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IoT BASED INDUSTRIAL AIR, WATER AND NOISE POLLUTION MONITORING SYSTEM

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Abstract - *globalization, and industrialization is negatively affecting the equilibrium of the environment by releasing untreated harmful toxic elements into the atmosphere this resulted in contamination of basic elements of the ecosystem like water, air, and soil which are essential for humans to sustain, the 4 major types of pollution caused by the industries are air pollution, water pollution, soil pollution, and noise pollution. This leads to air and water borne diseases in both humans and animals. Hence the control of these pollution parameters is a great challenge. This paper presents IoT based industrial air, water and sound pollution monitoring system, the main objective of this project is to design an efficient and robust system to monitor the parameters which are causing pollution. The working methodology of this project/system is to read and monitor pollution parameters and inform pollution control authorities when the release of any of these pollutants goes higher than industry standards. The system investigates the level of PH in industrial effluents, level of CO, carbon dioxide, combustible gas, humidity in the air and the minute optical dust particles released during industry process and also the level of sound produced by the industry, using various sensors like PH sensor, MQ6, MQ9, temperature sensor, humidity sensor, noise sensor, and dust density sensor. The system records the values of pollutants released on a particular date and time and also sends both SMS and E-mail alerts to the environmental pollution monitoring authorities when there is an increase in the emissions through wireless technology (i.e.) Internet of Things using GPRS modem with the help of cloud technologies. The system is developed cost-effectively and compatible for future enhancement.*

Key Words: **CO, MQ6, MQ9, Iot, GSM, GPRS, DUST DENSITY SENSOR, CLOUD TECHNOLOGIES,**

1. INTRODUCTION

Pollution is an important and major factor that is Negatively affecting the quality of the lives of millions. Most of the pollutants in the environment are a result of untreated emissions and the release of industrial wastes from factories to the environment, with the growing world population and industry advancement, Environmental pollution became a big concern. Many Processing and manufacturing industries majorly contribute to 4 types of pollution

1. Air pollution.
2. Water pollution.
3. Soil pollution.
4. Noise pollution

Air pollution is caused by the emission of a high amount of untreated industrial waste such as carbon dioxide, carbon monoxide, sulfurous oxides, nitrous oxides, minute particulate matters like optical dust, and also a considerable amount of vapours of polymers such as methane's and butanes which are formed as a by-product due to burning coal, burning natural oils, fossil fuels and petroleum products to perform industrial processing activities. As per estimation made by the Indian pollution control authority that every year nearly a 1.2million Indians die because of air-borne diseases.

Similarly, the Major reason for water pollution through industries is caused by discharging the untreated industrial waste that is generated during various processing activities, the industrial wastes include asbestos, lead, mercury, nitrates, phosphates, sulfur, and other petrochemicals, etc. The untreated acidic effluents which are released to natural reservoirs decrease the pH value of the reservoir water resulting in a decreased microbial activity affecting the growth of the algae and other aquatic plants resulting in a decrease in the level of BOD (biological oxygen demand) that is the level of dissolved oxygen in the

water which affects in the breathing of the aquatic animals resulting in their death.

Likewise, Thermal pollution can be defined as the sudden increase or decrease in the temperature of a natural water reservoir, which may be oceans, ponds, rivers, lakes, etc. due to human activities. Thermal pollution usually occurs when the processing plants take the water from the natural reservoir and let out the used water back to the reservoir with extreme differences in temperatures. The sharp increase in the temperature of the water reservoir causes a decrease in the level of dissolved oxygen in the water affecting the life of aquatic plants and animals.

Noise is defined as the unwanted, loud and unpleasant sound, if this noise cause disturbance, irritation, or negatively effects causing harm to humans and animals then it is called noise pollution, according to WHO if the sound exceeds 75dB then it is considered as noise pollution. WHO recommends noise levels should be kept below 65dB during daytime and during night time noise levels must be kept below 30dB. noise pollution can be caused by various reasons like air traffic noise, traffic noise but one of the major reasons for noise pollution is heavy industrial machines for example a pneumatic drilling machine in the construction sites can produce up to 110dB noise. Noise pollution has a serious effect on both humans and animals such as constant loud noises that can result in hearing loss, respiratory agitation, high blood pressure, severe headaches, and many psychological disorders.

