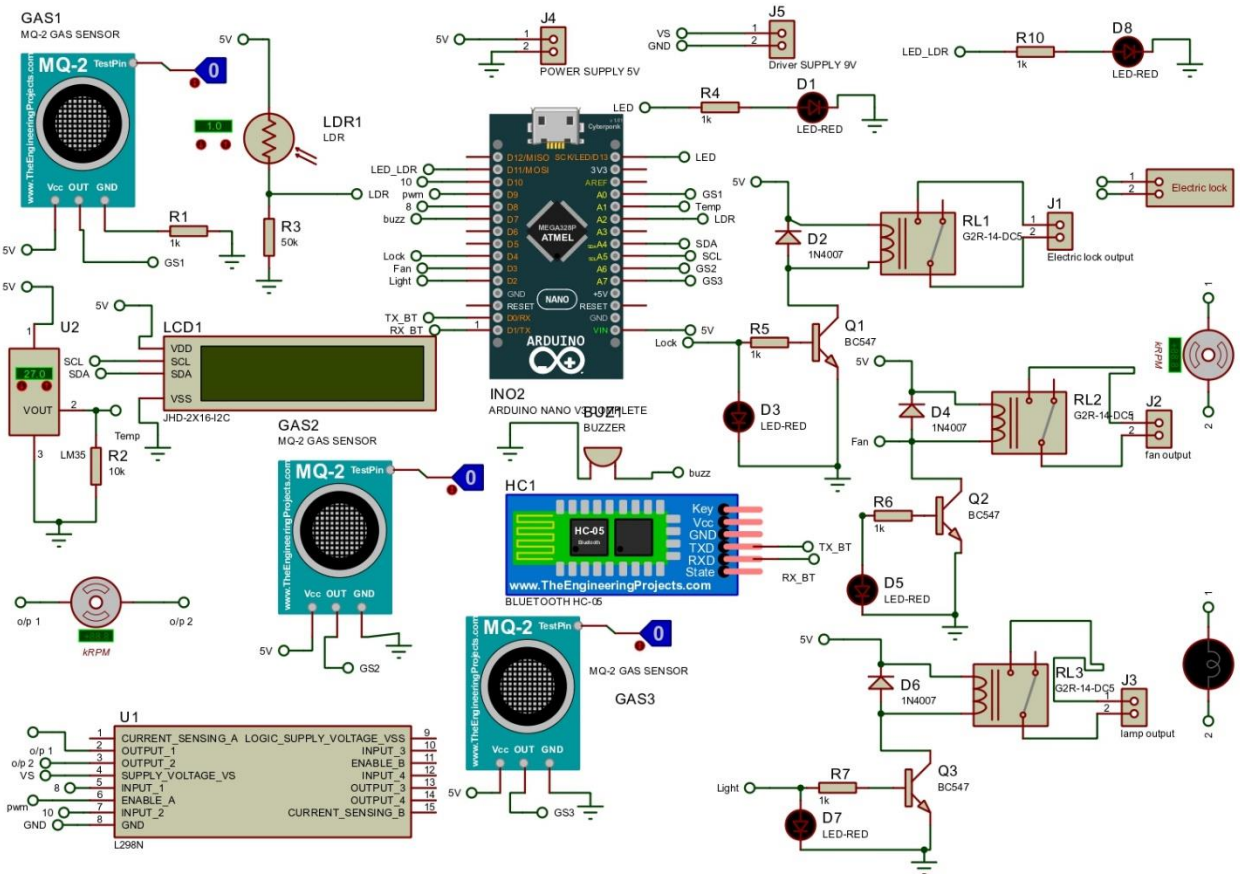

Figure 1 : Circuit Diagram of Android Based Home Automation & Security System

1.5 App Interface:

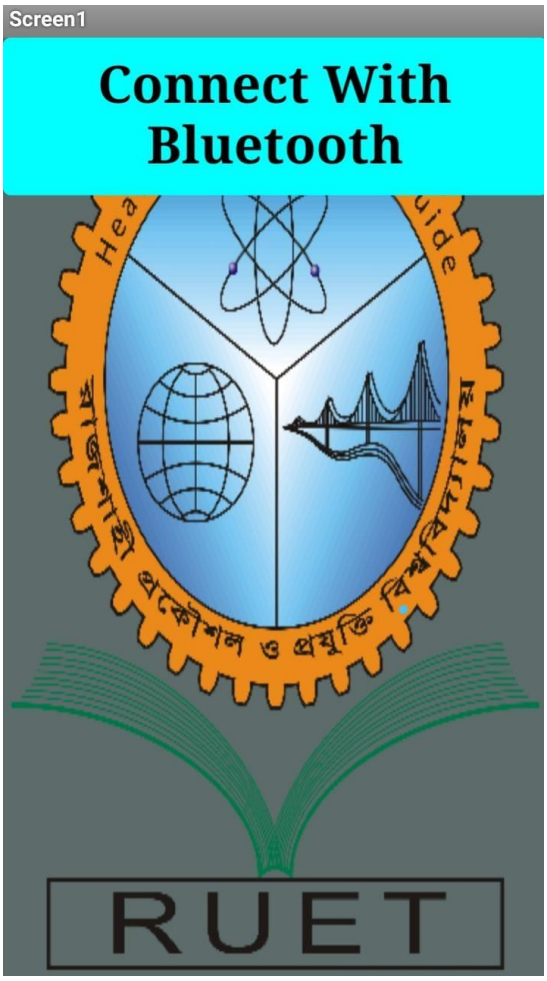

Figure 2 : UI design before connecting to bluetooth

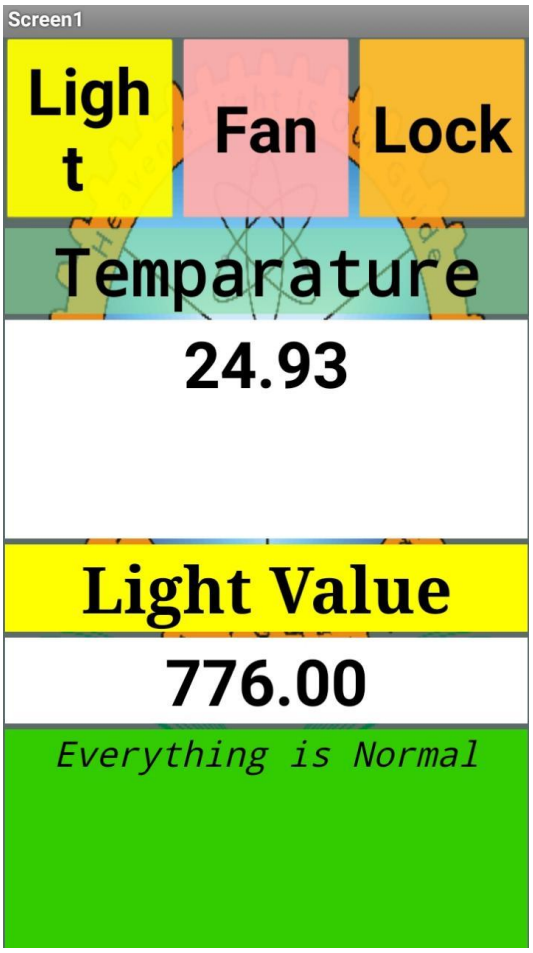

Figure 3 : UI design After connecting to bluetooth

Chapter 2

2.1 System Description and Operation:

This project is about to control the house light, fan and door lock via Bluetooth with an android app and to get notification when there is a gas leakage or fire. At first the app has to be connected to system's Bluetooth. When the Bluetooth is connected, if 'Light' button is pressed, a character is transferred from app to micro-controller. When the character is reached at controller, it verifies the order that is described in the code and then works according to that order and turns on the light. This app has three different buttons –'Light', 'Fan', and 'Lock' and each button sends a unique character to the microcontroller and the microcontroller works accordingly to those characters. The app shows 'Temperature' and 'Light Value' values from LM35 sensor and LDR. LM35 reads room temperature and then send these float values to the micro controller. Whenever the room gets dark , the value of 'Light Value' decreases . When the value is smaller than 500, the background of 'Light Value' screen turns dark and an external LED light turns on. And when the room is lighted, the value of 'Light Value' is greater than 500 and the background of 'Light Value' screen turns yellow and the external LED light turns off. The 'Temperature' value and 'Light Density' value are also displayed in the 16x2 LCD screen that is connected with the controller . The security system consists of three MQ-2 sensors, a buzzer , an LED and an external fan . MQ-2 sensor can detect LPG, Alcohol, Propane, Hydrogen, CO and even methane gas and give values accordingly. When the average value of three MQ-2 sensors is greater than 100 then it seems there is a gas leakage or fire burning. When this value crosses 100 , the buzzer alarm turns on, the LED turns on and the security alarm from the android app turns on and by vibrating the phone and showing an alert message , it warns the user about the danger. Alongside the exhaust fan turns on and cleans the air . The exhaust fan turns on till the MQ-2 value is less than 100. When the value is smaller than 100, the fan automatically turns off. In this way, the system alerts the user on the one hand and keeps the environment safe on the other.

