Ping. - Disturbance Preventer

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ROB-GY-5103- Mechatronics

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1. Introduction

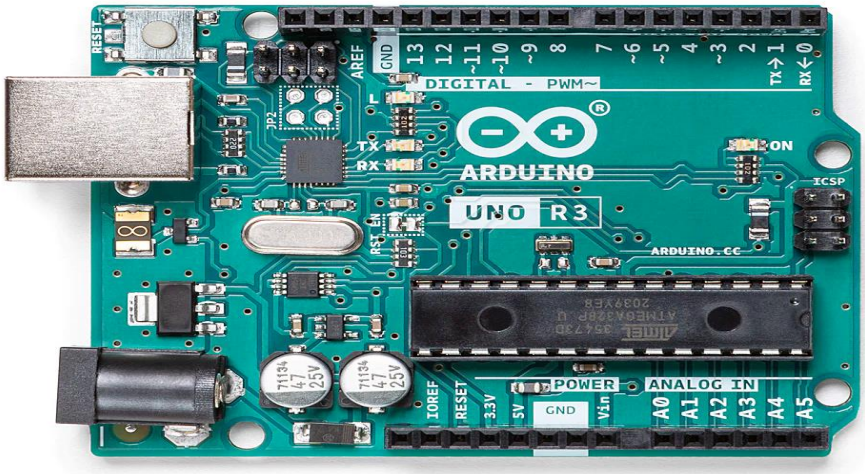
In this project, we employed the Arduino Uno R3 microcontroller to perform a string of tasks that range from Ultrasonic Sensor, MQ2 Gas Sensor, LED, and LCD operations for sensing the object and smoke. Furthermore, we comprehensively understood the Arduino Uno R3 microcontroller hardware and Arduino syntax.

The prevalence of smoking in public spaces is a widespread issue as highlighted by Imtiaz et al. (2019) and Zhang et al. (2018). Given the numerous health risks associated with cigarette smoke, government initiatives persist in enhancing smoking prevention through policies promoting smoke-free areas. To enforce such measures, a microcontroller serves as the central control unit, coordinating various components. An alarm system, utilizing a buzzer, signals when the smoke level in a room becomes hazardous. This finalized product plays a crucial role in deterring individuals from smoking near their surroundings.

2. Parts Used

a) Arduino Uno R3

The Arduino Uno R3, centered on the ATmega328P microcontroller, operates at 5V and accepts input voltages between 7-12V (with a range of 6-20V). It provides 14 digital I/O pins, 6 supporting PWM, and 6 analog input pins. Each I/O pin handles up to 20mA, while the 3.3V pin manages up to 50mA. With 32KB flash memory (0.5KB used by the bootloader), 2KB SRAM, and 1KB EEPROM, it runs at a clock speed of 16MHz. Its compact size of 68.6mm length, 53.4mm width, and weight of 25g make it suitable for various projects, from basic LED tasks to complex robotics and IoT endeavors.

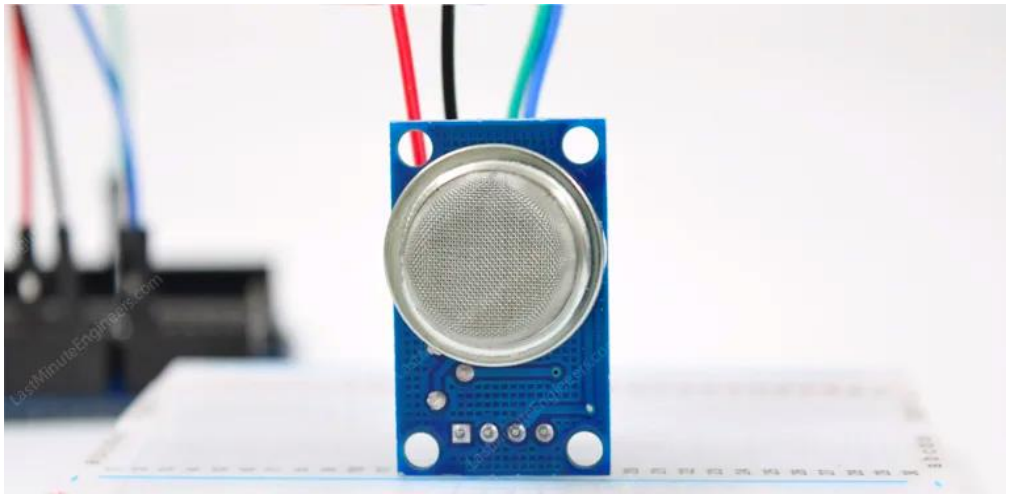


b) Parallax LCD

Parallax LCD modules vary in specifications, but a typical version consists of a 16x2 character display. They usually operate on a 5V power supply and use an HD44780 or compatible controller. These modules connect to a microcontroller via a parallel interface and may include LED backlighting in colors like white or blue. They typically support standard ASCII characters and work within a temperature range of 0°C to 50°C. For exact details on a specific Parallax LCD module, consulting the provided datasheet or documentation by Parallax is advised.