1.1 Major reasons for Industrial pollution

1. Lack of policies to control pollution.
2. Unplanned industrial growth
3. Use of outdated technologies in treating toxic effluents.
4. Industries purposefully neglect thinking that the cost of pollution control will reduce their profit margins.

1.2 Solution through IoT

IoT is one of the powerful tools in modern technologies which help to access data from remote locations and save them in cloud storage. With the increase in pollution and advanced technologies, various new methods were initiated to watch over the rapid increase in pollution more efficiently, where the Internet of things is one among them which played a major role in this domain. With the increase in the use of the internet and devices connected to the internet works on the principle of artificial intelligence IoT has become the most popular tool for the exchange of information among the devices connected to the internet. IoT helps exchange of information among various devices maybe household devices like fridges, washing machines or industrial machines, automobiles, watches, etc. The exchange of information occurs with the help number of sensors. IoT has become one of the most used technologies because of its flexibility, efficiency, and low-cost properties. This paper proposes a pollution monitoring system that allows us to monitor the level or quantity of pollutants released by different industries in various locations area using GSM and GPRS. The system collects various analog data like level of PH in industry effluents, level of CO, CO2, combustible gas, humidity in the air and the level of minute optical dust particles released during the industrial manufacturing process and also the intensity of noise produced by the industries using various sensors like PH sensor, MQ-6, MQ-9, temperature sensor, humidity sensor, dust density sensor, and noise sensor respectively. The system also records the values of pollutants released on a particular date and time and also sends both SMS and E-mail alerts to the environmental pollution monitoring authorities, when there is an increase in the emissions in compared to pre-set industrial standards where necessary actions can be taken further to control the release of pollutants.

2. LITERATURE SURVEY

[1]Zumyla Shanaz, Prem Kumar S investigated 'IoT based Industrial Pollution Monitoring System'. The Author proposed to build a robust system that continuously monitors the air quality around the industry by monitoring the level of various pollutants released during the industrial process with less human

intervention with the aim of providing a healthy environment to workers of the industries. Here the author used MQ-6 and MQ2 sensors for analyzing the level of CO, CO2, and quality of smoke released in the atmosphere with the help of GSM technology for the exchange of the data from sensors to the monitoring authorities.

[2] Ms.Aarthi, Karan Kapoor addressed 'Air and Sound Pollution Monitoring System Using IoT'.In this research, the author develops a system that monitors both air quality and intensity of noise produced during the industrial process using various sensors like MQ-135 to detect the level of CO2 in the atmosphere, DHT11 sensor to monitor both temperatures and humidity, LM393 sensor to monitor sound intensity. The system is integrated using Raspberry Pi 3B module, Raspberry Pi 3B is an ARM-based credit card sized SBC (Single Board Computer) which has an in-built Wi-Fi and Bluetooth module in it. The author used GPRS technology to exchange the data from the sensors to the specified locations through IoT.

[3] Kavitha.B.C. B.C, Deepa Jose proposed 'IoT based pollution monitoring system using raspberry – pi' Here the author develops a system that comprises various sensors like MQ-6, MQ-7, MQ-135, LDR, and DHT11 sensors to monitor the presence of various pollution causing parameters like carbon monoxide, carbon dioxide, smoke and butane, the system also monitors the increase in the atmospheric temperature and humidity due to pollutants released. The microcontroller used is raspberry pi with an inbuilt Wi-fi module. The system continuously keeps an eye on data of the quantity of pollutants in the atmosphere and sends alarming messages to the governing authorities when the emission of pollutants exceeds the pre-set values by the pollution board.

[4] T H Nasution, M A Muchtar addressed 'Designing an IoT-based air quality monitoring system' in this research the author has developed a system that consists of various analog sensors like MQ-135, MQ-7, and dust density sensor which are interfaced to Arduino microcontroller for exchange of data from the sensor the Arduino microcontroller is connected to ESP822 Wi- fi module, the author used a mobile application called ThingsSpeak cloud which stores the data obtained by the sensors in cloud storage and helps in accessing the data recorded even in remote locations.

