# CSE360 Project Based Theory Assignment

# Fall-2021

**Project Title: Environment Pollution Defense Mechanism**

**Section: 6**


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# ENVIRONMENT POLLUTION DEFENSE MECHANISM

## Introduction:

Pollution is one of the major factors that is adversely affecting the quality of the lives of millions around us. Globalization and industrialization are disrupting the environment's equilibrium by releasing untreated hazardous toxic substances into the atmosphere, resulting in contamination of basic ecosystem elements such as water, air, and soil, which are necessary for human survival. With the expanding global population and industrial advances, the majority of pollutants in the environment are a result of untreated emissions and the release of industrial wastes into the environment. Many processing and manufacturing businesses contribute significantly to four different forms of pollution: **Pollution of the air, Pollution of the water supply, Pollution of the sound, Pollution of the soil.**

The methodology used in the project is to read and monitor pollution parameters, then inform pollution control authorities when any of these pollutants exceeds industrial standards. The system investigates the level of PH in industrial effluents, the level of CO, carbon dioxide, combustible gas, humidity in the air, and the minute optical dust particles released during industry processes, as well as the level of sound produced by the industry, using various sensors such as a PH sensor, MQ6, MQ9, temperature sensor, humidity sensor, noise sensor, and dust density sensor. When emissions rise, the system gathers the values of pollutants discharged on a specific day and time and uses wireless technology to send SMS and E-mail notifications to environmental pollution monitoring authorities. The system is developed cost-effectively for industrial usage and it is also upgradeable for future endeavors.

## Application Area:

Every project is built keeping all the application areas in mind. The areas in which the project/system can be applied is regarded as the practical field of the project. The base application area of the project we have developed is '**Security and Defense System**'. Now, questions may arise, how is environment and security related each other? The best possible answer is that Environment can be treated as the most valuable treasure, since we live within it. So, ensuring the security of something of this caliber holds utmost importance.

Untreated emissions and factory discharges of industrial wastes into the environment contribute to pollution. As a result, there are four types of pollution: air, sound, water, and soil. According to the World Health Organization, up to 0.1 million people worldwide die prematurely each year as a result of indoor air pollution. Similarly, water is responsible for almost 0.9 million premature deaths. In 2021, environmental deaths will account for 2% of all deaths, up from 0.7% in 2002. Here is a list of the Top 10 Countries with the Worst Air Pollution - PM2.5 exposure ($\mu g/m^3$) - IQ Air 2020:

| Ranking | Country | Pollution Index |
|---|---|---|
| **1** | Bangladesh | 77.10 |
| **2** | Pakistan | 59.00 |
| **3** | India | 51.90 |
| **4** | Mongolia | 46.60 |
| **5** | Afghanistan | 46.50 |
| **6** | Oman | 44.40 |
| **7** | Qatar | 44.30 |
| **8** | Kyrgyzstan | 43.50 |
| **9** | Indonesia | 40.70 |
| **10** | Bosnia & Herzegovina | 40.60 |

Without a shadow of doubt, the above mentioned countries can benefit a lot from our project. Specially, Bangladesh can lower its pollution index in the next 5 years through using this project and monitoring the most polluted areas. Saving our environment needs to be our topmost priority, and this project can be considered as a starting step towards it.

## Technology & Tools:

[1] **Power Supply Unit:** These packs (PSUs) are AC / DC converters that convert 9VAC to 5VDC. The 7805 regulator is connected in parallel with the bridge rectifier to provide a constant voltage to the system. It also contains a 1000uf filter capacitor used to remove noise in the circuit.

[2] **MQ9 sensor:** The MQ9 sensor is used to detect the concentration of CO in the atmosphere. The conductivity of the sensor is low in clean or pure air, but increases with increasing CO content.

[3] **MQ6 sensor:** The MQ6 sensor is used to detect the concentration of various flammable gases such as propane, butane and LPG in the atmosphere. It can detect gas concentrations of almost 200 to 10,000 ppm. The maximum operating voltage is 5V. The output of the sensor depends on the analog resistance.

[4] **LM35 Temperature Sensor:** The system uses the LM35 sensor to detect the temperature of heat-treated water before it is sent to a natural reservoir. When the temperature changes by 1 degree, the sensor shows a voltage difference of 10 mV. It measures approximately 55 to 150 degrees.