c) MQ2 /Gas Sensor

The MQ2 gas sensor is a versatile module detecting gases like methane, propane, and smoke concentrations ranging from 200 to 10000 ppm. Operating from 5V to 12V, it contains a heater coil and a tin dioxide semiconductor. When heated, the semiconductor's resistance changes in the presence of gases, altering the analog output voltage. A digital pin indicates gas presence above a set threshold. Calibration for specific gases is crucial for accurate readings. Widely used for gas detection in safety systems and air quality monitoring, it offers an affordable solution across various applications.



d) Ultrasonic Sensor

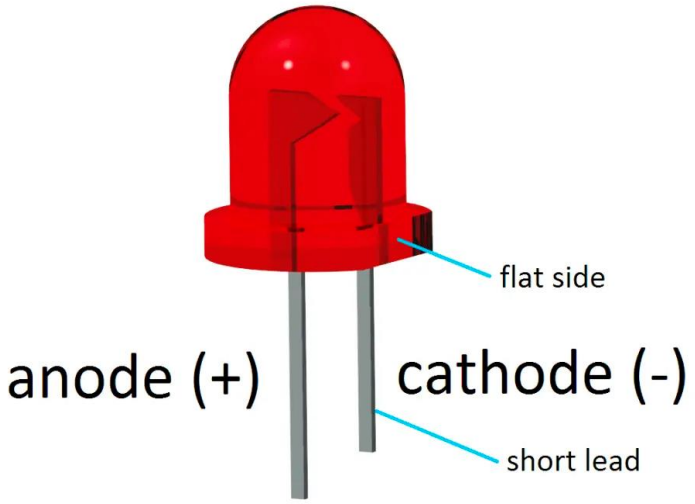
The ultrasonic sensor, like the HC-SR04, works by emitting ultrasonic waves and measuring the time taken for them to bounce back from an object. Operating on 5V, it typically measures distances from 2cm to 400cm with high accuracy. With a trigger and echo pin setup, it calculates distance based on the time taken for the waves to return. Widely used in robotics and distance measurement, it's prized for its accuracy, non-contact nature, and versatility in various applications.

e) Buzzer

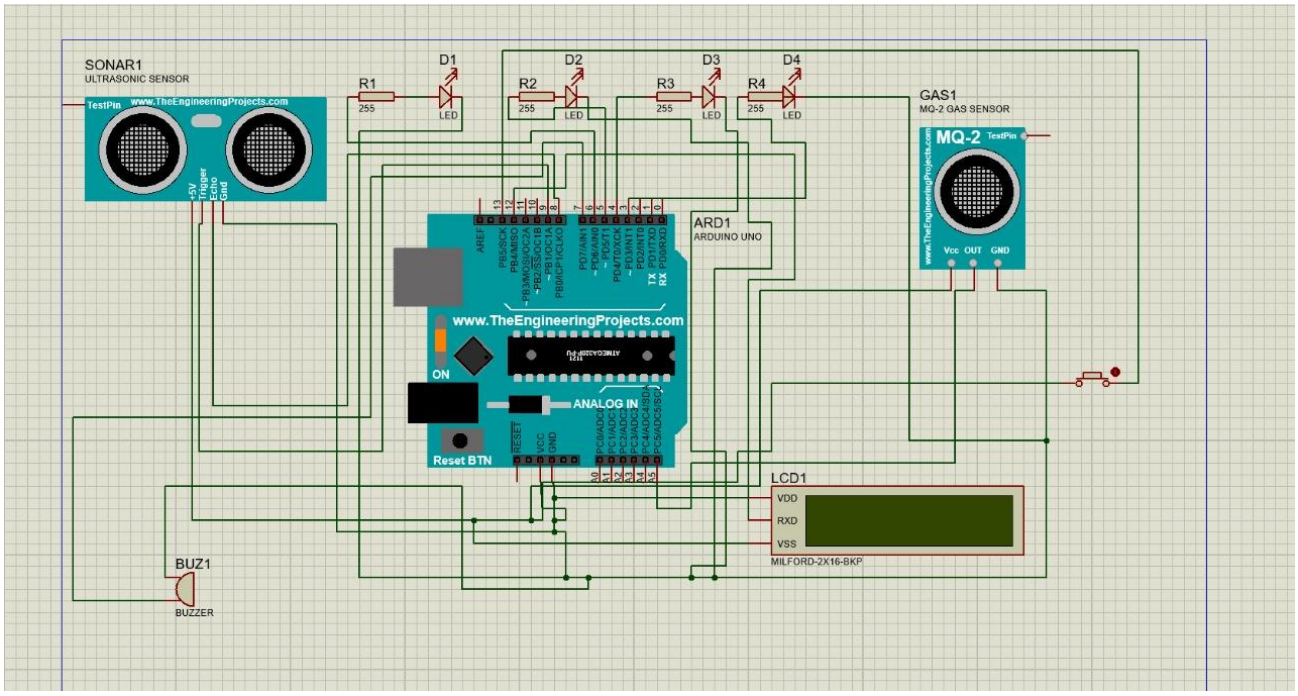
Buzzer modules paired with Arduino operate at 3-5V, producing audible tones. They come in piezoelectric or electromagnetic types. Piezoelectric buzzers use a material that vibrates when powered, while electromagnetic ones use coils and diaphragms for sound. Connected to Arduino's digital pins, they generate sound by receiving signals at specific frequencies and durations. Widely used for alerts and audio feedback in Arduino projects due to their simplicity and effectiveness in producing various tones.