[5] Mahammad D.V proposed 'Design and implementation of IoT based Portable Outdoor Dust Density Monitoring System' Here the author uses the optical dust density sensor which is interfaced with the Arduino microcontroller to detect the level of minute optical pollutants which are in the form of micro particles. The transmission of data is done using the internet of things in which a Wi-fi module is used which transmits the data through a mobile application called the Blink app.

[6] Palaghat Yaswanth Sai proposed 'An IoT Based Automated Noise and Air Pollution Monitoring System'. With an aim of monitoring both air quality and intensity of noise pollution in hospitals and school zones. The author used an LM393 sensor to get the analog data of the noise and an MQ-135 sensor to measure the presence of any toxic or combustible gases like Butane or LPG, the sensors are connected to an Arduino microcontroller which has an inbuilt Wi-fi module slot. ESP8266 Wi-fi module is used to transmit the data to the authorities with the help of the mobile application.

[7] Vennam Madhavireddy, B. Koteswarrao proposed 'Smart water quality monitoring system using IoT'. Here the authors developed a system that monitors the quality of the water in real-time. The proposed system consists of various sensors like a CO2 sensor to measure the percentage of CO2 dissolved, a pH sensor to measure the pH of the water, a water level sensor, and a temperature sensor to measure the temperature of the water. These sensors are interfaced with the Arduino microcontroller along with the Wi-fi module to transmit the data from sensors to the user using the internet. The system also records the detailed data obtained by the sensors on a particular date and time and also sends alarming messages to the user when the

level of a specific parameter increases or reaches beyond the pre-set value.

[8] Anuradha, Bhakti came up with the idea 'IoT Based Low-Cost System for Monitoring of Water Quality in Real Time' aiming to monitor various parameters of water to measure the degree of pollution in water. The system comprises sensors like a turbidity sensor to measure the number of particles dissolved in the water, a pH sensor to measure the pH of the water, and a Temperature sensor to access the increase or decrease in water temperature which may cause thermal pollution, Raspberry microcontroller is used to interface all the sensors. The exchange of the information from sensors to the user is done using a Wi-fi module through a mobile application called ThingsSpeak which enables sensor logging and location tracking of the device.

[9] Vaishnavi V. Daigavane and Dr. M.A Gaikwad proposed 'Water Quality Monitoring System Based on IoT' in this research author developed a system which comprises sensors such as pH sensor, Turbidity sensor, Temperature sensor, and Flow sensor to measures various parameters like the presence of minute particles in the water, pH of the water, water flow and also the temperature of the water, the sensors are controlled using Arduino microcontroller and Wi-fi module to transmit data received from the sensors to the user. The data is displayed on the website. If any one of the parameters goes beyond the set value the system automatically sends warning messages to the user.

3. PROBLEM STATEMENT

In the last few decades, because of the progress in urbanization, there is a drastic increase in industries, these industries resulted in an increase in environmental pollution by releasing harmful untreated toxic elements into the atmosphere which resulted in contamination of basic elements of the ecosystem like water, air, and soil. The living organisms which live in this polluted area are prone to various types of air and water borne diseases.

The major reasons for industrial pollution are Lack of policies to control pollution, unplanned industrial growth, Use of outdated technologies in treating toxic effluents, and also Industrial negligence. Even though many laws were introduced by the pollution controlling authorities by setting up limits to the industries pertaining to the release of any pollutants to the environment may be in any form like air, water, soil, and even unwanted noise produced, which causes serious health-related problems in both humans and animals, these laws are not effectively followed by the industries. The authorities are also failing to keep control of this industrial pollution due to the lack of technical support that is required to monitor and provide the exact record of the pollutants released by the industries, present even in the remote locations, on the basis in which necessary actions can be taken. Even though many researches have been done in this area many of them focused on detecting only one or two types of pollution like either measuring the air quality or water quality.

Therefore there is a need for the development of a robust industrial pollution monitoring system that monitors all types of pollution and records the values of all types of pollutants released on a particular date and time. The system must also be able to send warning alerts to the environmental pollution monitoring authorities when there is an increase in the release, where necessary actions can be taken further to control the release of pollutants.