2.2 Circuit Description :

In circuit LDR, LM35, and MQ-2 sensors are connected with the analog pins of Arduino Nano as these sensors are sending analog values. Whereas buzzer and led are connected to digital pins of micro controller. Here Bluetooth module HC05 communicates with serial communication or UART communication. To enable this communication , receiver pin of HC-05 is connected with the transfer pin of Nano and transfer pin of HC-05 is connected with the receiver pin of Nano. 16x2 LCD display is connected with a I2C module to communicate with the Arduino. The two connections for the I2C bus are called SCL(clock signal) and SDA(data transfer) . These two pins are connected to Arduino's SCL(A5) and SDA(A4) pins. There is a 10K resistor between ground and output of LM35 to prevent fluctuation. There is also a 50K resistor is connected between the output and ground of LDR. This 50K resistor works as a reference point. LDR is a kind of variable resistor, so its voltage is also variable. This 50k resistor works to make this variable voltage to a fixed voltage point so that this variable voltage can not do any harm to the circuit. This 50K resistor also works to prevent short circuit when the resistance of LDR is too low. The L298N motor driver is used to give proper power and rotation to the motor that is adjusted with the exhaust fan. 5V relay is used to switching the loads. A 5V adapter is used to power up the circuit and a 9V adapter is used to run the motor driver.

Chapter 3

3.1 Components Description:

1.Arduino Nano:

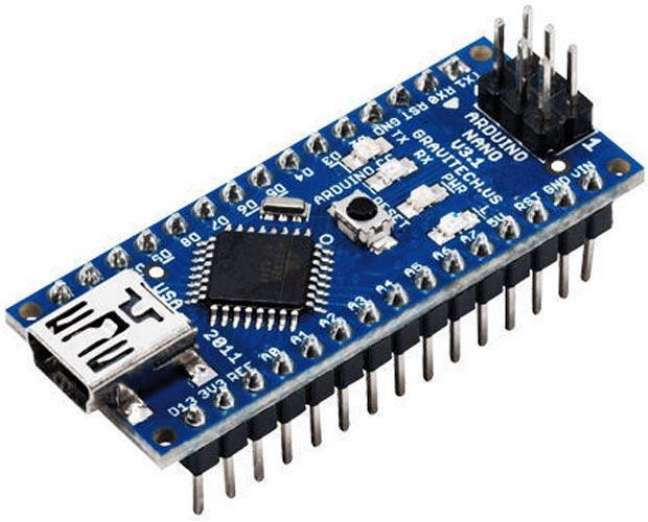

Fig 4: Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

Technical specifications of the Arduino Nano board

The technical specifications of the Arduino Nano board are as follows:

- Microcontroller ATmega328
- Operating Voltage (logic level): 5 V
- Input Voltage (recommended): 7-12 V
- Input Voltage (limits): 6-20 V
- Digital I/O Pins : 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O Pin: 40 mA

- Flash Memory 32 KB (ATmega328) of which 2 KB used by bootloader
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz
- Dimensions: 0.73" x 1.70"

2. Bluetooth Module (HC-05):

Figure 5 : HC-05

HC-05 is a Bluetooth module which is designed for wireless comunication. This module can be used in a master or slave configuration. HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds. To communicate smartphone with HC-05 Bluetooth module, smartphone requires Bluetooth terminal application for transmitting and receiving data. It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

HC-05 Technical Specifications

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

3. Gas Sensor (MQ-2):

Figure 6 : MQ-2 Gas Sensor

A gas sensor is a device which detects the presence or concentration of gases in the atmosphere. Based on the concentration of the gas the sensor produces a corresponding potential difference by changing the resistance of the material inside the sensor, which can be measured as output voltage. Based on this voltage value the type and concentration of the gas can be estimated. The type of gas the sensor could detect depends on the sensing material present inside the sensor. Normally these sensors are available as modules with comparators as shown above. These comparators can be set for a particular threshold value of gas concentration. When the concentration of the gas exceeds this threshold the digital pin goes high. The analog pin can be used to measure the concentration of the gas. The ability of a Gas sensor to detect gases depends on the chemiresister to conduct current.