f) LED

LEDs, or Light Emitting Diodes, are semiconductor devices that emit light when an electric current passes through them. They operate on the principle of electroluminescence, releasing energy as light when electrons combine with electron holes. LEDs vary widely in their specifications, encompassing aspects like operating voltage (around 1.5V to 3.5V), current requirements (from a few mA to tens of mA), brightness (ranging from a few mcd to thousands of lumens), colors, viewing angles, operating temperatures (-40°C to 100°C), lifespan (tens of thousands of hours), package types (through-hole or surface mount), forward voltage drop, and forward current limits.



3. Circuitry



HC-SR04 Ultrasonic Sensor:

- The Echopin and Trigger Pin is connected to 8 and 9 Digital Pins of Arduino
- VCC Connected to +5V, Ground Connected to the Ground of Arduino.

MQ-2 Gas Sensor:

- The A0 pin of the Gas sensor is connected to 5 Analog pins of Arduino.
- VCC Connected to +5V, Ground Connected to the Ground of Arduino.

Piezo Electric Buzzer:

- The Positive pin of the Buzzer connected to Arduino's Digital Pin 7.
- Negative Pin connected to the Ground of Arduino.

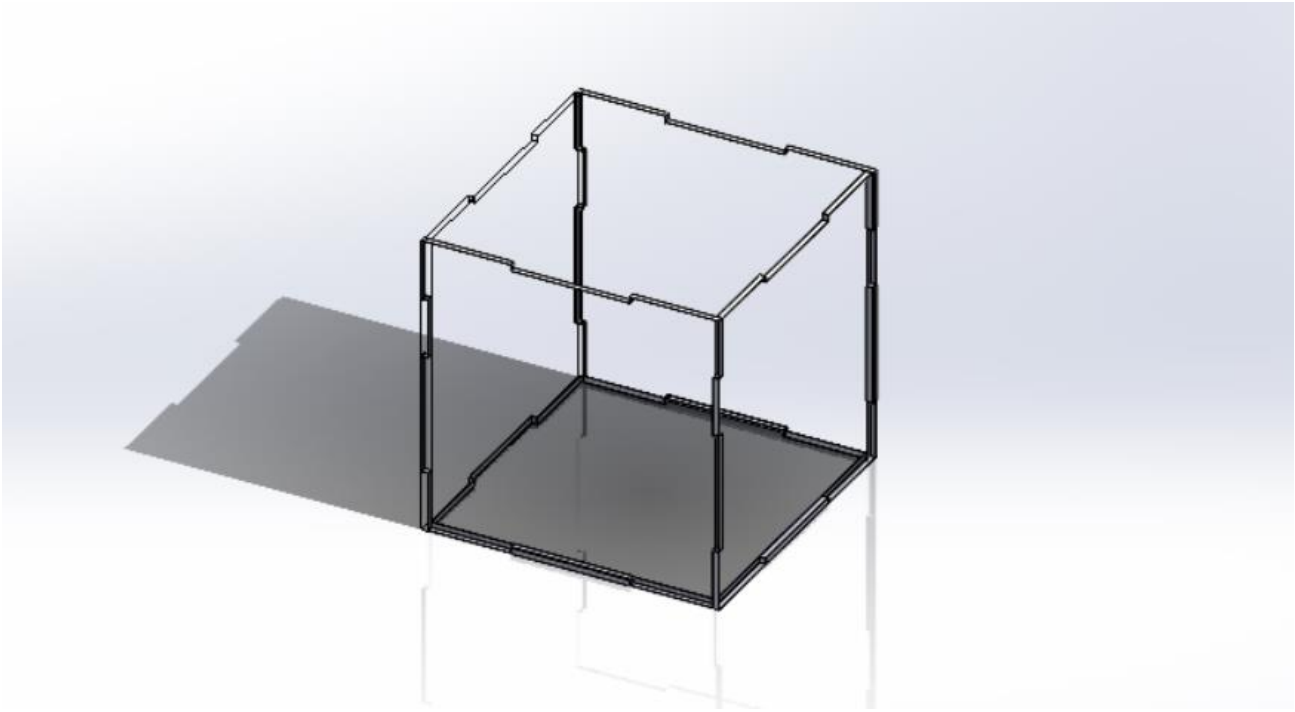
Parallax LCD 27977:

