আন্তর্জাতিক ইসলামী বিশ্ববিদ্যালয় চট্টগ্রাম
الجامعة الإسلامية العالمية شيتاغونغ
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Air Quality Measurement Device

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***Abstract*—** The air quality sensor developed by our group senses various gasses but mainly carbon dioxide (CO_2) in the environment in PPM (parts per million).
The main aim of this project is to develop a device which can monitor PPM in air in real time.
The air monitoring device developed in this project is based on Arduino Uno. The sensor used for monitoring the air pollution is MQ-135 gas sensor. The Arduino board connects with the sensor using analog pins. The sensor data is also displayed on the serial monitor of Arduino software.

***keyword*—** Arduino, MQ-135, Gas, PPM, Arduino IDE, Sensor.

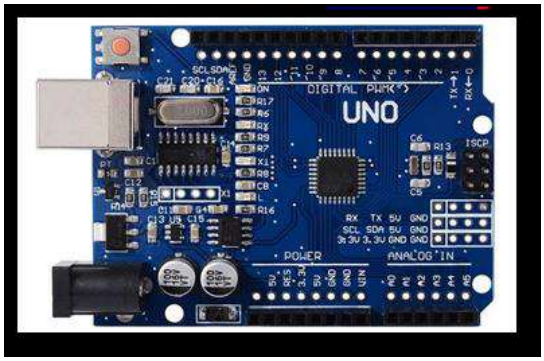
I. INTRODUCTION

The temperature of the earth has increased significantly over the past few decades. Scientists around the world have predicted that the average temperature of the Earth's atmosphere will increase by 2° to 6° Celsius by the end of the 21st century unless appropriate measures are not taken. The Industrial Revolution has played the principal role in triggering this rise, followed by other human activities like burning of fossil fuels, deforestation, etc. Release of greenhouse gases like carbon dioxide, methane, nitrous oxide and fluorinated gases trap the heat in the atmosphere, leading to global warming. Gas Sensing and Monitoring refers to the process of continuously tracking the changes in concentration of different air component.
Growing urbanization and no. of Industrial towns make it a requirement to have a close concern of the environment. Hard to keep monitoring continuously certain sites such as industries, busy traffic signals, villages prone to soil erosion & high ammonia concentration etc.
Air quality monitoring is the process of assessment of pollutants present in atmosphere by their quantity and types as per air quality standards. Air quality monitoring helps us to take action based on pollutants present in atmosphere to improve air quality

II. CELL MODELING

1. Arduino Uno

Arduino Uno is one of the most popular prototyping boards. It is small in size and packed with rich features. The board comes with built-in Arduino boot loader. It is an Atmega 328 based controller board which has 14 GPIO pins, 6 PWM pins, 6 Analog inputs and on board UART, SPI and TWI interfaces. In this IOT device, 9 pins of the board are utilized. There are six pins used to interface the character LCD. There are two pins utilized to interface the ESP8266 Wi-Fi Module and an analog input pin is used to connect the MQ-135 sensor. It is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The ATmega328 on the Arduino Uno comes pre-programmed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.



Technical specifications:

- Operating Voltage: 5 Volts
- Microcontroller: Microchip ATmega328p
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

2. MQ-135 gas sensor:

- The MQ-135 gas sensor senses the gases like ammonia nitrogen, oxygen, alcohols, aromatic compounds, sulphide and smoke. The operating voltage of this gas sensor is from 2.5V to 5.0V. MQ-135 gas sensor can be implementation to detect the smoke, benzene, steam and other harmful gases.

- The MQ-135 alcohol sensor consists of a tin dioxide (SnO2), a perspective layer inside Aluminium Oxide micro tubes (measuring electrodes) and a heating element inside a tubular casing.

- It has lower conductivity compare to clean air and due to air pollution the conductivity is increases. The air quality sensor detects ammonia, nitrogen oxide, smoke, CO2 and other harmful gases.

- The VCC and Ground terminals of the sensor are connected to the common VCC and Ground. The Analog Output pin of the sensor is connected to the A0 pin of the Arduino. The analog output voltage from the sensor can be assumed directly proportional to the concentration of CO2 gas in PPM under standard conditions. The analog voltage is sensed from the sensor and converted to a digital value in range from 0 to 1023 by the inbuilt ADC channel of the controller. The digitized value is hence equal to the gas concentration in PPM.