The most commonly used chemiresistor is Tin Dioxide (SnO2) which is an n-type semiconductor that has free electrons (also called as donor). Normally the atmosphere will contain more oxygen than combustible gases. The oxygen particles attract the free electrons present in SnO2 which pushes them to the surface of the SnO2. As there are no free electrons available output current will be zero. The below gif shown the oxygen molecules (blue color) attracting the free electrons (black color) inside the SnO2 and preventing it from having free electrons to conduct current. When the sensor is placed in the toxic or combustible gases environment, this reducing gas (orange color) reacts with the adsorbed oxygen particles and breaks the chemical bond between oxygen and free electrons thus releasing the free electrons. As the free electrons are back to its initial position they can now conduct current, this conduction will be proportional the amount of free electrons available in SnO2, if the gas is highly toxic more free electrons will be available.

Features

- Operating Voltage is +5V
- Can be used to Measure or detect LPG, Alcohol, Propane, Hydrogen, CO and even methane
- Analog output voltage: 0V to 5V
- Digital Output Voltage: 0V or 5V (TTL Logic)
- Preheat duration 20 seconds

- Can be used as a Digital or analog sensor
- The Sensitivity of Digital pin can be varied using the potentiometer

4. LM35:

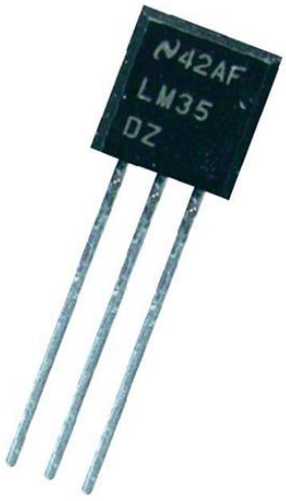

Figure 7 : LM35 Temperature Sensor

LM35 is a temperature sensor that outputs an analog signal which is proportional to the instantaneous temperature. The output voltage can easily be interpreted to obtain a temperature reading in Celsius. The advantage of lm35 over thermistor is it does not require any external calibration. The coating also protects it from self-heating. Low cost (approximately $0.95) and greater accuracy make it popular among hobbyists, DIY circuit makers, and students. Many low-end products take advantage of low cost, greater accuracy and used LM35 in their products. Its approximately 15+ years to its first release but the sensor is still surviving and is used in any products. LM35 can measure from -55 degrees centigrade to 150-degree centigrade. The accuracy level is very high if operated at optimal temperature and humidity levels. The conversion of the output voltage to centigrade is also easy and straight forward. n order to understand the working principle of LM35 temperature sensor we have to understand the linear scale factor. In the features of LM35 it is given to be +10 mills volt per degree centigrade. It means that with increase in output of 10 mills volt by the sensor vout pin the temperature value increases by one. For example, if the sensor is outputting 100 mills volt at vout pin the temperature in centigrade will be 10-degree centigrade. The same goes for the negative temperature reading. If the sensor is outputting -100 mills volt the temperature will be -10 degrees Celsius.

The formula to convert the voltage to centigrade temperature for LM35 is

Centigrade Temperature = Voltage Read by ADC / 10 mV(mills Volt)

Reading is divided by 10 mV because Linear scale factor is for LM35 is 10mV.