- Rx Connected to the Digital pin 12 of Arduino.
- VCC Connected to +5V, GND Connected to the Ground of Arduino.

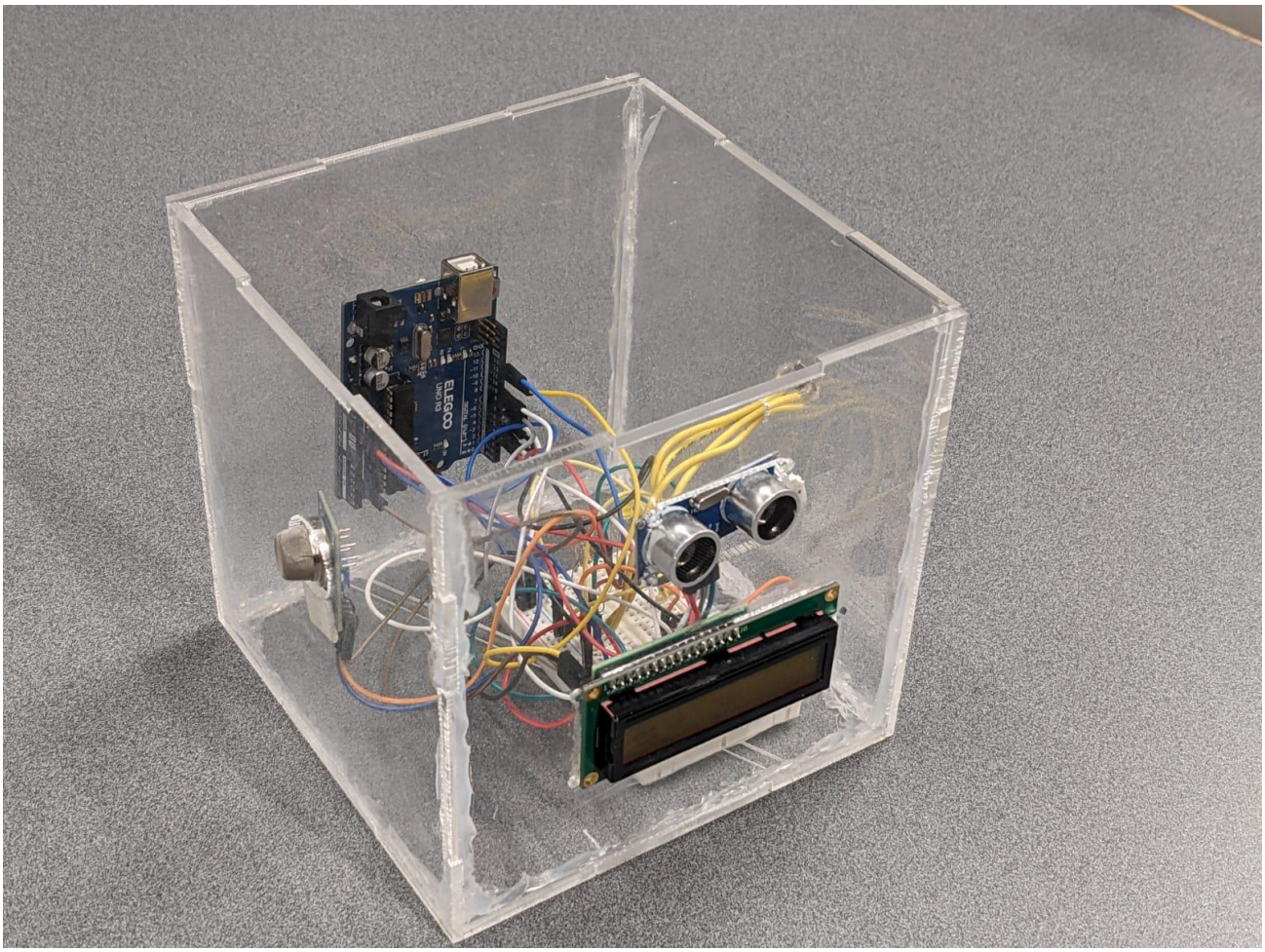
Light Emitting Diode:

- Positive terminals are connected to respective Digital Pins 3,4,6,5 of Arduino with in between of Resistors.
- Negative terminals connected to the GND of Arduino.