[5] **DHT11 Humidity Sensor:** DHT11 is a commonly used sensor to detect temperature and humidity. When the sensor detects

the humidity in the area, it calculates the relative humidity. The maximum operating voltage is 3.55.5V. Light Dust Sensors: Light dust density sensors are used to detect light dust present in the atmosphere. The sensor consists of an infrared light emitting diode and a phototransistor. It can also detect very fine particles in the area, such as particles in cigarette smoke.

[6] **PH Sensor:** The pH scale ranges from 0 to 14, with 7 being neutral and 8 being basic. The operating voltage is between 3.55V. High levels of lead, mercury and asbestos have a pH of 23 and are acidic.

[7] **M393 Sound Sensor:** The LM393 sensor is used to detect the intensity of sound in your environment. Converts the barometric pressure difference into an electrical signal. The operating voltage is between 45V. The sound vibrates the membrane of the sensor and internally vibrates a small magnet.

[8] **Arduino Mega2560 Microcontroller:** The Arduino mega2560 is a microcontroller with 54 digital input / output pins, 15 of which can be used as PWM outputs. It contains 16 analog inputs, a USB socket, an ICSP header, a 16 MHz crystal oscillator, and 4 serial UART hardware inputs. The maximum input voltage limit is 620V.

[9] **SIM800LGPRS Modem:** SIM800 is a quad band GSM / GPRS module. It consists of a UART port, a USB port, and various audio channels. It operates with a power of 3.44.4V. SIM800L is used to send and receive voice calls that send and receive data over the Internet.

[10] **Dust Sensor:** An optical dust density sensor is utilized to determine the amount of optical dust in the atmosphere. The sensor is made up of a **phototransistor** and an infrared light-emitting diode that are positioned diagonally.

[11] **LCD Screen:** LCD is basically an optical device to display output. It uses the light modulating properties of liquid crystals and combines it with polarizers.

## Programming Language:

The Arduino Mega 2560 microcontroller is programmed using the Arduino Integrated Development Software, and the complete project is written in the language **Embedded C.** As we know, C programming language is used in a processor which has operating system installed in it, which suggests that this particular language is designed to run on systems which has pretty high resources.

However, we are using microcontroller (Arduino Mega2560) for this project and every microcontroller has a limited RAM, ROM and programmable memory. So, in this case, we have to opt for an extended version of C Language which is Embedded C. The main benefit of Embedded C is that it has a fast coding speed and is lightweight and simple to learn.

## Working Mechanism of Sensor:

There are several sensors used in this project. However, if we categorize them, there are a total of 6 types of sensors used. They are:

1. Gas Sensors (MQ9 and MQ6)
2. Temperature Sensor (LM35)
3. Humidity Sensor (DHT11)
4. Dust Sensor
5. PH Sensor

6. Sound Sensor (LM393)

The working mechanism of these sensors are described below:

1. **Gas Sensors:** A gas sensor detects the presence of one or more types of gases in the environment. These sensors have a wide range of applications, including refinery security systems, industrial facilities, and even houses. These sensors can detect flammable, poisonous, and polluting gases, among other things. Gas detection can be accomplished in a variety of ways, the most popular of which are electrochemical sensors. By generating a chemical reaction on their heated electrodes and monitoring the ensuing electric current, these sensors may determine the concentration of a given gas.

   **Carbon monoxide** and **combustible gases** are detected using the MQ9 sensor. It can detect carbon monoxide concentrations ranging from 10ppm to 1000ppm, as well as combustible gas concentrations ranging from 100ppm to 10000ppm. When a 5V voltage is introduced to the MQ9, the internal heater begins to warm up. As the density of the observable gas changes, so does the internal resistance of this sensor. A simple circuit can be used to read this value. MQ6 works in a similar fashion but it detects **Propane**, **Butane** instead.

2. **Temperature Sensor:** The LM35 sensor is based on the **diode** principle, which states that when the temperature rises, the voltage across the diode rises at a predictable rate. It is simple to construct an analog signal that is directly proportional to temperature by properly magnifying the voltage change.