LM35 Temperature sensor Features

- Calibrated Directly in Celsius (Centigrade)
- Linear + 10-mV/°C Scale Factor
- 0.5°C Ensured Accuracy (at 25°C)
- Rated for Full −55°C to 150°C Range
- Suitable for Remote Applications
- Operates from 4 V to 30 V
- Less than 60-µA Current Drain
- Low Self-Heating, 0.08°C in Still Air
- Non-Linearity Only ±¼°C Typical
- Low-Impedance Output, 0.1 Ω for 1-mA Load

5. 16x2 LCD Display:

Figure 8 : 16x2 LCD Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc. A 16×2 LCD has two registers like data register and command register. The RS (register select) is mainly used to change from one register to another. When the register set is '0', then it is known as command register. Similarly, when the register set is '1', then it is known as data register. The main function of the command register is to store the instructions of command which are given to the display. So that predefined tasks can be performed such as clearing the display, initializing, set the cursor place, and display control. Here commands processing can occur within the register. The main function of the data register is to store the information which is to be exhibited on the LCD screen. Here, the ASCII

value of the character is the information which is to be exhibited on the screen of LCD. Whenever we send the information to LCD, it transmits to the data register, and then the process will be starting there. When register set =1, then the data register will be selected.

Features of LCD 16x2

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters

6. I2C Module:

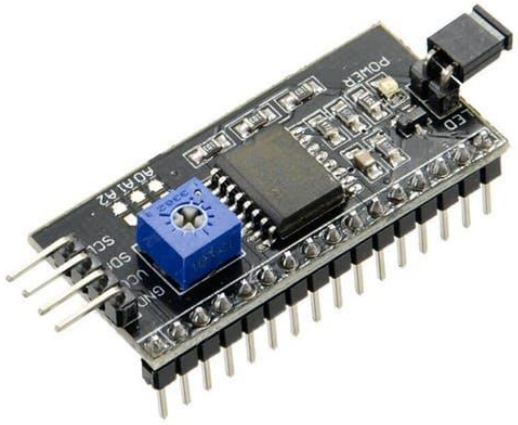

Figure 9 : I2C Module

The I2C(Inter Integrated Circuit) standard was created to provide simple ways for digital information to be transformed between sensors and micro controllers. I2C has the advantage that it only needs two signal connection (clock and data) to microcontroller. One device on the I2C bus is considered the master (or primary) device. Its job is to coordinate the transfer of information between the other devices (slaves, secondary components) that are attached. Slave devices are identified by their address number. Each one must have a unique address. Some I2C devices have a fixed address while others allow to configure their address by setting pins high or low or by sending initialization commands.

I2C Module has a inbuilt PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD display. These modules are currently supplied with a default I2C address of either 0x27 or 0x3F.

Features:-

- Operating Voltage: 5V
- Backlight and Contrast is adjusted by potentiometer
- Serial I2C control of LCD display using PCF8574
- Come with 2 IIC interface, which can be connected by Dupont Line or IIC dedicated cable
- Compatible for 16x2 LCD
- This is another great IIC/I2C/TWI/SPI Serial Interface
- With this I2C interface module, one will be able to realize data display via only 2 wires.

7. L298N Motor Driver :

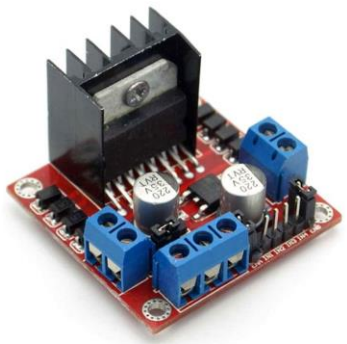

Figure 10 : L298N Motor Driver

This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control. The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A.

L298 Module Features & Specifications

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V

- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V
- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heatsink for better performance
- Power-On LED indicator

8. Relay (5V):

Figure 11 : Relay (5V)

A 5v relay is an automatic switch that is commonly used in an automatic control circuit and to control a high-current using a low-current signal. The input voltage of the relay signal ranges from 0 to 5V. The relay uses the current supply for opening or closing switch contacts. Usually, this can be done through a coil to magnetize the switch contacts & drags them jointly once activated. A spring drives them separately once the coil is not strengthened. By using this system, there are mainly two benefits, the first one is, the required current for activating the relay is less as compared to the current used by relay contacts for switching. The other benefit is, both the contacts & the coil are isolated galvanically, which means there is no electrical connection among them.