4. Design



A 15-centimeter cube designed with precision using Computer-Aided Design (SolidWorks) software and manufactured through laser cutting for impeccable accuracy. The cube's sides are seamlessly joined with intricate finger joints, ensuring structural stability and aesthetic appeal. The use of high-quality materials adds durability and a sleek finish, making it a versatile addition to any setting. This precision-engineered cube is a unique blend of technology and craftsmanship, embodying design excellence for functional and decorative purposes alike.

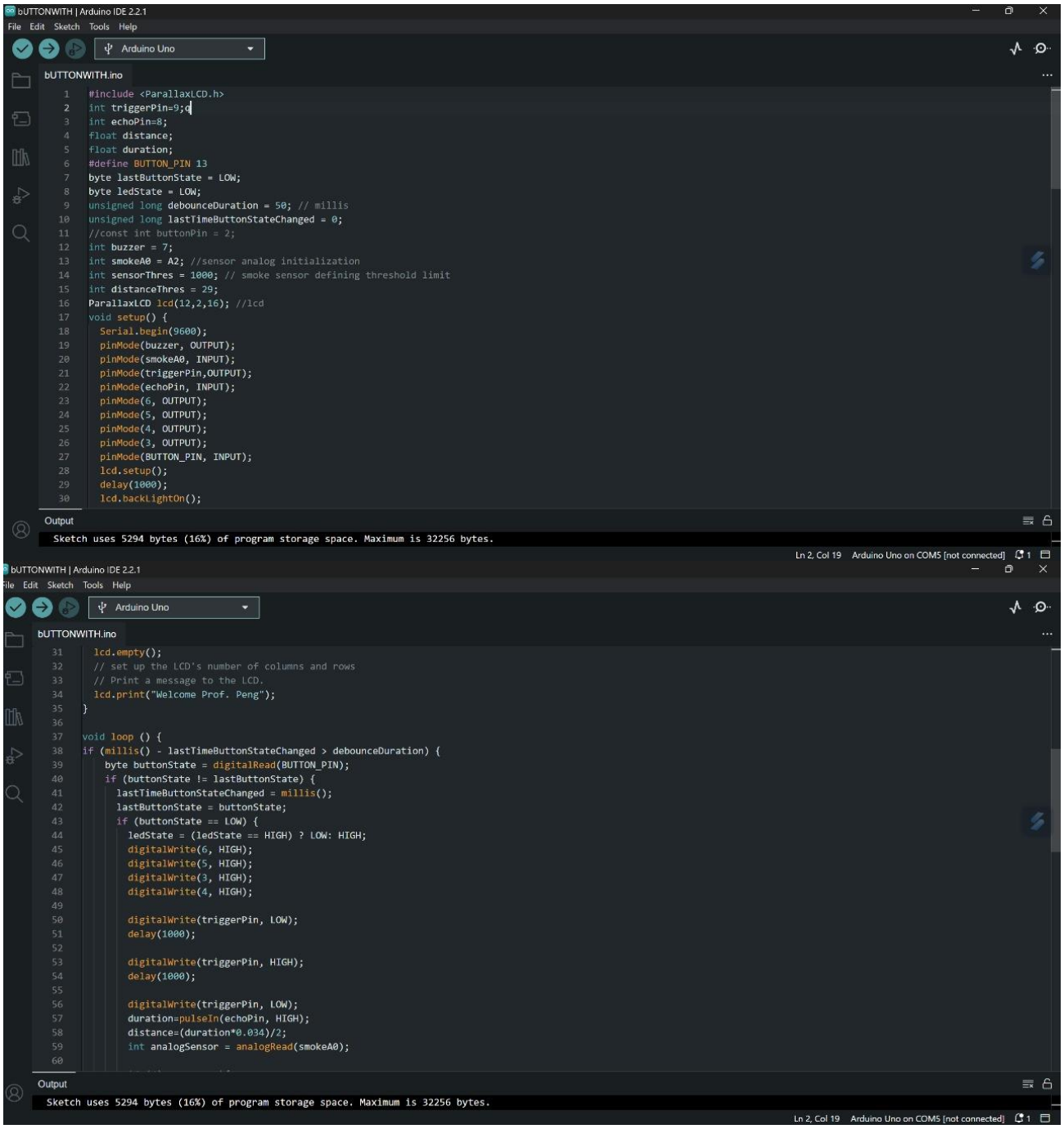


5. Code Implementation

Arduino IDE

The Arduino IDE is software used for programming Arduino boards. It includes a code editor, compiler, and uploader for sketches. Users write code in a simplified C/C++ language, verify it for errors, and then upload it to the connected Arduino. The IDE is beginner-friendly, offers community support, and is available across various operating systems. It's the go-to tool for creating projects, from basic LED experiments to advanced robotics, thanks to its simplicity and functionality.