- The three basic units of measure used in reporting air pollution data are micrograms per cubic meter (JLg/m3), parts per million (PPM), and the micron (JL). Micro grams per cubic meter and parts per million are measures of concentration. Both microgram per meter cube and ppm are used to indicate the concentration of a gaseous pollutant. There is an advantage to the unit ppm that frequently makes it the unit of choice. PPM is a volume-to-volume ratio.

3. Arduino IDE

To Program Arduino Uno we need IDE. Arduino IDE contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

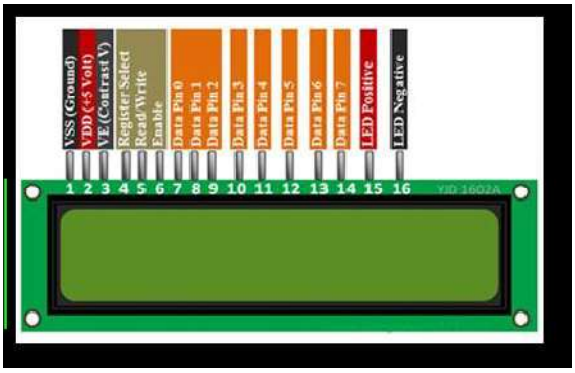
Code:

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
int Gas = A0;
int th=250;
void setup()
{
pinMode(A0 , INPUT);
lcd.begin(16, 2);
}
void loop()
{
int ppm=analogRead(A0);
lcd.print("Gas: ");
lcd.print(ppm);
lcd.print(" ppm");
if (ppm > th)
{
lcd.setCursor(0,1);
lcd.print("Bad Air Quality");
}
else
{
lcd.setCursor(0,1);
lcd.print ("Good Air Quality");
}
delay (400);
lcd.clear();
}
```

4. 16X2 Character LCD

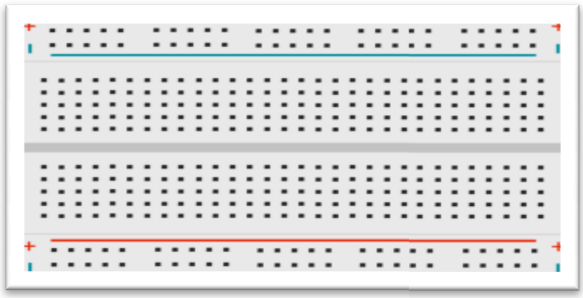
The 16X2 LCD display is used to monitor the sensor values read by the Arduino board from MQ-135. It is interfaced with the Arduino Uno by connecting its data pins D4 to D7 with pins 5 down to 2 of the controller respectively. The RS and E pins of the LCD are connected to pins 12 and 11 of the

controller respectively. The RW pin of the LCD module is connected to the ground.



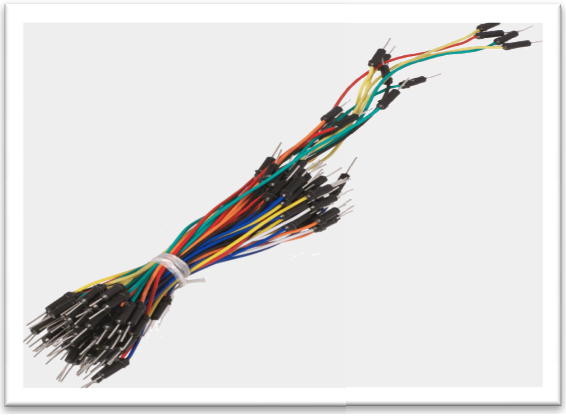
5. Breadboard:

A thin plastic board used to hold electronic components (transistors, resistors, chips, etc.) that are wired together. Used to develop prototypes of electronic circuits, breadboards can be reused for future jobs. They can be used to create one-of-a-kind systems but rarely become commercial products. The breadboard contains spring clip contacts typically arranged in matrices with certain blocks of clips already wired together. The components and jump wires (assorted wire lengths with pins at both ends) are plugged into the clips to create the circuit patterns. The boards also typically include metal strips along the side that are used for common power rails and signal buses.



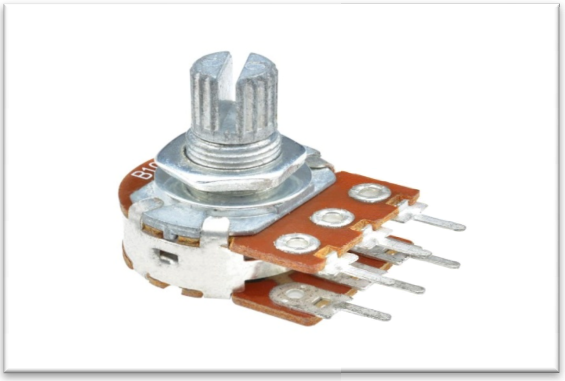
6. Jumper wires :

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed.