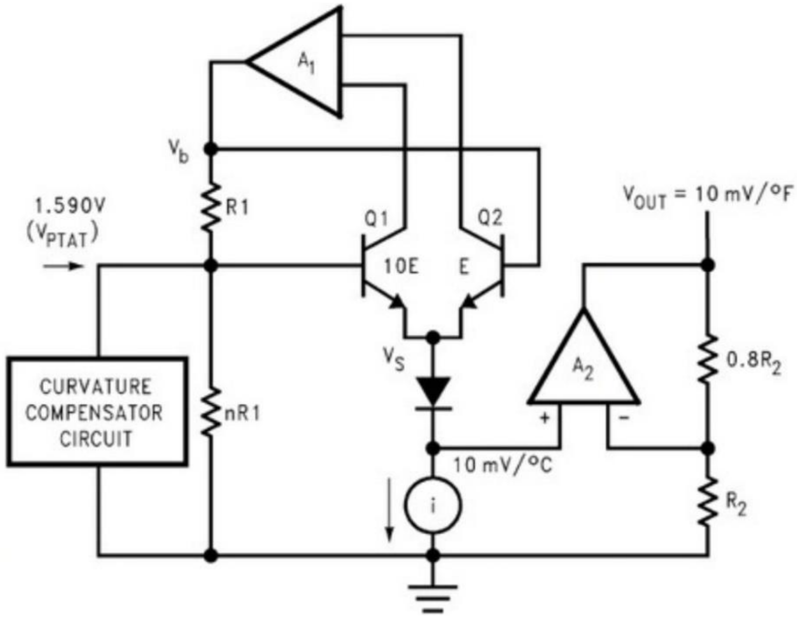



**Figure: LM35 Circuit**

By comparing the outputs of the two transistors, the amplifier at the top assures that the voltage at the base of the left transistor (Q1) is proportional to absolute temperature.

Depending on the part, the amplifer on the right transforms absolute temperature (measured in Kelvin) into Celsius.

3. **Humidity Sensor:** Electronic sensors measure the **capacitance** or **resistance** of air samples to determine humidity. The air flows between two metal plates in a capacitive hygrometer. The change in capacitance between the plates is related to the change in air moisture. A ceramic or conductive polymer absorbs moisture in a resistive hygrometer, which alters its resistivity, is connected to a circuit where moisture impacts the material's resistance. The change in current is then used to calculate the relative humidity. Hygrometers commonly include a temperature sensor and a barometer, which integrate temperature and pressure data with capacitance/resistance change to determine humidity.

4. **Dust Sensor:** To determine the amount of optical dust in the atmosphere, an optical dust density sensor is utilized. The sensor is made up of a **phototransistor** and an infrared light-emitting diode that are positioned diagonally. When infrared light is first emitted, due to the existence of dust particles, partly infrared light is reflected, and when this reflected light lands on the phototransistor, voltage is created. The phototransistor's voltage is a direct measurement of the dust density in the surroundings. It can also pick up very small particles in the environment, such as those found in cigarette smoke. The operational voltage ranges from 2.5 to 5 volts.