Arduino Code for Disturbance Prevention



bUTTONWITH | Arduino IDE 2.2.1

File Edit Sketch Tools Help

Arduino Uno

bUTTONWITH.ino

```
#include <ParallaxLCD.h>
int triggerPin=9;
int echoPin=8;
float distance;
float duration;
#define BUTTON_PIN 13
byte lastButtonState = LOW;
byte ledState = LOW;
unsigned long debounceDuration = 50; // millis
unsigned long lastTimeButtonStateChanged = 0;
//const int buttonPin = 2;
int buzzer = 7;
int smokeA0 = A2; //sensor analog initialization
int sensorThres = 1000; // smoke sensor defining threshold limit
int distanceThres = 29;
ParallaxLCD lcd(12,2,16); //lcd
void setup() {
  Serial.begin(9600);
  pinMode(buzzer, OUTPUT);
  pinMode(smokeA0, INPUT);
  pinMode(triggerPin,OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(6, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(4, OUTPUT);
  pinMode(3, OUTPUT);
  pinMode(BUTTON_PIN, INPUT);
  lcd.setup();
  delay(1000);
  lcd.backLightOn();
```

Output

Sketch uses 5294 bytes (16%) of program storage space. Maximum is 32256 bytes.

Ln 2, Col 19 Arduino Uno on COM5 [not connected]