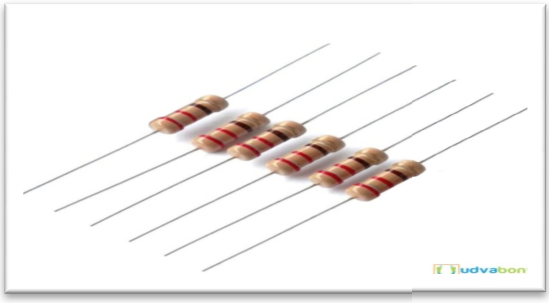
7. Potentiometer 10k:

Potentiometers are very useful in changing the electrical parameters of a system. It is a single turn 10k Potentiometer with a rotating knob. These potentiometers are also commonly called as a rotary potentiometer or just POT in short. These three-terminal devices can be used to vary the resistance between 0 to 10k ohms by simply rotating the knob. A potentiometer knob can also be used along with this POT for aesthetic purposes.

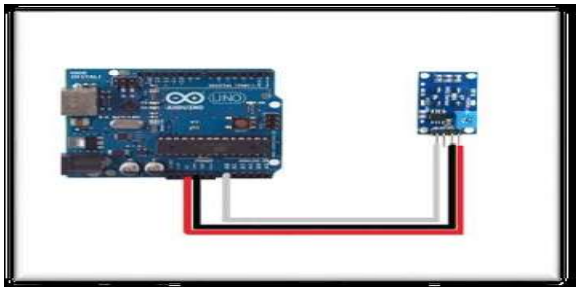


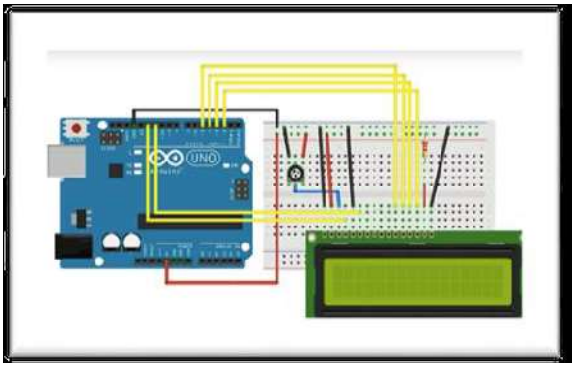
8. Resistors 220 ohm:

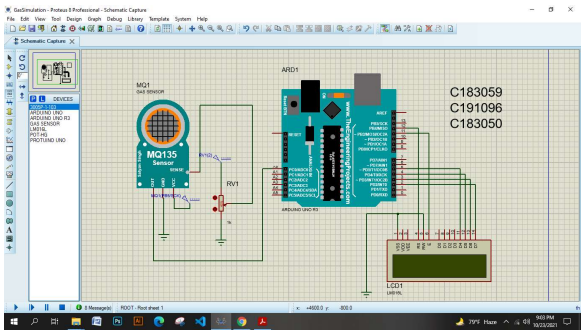
A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, to adjust signal levels, bias active elements, and terminate transmission lines among other uses.



9. Circuit Diagram







10. Working Principle

- As the device is powered, the Arduino board loads the required libraries.
- The analog voltage sensed at the pin A0 of the Arduino is converted to a digital value by using the in-built ADC channel of the Arduino.
- The Arduino board has 10-bit ADC channels, so the digitized value ranges from 0 to 1023. The digitized value can be assumed proportional to the concentration of gases in PPM.
- The code is uploaded on the board using the USB drive and then run. The output is observed on the LCD directly in PPM unit.

11. Parameters used

Voltage Source (v)	Resistor (ohm)	Potentiometer (k-ohm)
5	220	10

12. How we worked

The 16X2 LCD display is used to monitor the sensor values read by the Arduino board from MQ-135. It is interfaced with the Arduino Uno by connecting its data pins D4 to D7 with pins 5 down to 2 of the controller respectively. The RS and E pins of the LCD are connected to pins 12 and 11 of the controller respectively. The RW pin of the LCD module is connected to the ground. VDD pin is connected to 5v voltage source and V0 is connected to the middle pin of potentiometer. A pin is connected to the 5v through 220 ohm resistor and K to ground.
The other two pins of potentiometer connected to the common 5v source slot of breadboard and common ground. The potentiometer will control the contrast of the LCD.
The MQ-135 sensor's Vcc pin connects to the common 5v source slot, GND pin connects to the common ground slot and A0 pin connects to the analog A0 pin of the Arduino.