Features of 5-Pin 5V Relay-

- Trigger Voltage (Voltage across coil) : 5V DC
- Trigger Current (Nominal current) : 70mA
- Maximum AC load current: 10A @ 250/125V AC

- Maximum DC load current: 10A @ 30/28V DC
- Compact 5-pin configuration with plastic molding
- Operating time: 10msec Release time: 5msec
- Maximum switching: 300 operating/minute (mechanically)

9. BC547 :

Figure 12 : BC547

BC547 is a NPN transistor hence the collector and emitter will be left open (Reverse biased) when the base pin is held at ground and will be closed (Forward biased) when a signal is provided to base pin. BC547 transistor has a gain value of 110 to 800, this value determines the amplification capacity of the transistor. The maximum amount of current that could flow through the Collector pin is 100mA, hence we cannot connect loads that consume more than 100mA using this transistor. To bias a transistor we have to supply current to base pin, this current (I_B) should be limited to 5mA. When this transistor is fully biased then it can allow a maximum of 100mA to flow across the collector and emitter. This stage is called Saturation Region and the typical voltage allowed across the Collector-Emitter (V_{CE}) or Base-Emitter (V_{BE}) could be 200 and 900 mV respectively. When base current is removed the transistor becomes fully off, this stage is called as the Cut-off Region and the Base Emitter voltage could be around 660 mV.

BC547 Transistor Features

- Bi-Polar NPN Transistor
- DC Current Gain (h_{FE}) is 800 maximum
- Continuous Collector current (I_C) is 100mA
- Emitter Base Voltage (V_{BE}) is 6V
- Base Current(I_B) is 5mA maximum
- Available in To-92 Package