bUTTONWITH | Arduino IDE 2.2.1

File Edit Sketch Tools Help

Arduino Uno

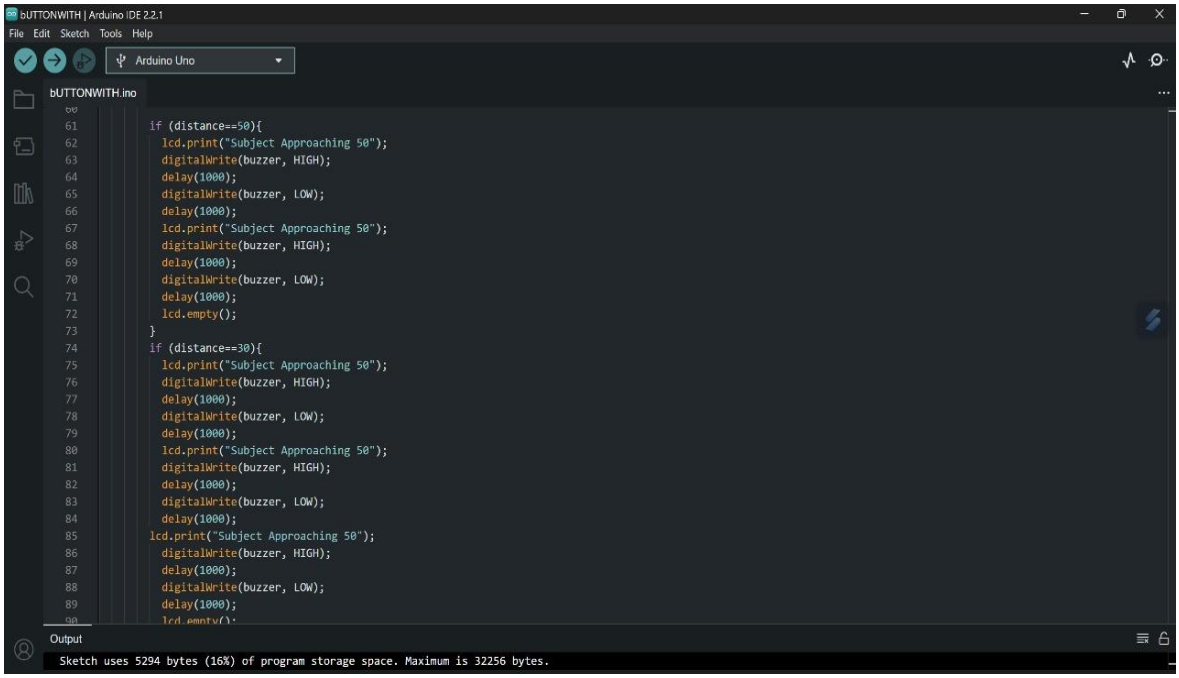
bUTTONWITH.ino

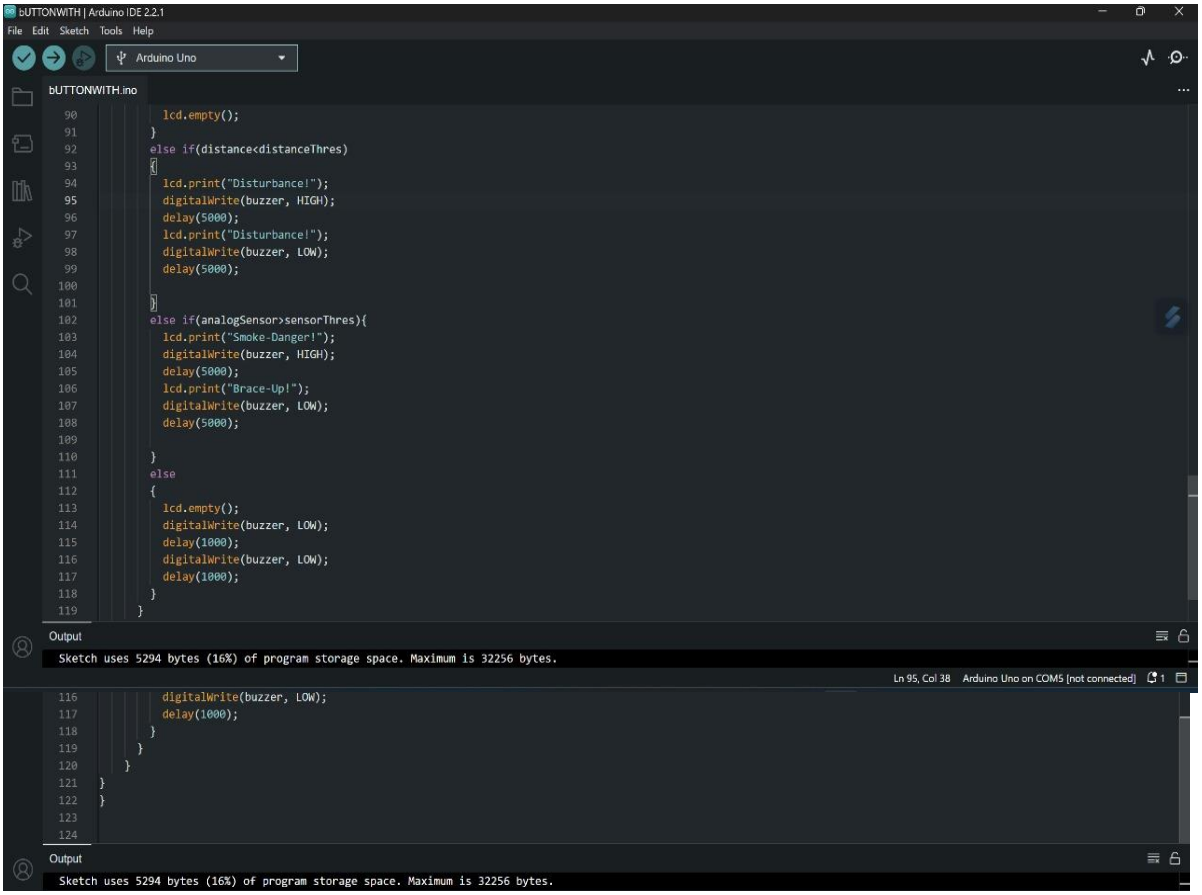
```
  lcd.empty();
  // set up the LCD's number of columns and rows
  // Print a message to the LCD.
  lcd.print("Welcome Prof. Peng");
}

void loop () {
if (millis() - lastTimeButtonStateChanged > debounceDuration) {
    byte buttonState = digitalRead(BUTTON_PIN);
    if (buttonState != lastButtonState) {
      lastTimeButtonStateChanged = millis();
      lastButtonState = buttonState;
      if (buttonState == LOW) {
        ledState = (ledState == HIGH) ? LOW: HIGH;
        digitalWrite(6, HIGH);
        digitalWrite(5, HIGH);
        digitalWrite(3, HIGH);
        digitalWrite(4, HIGH);

        digitalWrite(triggerPin, LOW);
        delay(1000);

        digitalWrite(triggerPin, HIGH);
        delay(1000);

        digitalWrite(triggerPin, LOW);
        duration=pulseIn(echoPin, HIGH);
        distance=(duration*0.034)/2;
        int analogSensor = analogRead(smokeA0);
```

Output

Sketch uses 5294 bytes (16%) of program storage space. Maximum is 32256 bytes.