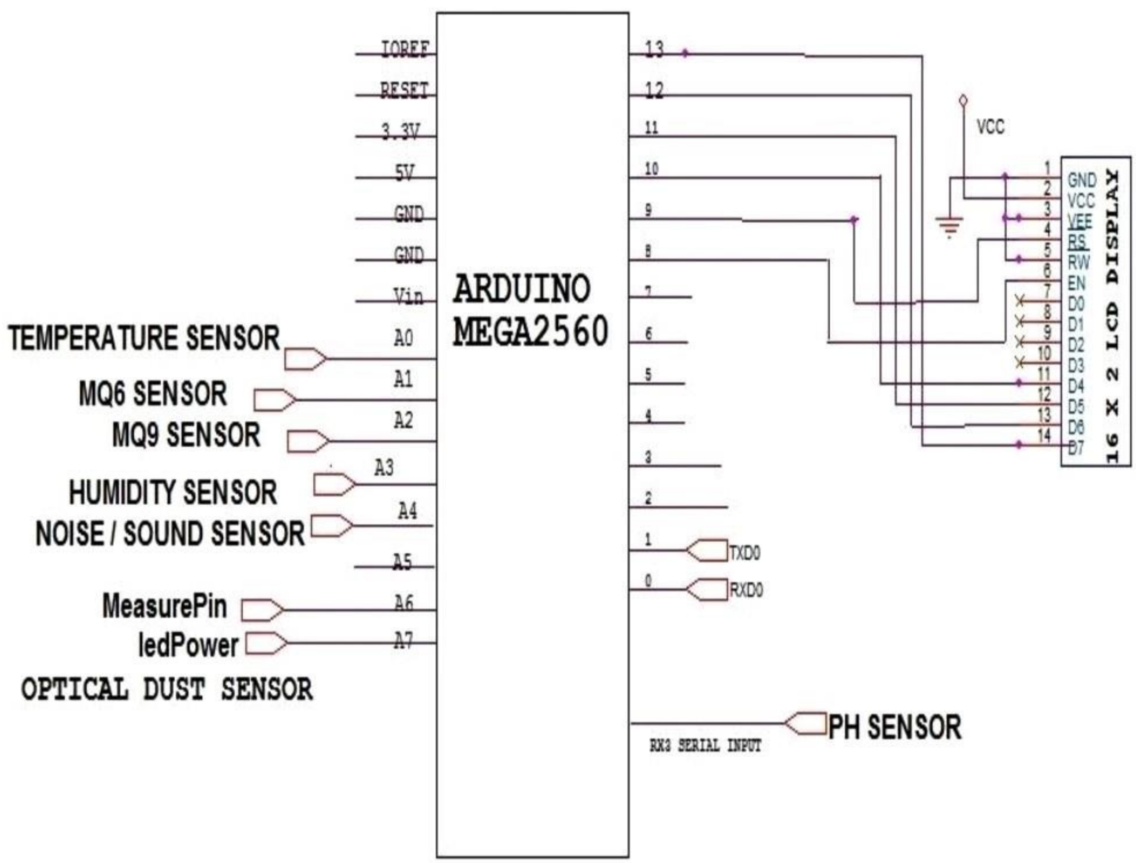
5. **PH Sensor:** The pH sensor is used to determine the acidity or alkalinity of industrial effluents before they are released into natural reservoirs. The pH is determined by the presence of hydrogen ions, which is measured by the **hydrogen potential**. The pH scale goes from 0 to 14 on a scale of 1 to 14. Acidic pH ranges from 1-6, neutral pH ranges from 7 to 14, and basic pH ranges from 8 to 14.
   Industrial effluents having significant levels of lead and mercury have a pH of 2-3, which is acidic in nature, but effluents containing asbestos have a pH of 12-14, which is alkaline in nature. A pH meter is made up of two electrodes. The pH is directly measured by the voltage differential between the two electrodes. The operational voltage ranges from 3.5 to 5 volts.

6. **Sound Sensor:** The LM393 sensor detects the strength of sound in the surroundings by converting air pressure differences into electrical impulses. The sound waves produced will cause the diaphragm of the sensor to oscillate, causing the small magnets inside the sensor to vibrate as well. This vibration causes a current

to flow through the coil, which is a direct measure of the sound's intensity. It creates a binary representation of the sound as well as an analog representation of the sound. The operating voltage is in the range of 4-5 volts. It is implied for detecting noise pollution in surrounding area.

## Connection With Arduino:

For this project, we are using the physically largest microcontroller titled Arduino Mega2560 which has a total of 54 I/O pins. It has a USB jack, 16 analog inputs, 16 MHz oscillator, 4UARTs hardware serial input, and lastly a reset button. The schematic depiction of the entire system consisting the sensors and other devices is shown in the diagram.



The sensors are wired to the Arduino Mega 2560 microcontroller's analog pins, and the connections are made by soldering the wires to a flat circuit board to avoid loose contacts. The GPRS modem and LCD panel are powered by the main power supply unit. Initially, a 9V 1A output power adapter with 5.5mm AC plugs was used. The power supply unit's circuit consists of a bridge rectifier that rectifies the main AC input to the DC output, converting a 9V AC power to a 5V DC power that is supplied to the system. Tables 1,2 and 3 illustrate the pin connections of the Arduino, sensors, LCD screen, and GPRS modem, respectively.

| **Pins in LCD display** | **External Pins in** |
|---|---|
| D4(Data pin) | Arduino Analog output pin 10 |
| D5(Data pin) | Arduino Analog output pin 11 |
| D6(Data pin) | Arduino Analog output pin 12 |
| D7(Data pin) | Arduino Analog output pin 13 |
| RS(Register select pin) | Arduino Analog output pin 9 |
| EN(Enable pin) | Arduino Analog output pin 8 |
| RW,RS,VEE,VCC,GND | GND and VCC pins of main power supply unit. |