Chapter 4

4.1 Simulation and Output:

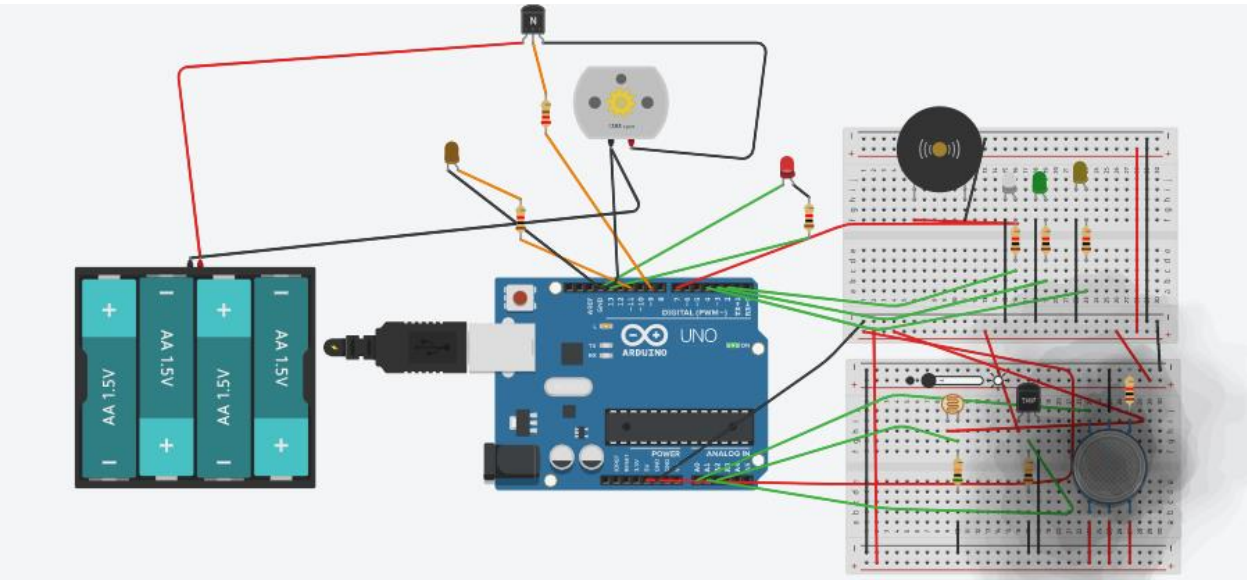

Figure 13 : Simulation using TinkerCad

4.2 Code:

```
#include<Wire.h>

#include<LiquidCrystal_I2C.h>

const int en = 2, rw = 1, rs = 0, d4 = 4, d5 = 5, d6 = 6, d7 = 7, bl = 3;

const int i2c_addr = 0x27;


LiquidCrystal_I2C lcd(i2c_addr, en, rw, rs, d4, d5, d6, d7, bl, POSITIVE);

float vout;

float temp;

float density;

int gs = A0;

int gs2 = A6;
```

```
int gs3 = A7;
int buzz = 7;
int led = 13;
int light = 2;
int fan = 3;
int lock = 4;
int autoled=11;
int dcfan_pwm =9;
int dcfan_inA =8;
int dcfan_inB = 10;
int spd = 200 ;
int smoke1 ;
int smoke2 ;
int smoke3 ;
int smoke ;
char sms;
void lightonoff()
{
  digitalWrite(buzz, HIGH);
  digitalWrite(led, HIGH);
  delay(5000);
  digitalWrite(led, LOW);
  digitalWrite(buzz, LOW);
  delay(5000);
}
```

```
void setup() {

  lcd.begin(16, 2);
  Serial.begin(9600);
  pinMode(buzz, OUTPUT);
  pinMode(light, OUTPUT);
  pinMode(fan, OUTPUT);
  pinMode(lock, OUTPUT);
  pinMode(led, OUTPUT);
  pinMode(autoled, OUTPUT);
  pinMode(dcfan_pwm, OUTPUT);
  pinMode(dcfan_inA, OUTPUT);
  pinMode(dcfan_inB, OUTPUT);



}

void loop() {

  density = analogRead(A2);
  if(density<500)
  {
    digitalWrite(autoled,HIGH);
  }
  else
  {
    digitalWrite(autoled,LOW);
```

```
}
smoke1 = analogRead(gs);
smoke2 = analogRead(gs2);
smoke3 = analogRead(gs3);
smoke  = ((smoke1 + smoke2 + smoke3) / 3);
vout = analogRead(A1);
temp = (vout * 500) / 1023;

if (smoke > 100)
{
  lightonoff();
  digitalWrite(dcfan_pwm,spd);
  digitalWrite(dcfan_inA, HIGH);
  digitalWrite(dcfan_inB, LOW);
}
else
{
  digitalWrite(buzz, LOW);
  digitalWrite(led, LOW);
  digitalWrite(dcfan_inA, LOW);
  digitalWrite(dcfan_inB, LOW);

}
lcd.setCursor(0, 0);
lcd.print("TEMP: ");
lcd.print(temp);
lcd.setCursor(0, 1);
```

```
lcd.print("Density: ");
lcd.print(density);

Serial.print(temp);
Serial.print("|");
Serial.print(density);
Serial.print("|");
Serial.println(smoke);
delay(3000);
//control
if (Serial.available() != 0)
{
  sms = Serial.read();
}
if (sms == '1')
{
  digitalWrite(light, HIGH);
}
if (sms == '2')
{
  digitalWrite(light, LOW);
}
if (sms == '3')
{
  digitalWrite(fan, HIGH);
}
if (sms == '4')
```

```
  {
    digitalWrite(fan, LOW);
  }
  if (sms == '5')
  {
    digitalWrite(lock, HIGH);
  }
  if (sms == '6')
  {
    digitalWrite(lock, LOW);
  }
}
```

Chapter 5

5.1 Result and Discussion:

After completing the circuit connection and applying code- both the simulation and practical implementation worked. In practical implementation MQ-2 sensors took almost 20 seconds to start up. During this period, MQ-2 Sensors gave unstable values. After 20 seconds, MQ-2 sensors got stable. It took almost two seconds to receive value from app for Arduino. L298N motor driver was needed an external 9V supply and the supply was given by a power adapter.

5.2 Application and Advantages:

- This system can be used not only at home but also in office or factory places.
- This project can prevent any gas leakage or fire incident.
- It will be possible to reduce the use of switches.
- When the residential area becomes dark, it will be automatically illuminated.
- This system allows controlling the electric fan, light, and electric door lock under one app.

5.3 Disadvantages:

- LM35 gives unstable values for excessive use.
- MQ-2 sensors take much time to start up.

5.4 Conclusion:

This project is a modified version of the general home automation system. By implementing this system in a residential area or business area, the area will be more secured from any type of explosion and the users will get more comfort and advantages while remaining in the area. A significant advantage of this system is that controls every load and gets notified of every environmental change via the Android application anytime. Finally, the developed system offers a flexible, economical, and remotely controllable smart home automation system.