Ln 2, Col 19 Arduino Uno on COM5 [not connected]


bUTTONWITH | Arduino IDE 2.2.1
File Edit Sketch Tools Help
Arduino Uno
bUTTONWITH.ino
if (distance==50){
lcd.print("Subject Approaching 50");
digitalWrite(buzzer, HIGH);
delay(1000);
digitalWrite(buzzer, LOW);
delay(1000);
lcd.print("Subject Approaching 50");
digitalWrite(buzzer, HIGH);
delay(1000);
digitalWrite(buzzer, LOW);
delay(1000);
lcd.empty();
}
if (distance==30){
lcd.print("Subject Approaching 50");
digitalWrite(buzzer, HIGH);
delay(1000);
digitalWrite(buzzer, LOW);
delay(1000);
lcd.print("Subject Approaching 50");
digitalWrite(buzzer, HIGH);
delay(1000);
digitalWrite(buzzer, LOW);
delay(1000);
lcd.print("Subject Approaching 50");
digitalWrite(buzzer, HIGH);
delay(1000);
digitalWrite(buzzer, LOW);
delay(1000);
Output
Sketch uses 5294 bytes (16%) of program storage space. Maximum is 32256 bytes.


bUTTONWITH | Arduino IDE 2.2.1
File Edit Sketch Tools Help
Arduino Uno
bUTTONWITH.ino
lcd.empty();
}
else if(distance<distanceThres)
{
lcd.print("Disturbance!");
digitalWrite(buzzer, HIGH);
delay(5000);
lcd.print("Disturbance!");
digitalWrite(buzzer, LOW);
delay(5000);
}
else if(analogSensor>sensorThres){
lcd.print("Smoke-Danger!");
digitalWrite(buzzer, HIGH);
delay(5000);
lcd.print("Brace-Up!");
digitalWrite(buzzer, LOW);
delay(5000);
}
else
{
lcd.empty();
digitalWrite(buzzer, LOW);
delay(1000);
digitalWrite(buzzer, LOW);
delay(1000);
}
}
Output
Sketch uses 5294 bytes (16%) of program storage space. Maximum is 32256 bytes.
Ln 95, Col 38 Arduino Uno on COM5 [not connected]
digitalWrite(buzzer, LOW);
delay(1000);
}
}
}
}
Output
Sketch uses 5294 bytes (16%) of program storage space. Maximum is 32256 bytes.

6. Future Scope

Future work on the intelligent monitoring system for asthmatics and smart smoking areas in green homes will prioritize the integration of advanced machine learning algorithms for personalized insights and enhanced prediction of asthma triggers. The system will evolve through the incorporation of additional environmental sensors, IoT technologies, and continuous collaboration with healthcare and environmental experts to stay abreast of the latest research and standards. Energy efficiency improvements and exploration of renewable energy sources will align with sustainable practices. User feedback and testing will be crucial for ongoing refinement, ensuring the system adapts to the changing needs of users and maintains a commitment to promoting healthier indoor environments.

7. Bill of Materials

ITEM	QUANTITY	URL	PRICE in USD
Arduino Uno R3	1		32.00
Parallax LCD	1	www.amazon.com/Parallax-20-Serial-LCD-Backlit	43.00
MQ2 /Gas Sensor	1	www.sparkfun.com	9.00
Ultrasonic Sensor	1	www.lionx.	13.00
Buzzer	1	www.digikey.com	0.99
LEDs	1	https://www.ledsupply.com/	6.99
AA Batteries (4 Pack)	1	https://www.batteryjunction.com/	4.49
Jumper Wires (Pack)	1	https://www.google.com/search?q=jum	5.94
Acrylic Sheets (12*24 inches)	2	https://www.novadisplaysystems.com/	30.00
Total		store.arduino.com	**$145.41**

8. Conclusion

In conclusion, the "Disturbance Preventer" project demonstrated the successful utilization of the Arduino Uno R3 microcontroller to create a versatile system for object detection, smoke sensing, and prevention of disturbances. Through the integration of sensors such as the Ultrasonic Sensor and MQ2 Gas Sensor, combined with LED and LCD components, the project showcased a comprehensive solution designed to detect and respond to potential disturbances. The practical hands-on experience provided valuable insights into the hardware capabilities of the Arduino Uno R3 and strengthened my proficiency in Arduino syntax. The project's success lies not only in its ability to perform a range of tasks, from object detection to monitoring smoke levels, but also in its capacity to prevent disturbances through proactive measures. The visual feedback provided by LED and LCD operations added a practical dimension to the disturbance-prevention aspect of the system.

9. Acknowledgements

The authors would like to express their gratitude to other researchers for their innumerable and invaluable contributions to the field of mechatronics. Furthermore, the authors would like to express their gratitude to Prof. William Peng and his Teaching Assistants for their advice and assistance during the entire project process. The great assistance enabled us to learn more about the roles and significance of Arduino in the context of mechatronics, as well as the specifics of Ultrasonic and gas sensors.

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