Lastly, after coding in LAPTOP at Arduino IDE, we uploaded the code to the Arduino plugging it by a D type cable. It took 30-60 minutes to warm up the MQ-135 sensor and get the correct Gas measurement in PPM. We used different types of environment and experiments on ourselves to see the results of our device and It was successfully detecting CO_2, Alcohol, Smoke, Naphthalene.

III. PROJECT COSTING

Arduino UNO	700 tk
Breadboard	120 tk
MQ135 sensor	300 tk
16*2 LCD Display	250 tk
Header male	20 tk
1k pot	30 tk
10k pot	30 tk
220 ohm resistor	10 tk
Jump wire	50 tk
Display soldering	100 tk
Total	1610 tk

IV. RESULT AND DISCUSSION

After connected the hardware parts of our project as show in figure and test the software we got monitoring of air pollution. When Sensor gas MQ135 detect air quality between (0PPM -250PPM) the LCD will show message "Gas: (The amount of gases present in the Air) and Good Air Quality". And when Sensor gas MQ135 detect gases more than (250 PPM) the LCD will show message " Gas: (The amount of gases present in the Air) and Bad Air Quality ".
The result PPM is based on the standard gas amount present in air according to https://www.kane.co.uk/

0-150ppm	Normal background concentration in outdoor ambient air
150-250ppm	Concentrations typical of occupied indoor spaces with good air exchange
250-2,000ppm	Complaints of drowsiness and poor air.
2,000-5,000 ppm	Headaches, sleepiness and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may also be present.
5,000	Workplace exposure limit (as 8-hour TWA) in most jurisdictions.
>40,000 ppm	Exposure may lead to serious oxygen deprivation resulting in permanent brain damage, coma, even death.

The comparison between the normal air quality and when other gases pushed into the air is given with the help of some charts:

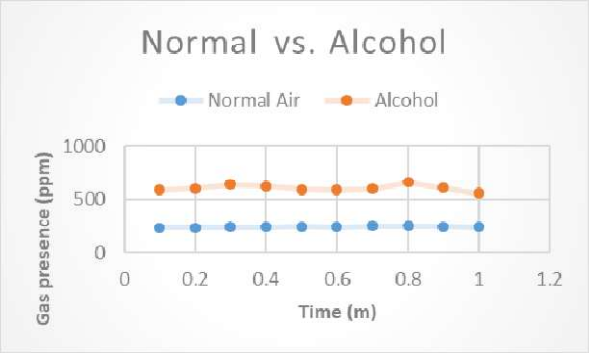


Fig. Normal Air vs Alcohol

Indoor normal air stays between 230-250 ppm with some fluctuations because of CO2 flushes by us and not so well ventilated modern homes. The alcohol when gets out of a bottle stays between 550-800 ppm and some fluctuation happens because of the mixture into normal indoor environment.

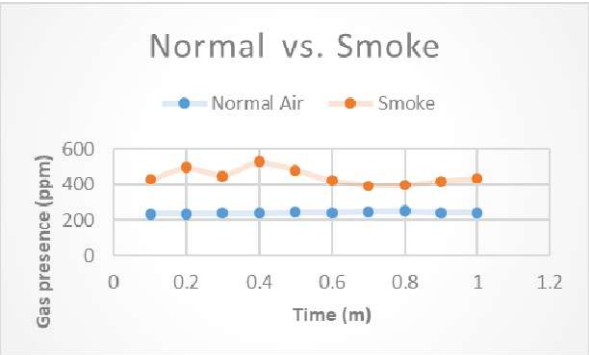


Fig. Normal Air vs Smoke