4. PROPOSED MODEL

This paper presents an 'IoT based industrial air, water and noise pollution monitoring system'. The proposed system helps to monitor all 4 types of pollution caused by the industries are monitored using the following methods.

1. Air pollution is monitored using MQ-6 sensor, MQ-9 sensor, humidity sensor, and dust density sensor, by analysing the level of carbon-di-oxide, carbon monoxide, combustible gases like Butane, LPG, humidity in the environment, and the

presence of minute particulate matters like optical dust which are released during the industrial process.

2. Similarly, Water pollution is monitored using a pH sensor by investigating the pH of the industrial waste effluents before releasing them into the natural reservoir.
3. In the same way, the system investigates the degree of the temperature of the heat-treated water that is released from the industries using an LM35 temperature sensor to avoid thermal pollution.
4. Similarly, the intensity of the noise produced by various heavy machines used in the industrial process is investigated using the LM393 sound sensor.

All the 7 sensors are interfaced using Arduino mega 2560 microcontroller. The analog data obtained by the sensors are converted into digital data and transmission of data is done through the internet of things using a GSM modem with the help of an android mobile application. The proposed system also records the sensor data on a particular date and time and sends alarming and warning messages to user SIM and email.

5. OBJECTIVES

1. The proposed system can monitor all 4 types of pollution caused by the industries such as air, water, thermal, and noise pollution.
2. Real-time monitoring of the pollutants released.
3. The detailed recording of the sensor data obtained on a particular date and time.
4. The data obtained from the sensors are displayed on both the LCD screen and webpage portal.
5. The system sends alarming or warning messages to both user's SIM card and email regularly when the emission of the pollutants from the industries goes above the pre-set value of the user.

6. WORKING METHODOLOGY

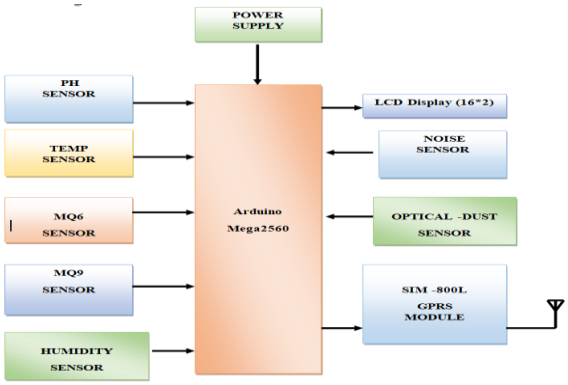

Fig -1: Transmitter section of the project.

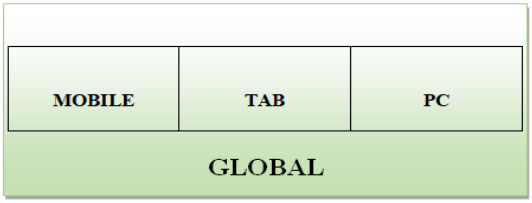

Fig -2: receiver section of the project.

The system consists of two sections namely the transmitter section and receiver section. The transmitter section is comprised of a power supply unit that provides power to the system and various analog sensors such as PH sensor, MQ-6 sensor, MQ-9 sensor, temperature sensor, humidity sensor, dust density sensor, and noise sensor which are interfaced with the Arduino Mega 2560 microcontroller. The GPRS module is used to transmit the data to the receiver section through the internet. The receiver section is generally a smartphone in which a webpage application of the project is developed using an embedded c and android programming. The receiver section displays and records the data obtained from the transmitter section, it also displays the SMS and email alerts sent by the transmitter section. The receiver section may be the owner of the industry or the pollution control authorities who is keeping an eye on the industrial emission in order to control the environmental pollution.

Initially, the power supply unit is turned on to provide power to the system. Both transmitter section and receiver sectioned should be connected to the Wi-fi to establish the communication between the transmitter and receiver section through the internet.