**Table-1: Analog Input Pins of Sensors**

| Pins in GPRS Modem | External pins |
|---|---|
| VCC and GND | VCC and GND pins of main power supply unit |
| RXD(Serial communication pin ) for Receiving data | RXO-0(Serial communication pins in Arduino)for Receiving data |
| TXD(Serial communication pin ) for Transmitting data | TXO-1Serial communication pins in Arduino)for Transmitting data |

**Table-2: Pins connected to LCD display**

| sensors | Analog input Pin number |
|---|---|
| LM-35(Temperature) | A0 |
| MQ-6(LPG) | A1 |
| MQ-9(co ) | A2 |
| DHT-11(Humidity) | A3 |
| LM393( Sound) | A4 |
| pH | A5 |
| Optical Dust | A6(Measure pin) |
| LED power | A7 |

**Table-3: Pins connected to GPRS Modem SIM 800L**

## Data Flow from Sensors through ICs to I/O Devices:

As we can see, the data flow is divided in two different parts. They are: Data flow from Sensors through ICs & Data flow to I/O Devices.

### 1. *Data flow from Sensors through Arduino*

This part includes a power supply unit that powers the system as well as analog sensors such the PH sensor, MQ-6 sensor, MQ-9 sensor, temperature sensor, humidity sensor, dust density sensor, and noise sensor, all of which are connected to the Arduino Mega 2560 microprocessor. The GPRS module is used to send data over the internet to the receiver.