Indoor normal air stays between 230-250 ppm with some fluctuations because of CO2 flushes by us and not so well ventilated modern homes. The smoke created by igniting a matvh stick stays between 400-590 ppm and some fluctuation happens because of the mixture into normal indoor environment.

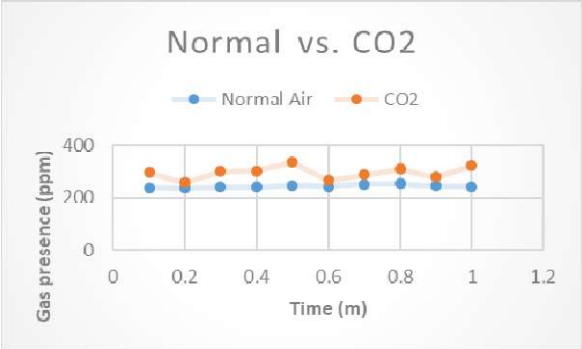


Fig. Normal Air vs CO_2

Indoor normal air stays between 230-250 ppm with some fluctuations because of CO2 flushes by us and not so well ventilated modern homes. The CO2 when gets out of our mouth stays between 260-350 ppm and some fluctuation happens because of the mixture into normal indoor environment.

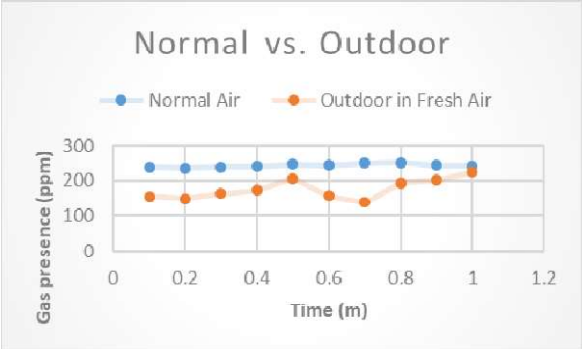


Fig. Normal Air vs Fresh Air

Indoor normal air stays between 230-250 ppm with some fluctuations because of CO2 flushes by us and not so well ventilated modern homes. The outdoor fresh air outside stays between 120-230 ppm and we can notice much ups and downs int the meter because though we have fresh air outside, but the air may contain other gases.

Lastly, The MQ-135 gas sensor also senses other gases like ammonia nitrogen, aromatic compounds, sulfide, etc. The boost converter of the chip MQ-3 gas sensor is PT1301. The operating voltage of this gas sensor is from 2.5V to 5.0V. The MQ-3 gas sensor has a lower conductivity to clean the air as a gas sensing material. In the atmosphere, we can find polluting gases, but the conductivity of the gas sensor increases as the concentration of polluting gas increases. MQ-135 gas sensor can be implemented to detect the smoke, benzene, steam, and other harmful gases.

V. CONCLUSION

Air quality can be checked at home level easily and effectively. The PPM levels can be compared with expected environmental PPM gas levels and the amount and extent of pollution can be found out. This is very cost effective and hence can be made by anyone as a project aiding movements against environmental air pollution at a local level.

VI. ACKNOWLEDGMENT

We would love to express our gratitude to our supervisor Md. Ashraful Alam for his guidance, encouragement and continuous support**.** Also thanks to the group members for a super teamwork.

VII. LIMITATION

This Project will not work instantly after connecting with pc or power source. For actual result we have to wait minimum 15 to 20 minutes after connecting with power.

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