The sensors of the system are initialized. The sensors capture the data from the industrial environment for example the MQ- 6 sensor captures the analog data of the level of combustible gases like LPG and Butane. Likewise, the MQ-9 sensor, temperature sensor, humidity sensor, pH sensor, dust density sensor, and noise sensor captures the analog data of presence of carbon monoxide, carbon dioxide, the temperature of the heat-treated water, humidity in the environment, pH of the industrial effluents, level optical dust particles present in the atmosphere and finally the Noise produced during the industrial process respectively. This analog data is sent to the Arduino Mega 2560 microcontroller. The Arduino Mega 2560 microcontroller converts the analog data of the sensor to digital data and the values of the respective data are displayed on the LCD screen. The GPRS module transmits the data to the project webpage of the receiver section with the help of the internet. The series of the data obtained from the transmitter section is displayed in the form of a table on the web page of the receiver section. The receiver section records the data in detail along with its exact date and time of capture. The transmitter section sends warning messages to mobile SIM or the email of the receiver, when the values of any particular data obtained by the sensors go above the preset value, indicating the increase in the emission of the respective pollutants by the industries, for example, if there is an increase in the emission of CO by the industries the MQ-9 sensor captures high-value analog data, this high-value analog data is converted into high-value digital data .when the Arduino microcontroller compares the data obtained by the sensor with the preset value it sends an alarming message about the increase in the emission of CO by the industry. Similarly, the system regularly compares the data obtained by the various sensors with the preset value and transmits the data simultaneously in real-time providing information about the level of pollutants released by the industries.

7. HARDWARE DISCRIPTION

(i) power supply unit

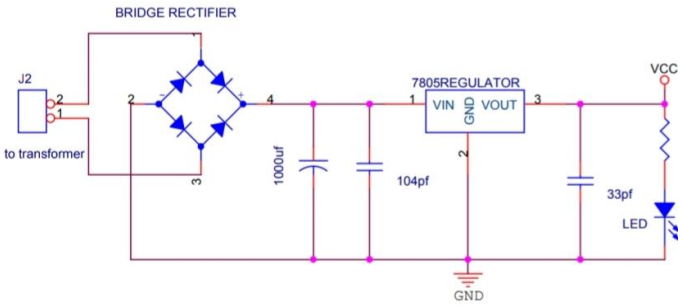

Fig -3: power supply unit

Initially, the Adapter having 9V 1A Output power with 5.5mm AC plugs. The circuit of the power supply unit consists of a bridge rectifier which rectifies the main AC input to the DC output which converts a 9V AC power to a 5V DC power which is supplied to the system, filter capacitor of 1000uf capacity which is connected in parallel with the output of the rectifier in a linear power supply. It is used to filter out the unwanted frequencies in the circuit. The 7805 regulator is connected in parallel to the bridge rectifier in order to provide the constant voltage to the system and an LED bulb in order to indicate the presence of the power.

(ii) MQ-9 sensor

Fig -4: MQ-9 sensor.

The MQ-9 Sensor is used to detect the concentration of CO in the atmosphere. The MQ-9 sensor is very sensitive to CO; the MQ-9 sensor can also be used to detect various other gases containing CO in them. Initially, the conductivity of the sensor is low in the clean or neat air, when the concentration of the gases

increases the conductivity of the sensor increases. The maximum operating voltage is 5V.

(iii) MQ-6 sensor

Fig -5: MQ-6 sensor.

The MQ-6 Sensor is used to detect the concentration of various combustible gases like propane, Butane, and LPG in the atmosphere; it also detects the presence of natural gases. The MQ-6 sensor can detect gas concentration nearly from 200 to 10000 ppm. The output of the sensor is dependent on the analog resistance. The maximum operating voltage is 5V.

(iv) LM35 Temperature sensor

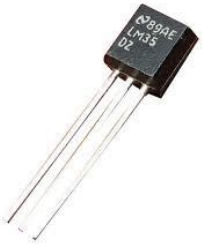

Fig -6: LM35 Temperature sensor.

The LM35 sensor is used to detect the ambient temperature. When there is a 1 degree change in the temperature the sensor shows a voltage difference of 10mV. Generally, an LM35 sensor has 3 terminals, an input terminal, an output terminal, and a terminal connected to the ground. It works on the principle that temperature is directly proportional to the difference in the voltage between the two terminals. It does not require any external calibration. It measures about -55 degrees to 150 degrees. The system uses an LM35 sensor to detect the temperature of the heat-treated water before letting it into the natural reservoir. The maximum output voltage is between 1.5V.