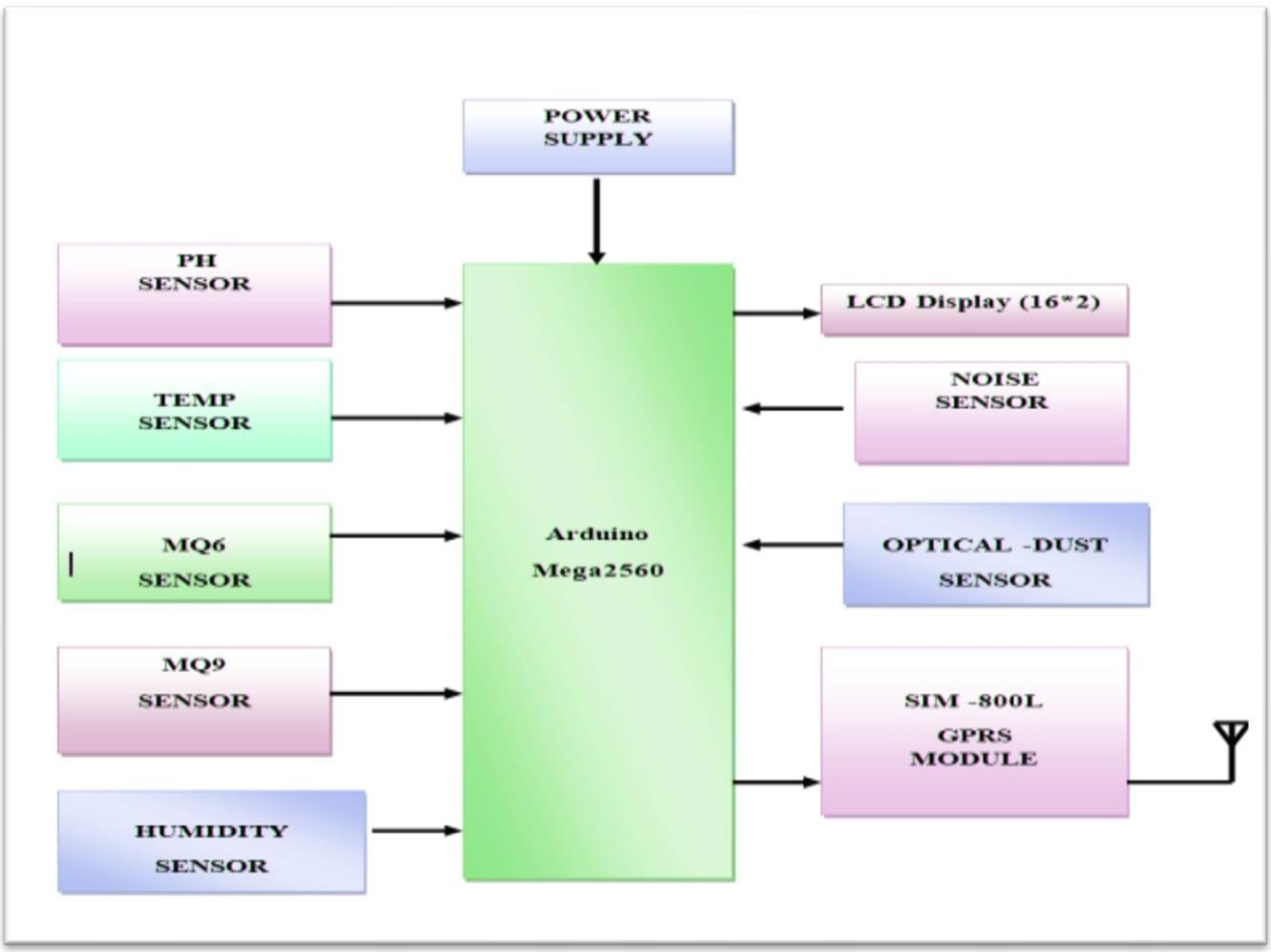



**Figure: Data Flow from Sensors to Arduino**

Now, to deliver electricity to the system, the power supply unit is initially turned on. To establish connection between the transmitter and receiver sections over the internet, both the transmitter and receiver sections need be linked to Wi-Fi. The system's sensors have been set up. The MQ- 6 sensor, for example, gathers analog data about the level of flammable gases such as LPG and Butane in the industrial environment.

Similarly, the analog data of presence of carbon monoxide, carbon dioxide, temperature of heat-treated water, humidity in the environment, pH of industrial effluents, level optical dust particles present in the atmosphere, and noise produced during the industrial process are captured by the MQ-9 sensor, temperature sensor, humidity sensor, pH sensor, dust density sensor, and noise sensor respectively. The Arduino Mega 2560 microprocessor receives this analog data, thus ending the first part of the entire process.

## 2. ***Data Flow to I/O Devices***

The data is sent to the receiver portion via the internet using the GPRS module. The receiver component is usually a smartphone on which the project's webpage application is built using embedded C and Android programming.

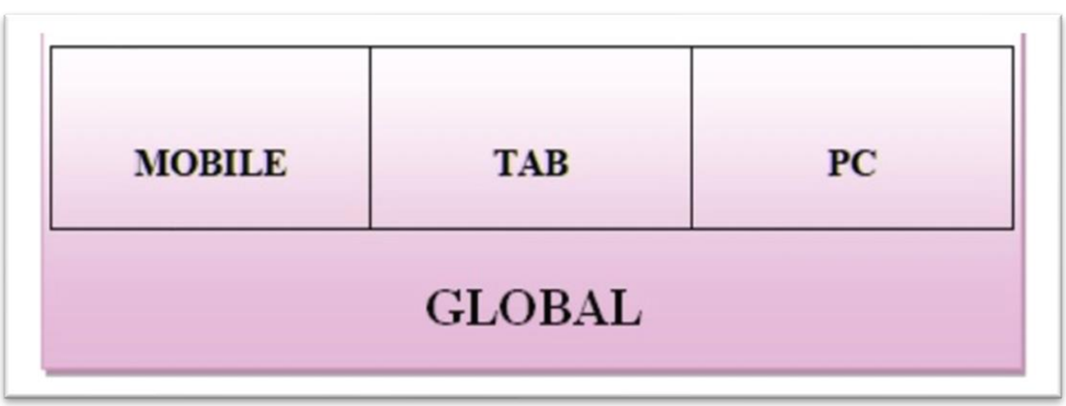



**Figure : I/O Devices Used In this Project**

The analog data from the sensor is converted to digital data by the Arduino Mega 2560 microcontroller, and the values of the respective data are shown on the LCD panel. With the use of the internet, the GPRS module sends data to the receiver section's project webpage. On the receiver part's web page, the series of data collected from the transmitter section is shown in the form of a table. The data is recorded in detail in the receiver section, together with the exact date and time of acquisition. When the levels of any particular data received by the sensors go over the preset value, indicating pollution, the transmitter section sends warning messages to the receiver's cell SIM or email which is an I/O device, thus completing the data flow.