(v) DHT11 Humidity sensor

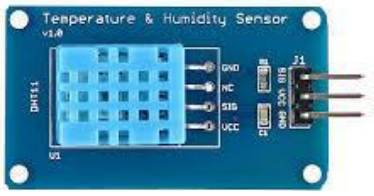

Fig -7:DHT11 Humidity sensor.

DHT11 is a commonly used sensor to detect temperature and Humidity. In this project, the DHT11 sensor is used to detect the relative humidity in the environment. The sensor consists of 2 electrodes separated by the moisture-holding substrate. When the sensor detects the moisture in the environment it calculates the relative humidity by comparing the difference in the electrical resistance between the two electrodes. The maximum operating voltage is 3.5- 5.5V.

(vi) Optical Dust sensor

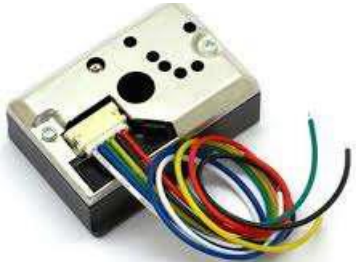

Fig -8: Optical Dust sensor.

An Optical dust density sensor is used to detect the level of optical dust present in the atmosphere. The sensor consists of an infrared light-emitting diode and a phototransistor which are arranged diagonally. Initially, when the infrared light is emitted, partial infrared light is reflected due to the presence of the dust particles, when this reflected light falls on the phototransistor the voltage is developed. This voltage developed by the phototransistor is the direct measure of the dust density in the environment.it can also detect very fine particles in the environment like particles in cigarette smoke. The operating voltage is between 2.5V-5V.

(vii) pH sensor

Fig -9: pH sensor.

The pH sensor is used to determine the acidity or the alkalinity of the industrial effluents before releasing them to the natural reservoir, the pH is determined by the measure of the presence of the hydrogen ions, called the potential of hydrogen. The pH scale ranges from 0 to 14 .in which the pH from 1-6 is called acidic, 7 being the neutral, and pH from 8-14 is called basic. the industrial effluents containing high amounts of lead, mercury have a pH of 2-3 which is acidic in nature, where the effluents containing asbestos have higher pH of 12-14. a pH meter consists of 2 electrodes .the voltage difference between the two electrodes is the direct measure of the pH. The operating voltage is between 3.5-5V.

(viii) LM393 Sound sensor

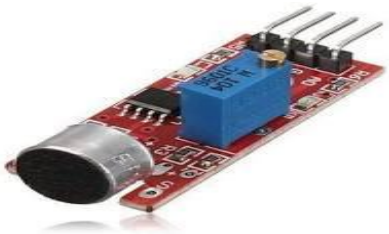

Fig -10:LM393 Sound sensor.

LM393 sensor is used to detect the intensity of the sound in the environment, it converts the difference in the air pressure into electrical signals. The sound waves produced will make the diaphragm of the sensor to vibrate, intern making the tiny magnets to vibrate which is present inside the sensor .this vibration induces the current in the coil which is a direct measure of the intensity of the sound. It develops a binary indication of the sound and also the analog representation of the sound obtained. The operating voltage is between 4-5V.

(ix) Arduino mega2560 microcontroller

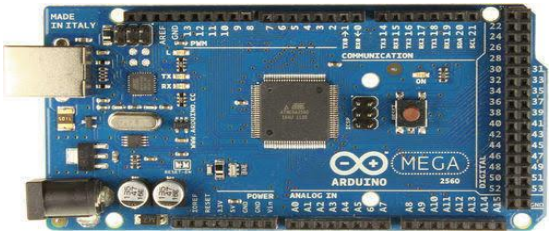

Fig -11: Arduino mega2560 microcontroller.

The Arduino mega 2560 is a microcontroller that has 54digital input/output pins, out of which 15 pins can be used as PWM outputs. It contains 16 analog inputs, a USB jack, an ICSP header, 16 MHz crystal oscillator, 4UARTs hardware serial input, and a reset button. It is powered using a USB cable or it can be powered through AC to DC adapter. The operating voltage is 5v. The maximum input voltage limit is 6-20v. It is physically larger than any other Arduino microcontroller and also having high flexibility working with large data or memory. It allows working with more number of sensors than any other Arduino board.

(x) SIM 800L GPRS modem

Fig -12: SIM 800l GPRS modem.

SIM 800 is a quad-band GSM/GPRS module which works on frequency of 850MHz GSM. It consists of a UART port (universal asynchronous receiver /transmitter), a USB port is used to update firmware and debugging. It also contains various audio channels which include microphone inputs and receiver output. SIM 800 has one SIM card slot which is integrated to TCP/IP protocol. It operates under the power of 3.4-4.4V. SIM800L is Used for sending and receiving messages, to make audio calls sending or receiving data through the internet.

(xi) LCD screen

Fig -13: LCD screen.

The LCD (liquid crystal display) which is also called as a flat panel display is an electronically modified optical device, it uses the light–modulating properties of the liquid crystals which are combined with the polarizers. Generally, liquid crystals do not emit light directly, the backlight or reflector is used to produce images in color or monochrome, generally, they are used in computer display or display of the data in mini-projects. The LCD screen used is having 16characters display in 2 lines, the input data is in the form of 4-bits or 8-bits, and the operating power is 5V. The display font is 5*8 dots. The various data obtained by the sensors is converted into digital data and the data is displayed using the LCD screen.

8. CIRCUIT CONNECTION

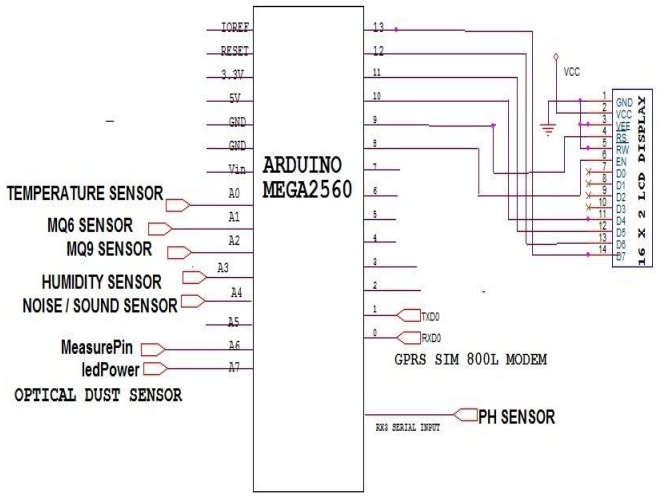

Fig -14: schematic circuit of the system.

The above figure shows the schematic representation of the entire system. The sensors are connected to the analog pins of the Arduino Mega 2560 microcontroller, the connections are made using soldering the wires using flat circuit board in order to eliminate the risk of loose contacts, Arduino and the sensors are powered using USB cable connected to the laptop or power banks. The main power supply unit is used to power the GPRS modem and the LCD screen. initially Adapter having 9V 1A Output power with 5.5mm AC plugs is used, the circuit of the power supply unit consists of bridge rectifier which rectifies the main AC input to the DC output which converts a 9V AC power to a 5V DC power which is supplied to the system .The respective pin connections of Arduino, sensors, LCD screen and GPRS modem are as shown in the following tables 1,2 and 3.

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 respective 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

9. SOFTWARE DISCRIPTION

The Arduino Integrated development software is used to program the Arduino Mega 2560 microcontroller; the entire project is programmed using Embedded C programming language.

9.1 Algorithm

a) Start
b) System initializing.
c) Capture Air quality data, water quality data, and noise intensity data.
d) Send captured data to webpage portal and display the data on the LCD screen and record the data along with its date and time of capture.
e) Compare the captured data with the pre-set point of the sensors.
f) If it exceeds send both SMS and email alerts to the user and also display the data on the webpage portal.
g) If it does not exceed no alarming messages should be sent but display the data on both LCD and webpage portal.
h) Go back to step c.