## Algorithm & Code:

The algorithm along with the code that would be used for this project is provided below.

1. ***Algorithm***

a) Start.

b) Initialize system and sensors.

c) Record data on air quality, water quality, and noise intensity.

d) Upload the data to the online portal, display it on the LCD screen, and record it together with the date and time it was recorded.

e) Compare the collected data to the sensors' pre-set point.

f) If the threshold is exceeded, send the user SMS and email alerts, as well as displaying the data on the webpage portal.

g) If it does not exceed, no alarm messages should be delivered; instead, the data should be displayed on both the LCD and the webpage portal.

h) Return to step c.

## 2. ***Code***

- Declaring Pins

```
Int TEMP; ////A0
Int MQ6; ////A1
Int MQ9; /////A2
Int HUM; /////A3
Int NOISE; ////A4
Int PH; ////A5
Int measurePin = A6; ////A6
Int ledPower = A7; ////A7
```

- Reading Sensor Data:

```
TEMP = analogRead (0)
MQ6 = analogRead (1)
MQ9 = analogRead (2)
HUM= analogRead (3)
NOISE = analogRead (4)
PH = analogRead (5)
```

```
Dust voMeasured = analogRead (measurePin)
```

- <u>Displaying Data in LCD:</u>

```
lcd.setCursor (0, 0);
lcd.print ("sensor data :");
lcd.setCursor (0, 0);
lcd.print (sensor data);
Delay (1000);
```

- <u>Sending Alarming Message to Output Device:</u>

```
lcd.clear (); lcd.setCursor (0, 0);
lcd.print ("SENDING SMS...”);
Serial.println ("AT+CMGF=1");
Delay (500);
Serial.println ("AT+CMGS=\"mob number\"");
Delay (500);
Serial.println ("alarming message");
Delay (500);
Serial.Write (26);
Delay (500); lcd.clear (); lcd.setCursor (0, 0);
lcd.print ("SMS SENT ")
```

This is all from the algorithm and code part.

## Estimated Cost Analysis:

Cost analysis is one of the most important parts of this kind of project. In addition, if the product's price is not equivalent to the impact, then it may not be considered an ideal project. Our system's standard cost should be around 7,000-7500/= per unit, which is quite worthy in contrast to the work it does.

| COMPONENT | PRICE |
|---|---|
| Power Supply Unit | 130/= |
| MQ9 Sensor | 200/= |
| MQ6 Sensor | 150/= |
| LM35 Temperature Sensor | 70/= |
| DHT11 Humidity Sensor | 180/= |
| pH Sensor | 3,500/= |
| LM393 Sound Sensor | 350/= |
| Arduino Mega2560 | 1200/= |
| SIM800LGPRS Modem | 400/= |
| 1.8inch TFT LCD Screen | 850/= |
| Dust Sensor | 400/= |
| **Total** | **7,430/=** |

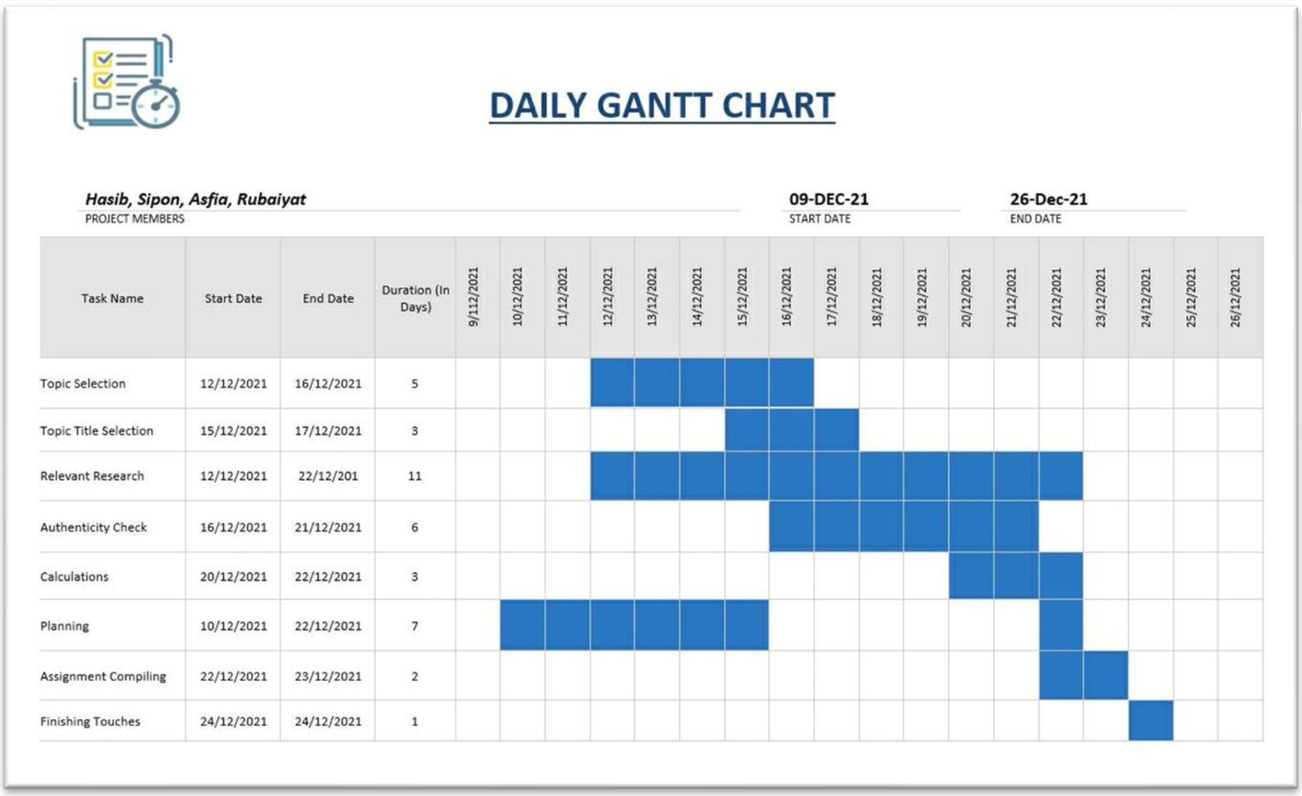
## Responsibilities of Each Members:

Every member of our group have tried to contribute equally as they have invested their time and knowledge into this project. Worth mentioning, we have held several meetings to ensure the completion of the assignment. Here in the below table, the parts on which each member has worked on are mentioned:

| Name | Contribution |
|---|---|
| **Asfia Rahman** | i. Introduction, Application Area, Technology and Tools, Programming Language<br><br>ii. Project Title Selection. |
| **Abdullah Al Sipon** | i. Connection with ICs, Data Flow from Sensors through ICs and I/O Devices, Algorithm & Code, Workplan<br><br>ii. Rendering MS Word & PDF, Tables, Customization & Correction. |
| **Md. Hasib Noor Nayeem** | i. Estimated Cost Analysis, Conclusion, Workplan<br><br>ii. Project Topic & Idea, Tables & Diagrams. |
| **Rubaiyat E Mohammad** | i. Working Mechanism of Sensors<br><br>ii. Resources, Pictures. |

## Workplan (Gantt Chart):

Each and every project requires proper planning. So, work plan is an essential part of the project undoubtedly. However, due to COVID-19 restrictions, most of the part throughout this work plan were carried over Google Meet and text messaging. The following diagram showcases our work plan:




**<u>Figure: Work Plan Gantt Chart</u>**

We used the last 2 days to make necessary amendments, citing proper references and finally submitting the assignment. By the end of the time span, 100% progress was made on the theoretical aspect of the project.

## Conclusion:

The project's ultimate purpose is to monitor and regulate pollution caused by the release of harmful, untreated chemicals in a cost-effective and secure manner. This system is more effective than the existing system because it aids environmental pollution control authorities in monitoring industrial environmental conditions with the help of seven sensors connected to an advanced controller that collects and records real-time data of various pollutants released by industries through various means, allowing authorities to maintain control and reduce pollution caused by industries in the air, water, soil, and noise.

Furthermore, the project homepage continuously saves data in full, including data and time of acquisition, and can access sensor data at any time and date. On the basis of the information gathered, relevant environmental pollution control measures can be implemented.

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