9.2 structure of program

a) Pin declarations

```
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
```

b) 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)
```

c) displaying the data in LCD

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

d) Sending alarming messages to SIM

```
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 ")
```

As per the structure of the program, initially, the pin declaration of respective sensors are done in order to get the analog data from the sensors every data of the sensors are taken in the form of integers this data can be read by using the command 'analogRead (0)' which reads the respective sensor data as per the analog pin number. Using the LCD screen the data is displayed on the screen by executing the commands such as 'lcd.setCursor (0, 0)' which is used to set the cursor position on the display unit, similarly 'lcd.print (sensor data)' command is used to print the respective sensor

data on the screen. When the values of the respective sensor data exceed the preset value the system is made to send the alarming messages and this is made possible by programming the GPRS modem the command such as 'Serial.println ("AT+CMGF=1")' to establish the serial communication with the respective mobile number, similarly Serial.println ("alarming message"); is to print the alarming messages on the user mobile phone screen. The program runs in a loop Executing the commands repeatedly.

10. RESULTS AND DISCUSSION

1. Initial readings of the sensors on LCD screen

Fig -15: temperature, MQ-6, MQ-9, Humidity sensor data

Fig -16: Noise and dust density sensor data

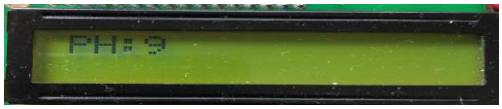

Fig -17: pH sensor data.

2. Increase in the values of the sensors data due to increase in the concentration of the pollutants in the atmosphere is displayed on the webpage portal.

Fig -18: temperature sensor data.

Fig -19: MQ-9 sensor data

Fig -20: MQ-6 sensor data.

Fig -21: Humidity data.

Fig -22: Noise sensor data.

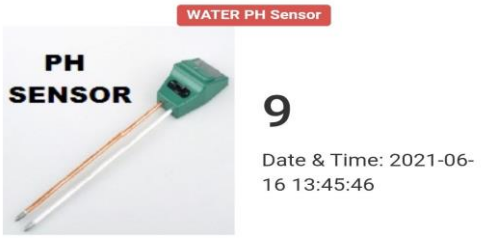

Fig -23: pH sensor data.

Fig -24: Dust density data

3. Sensor data recorded in detail along with its exact date and time of capture on the webpage spread sheet.

IOT Based Air, Water, Dust & Noise Monitoring System

TEMP	MQ6	MQ9	HUMIDITY	NOISE	PH	DUST	Date / Time
28	2	2	17	197	9	1.51	2021-06-16 13:48:15
60	2	2	18	197	9	2.12	2021-06-16 13:47:31
46	2	2	19	205	9	3.74	2021-06-16 13:46:17
24	2	2	20	205	9	3.74	2021-06-16 13:45:46
43	3	2	24	205	9	0.95	2021-06-16 13:43:47
31	3	2	26	197	9	0.98	2021-06-16 13:42:58
37	3	2	31	197	9	0.95	2021-06-16 13:42:01
31	203	3	16	197	9	0.96	2021-06-16 13:38:47
22	4	3	16	197	9	0.96	2021-06-16 13:38:25
21	20	207	16	196	9	0.98	2021-06-16 13:37:39
51	3	3	18	196	9	1.01	2021-06-16 13:34:31

Fig -25: various sensors data recorded in webpage spread sheet.

4. Pre-set Threshold value for respective sensor data above which the system sends alarming messages to the user.

SL NO.	Sensor data	Pre-set limit value
1	Temperature	50 degrees centigrade
2	Humidity	30%
3	CO	200mV
4	LPG	200mV
5	pH	7
6	Noise	200mV
7	Dust density	2V

Table-4: pre-set limit value for various sensors

5. Alarming messages are sent to the user if the values of the data exceed the pre-set value. For example, the pre-set value of the temperature of heat-treated water released to the natural reservoir is 50 degrees centigrade if the temperature of the heat-treated water exceeds 50 degrees then alarming messages are sent to both user's emails and SIM. Similarly, the pre-set limit value for MQ-6, MQ-9, pH, Dust density, and Noise sensors are shown in table 1, if the values of any sensor data exceed the respective pre-set values of the data, then alarming messages are sent to the user as shown in the fig-26 and fig-27.

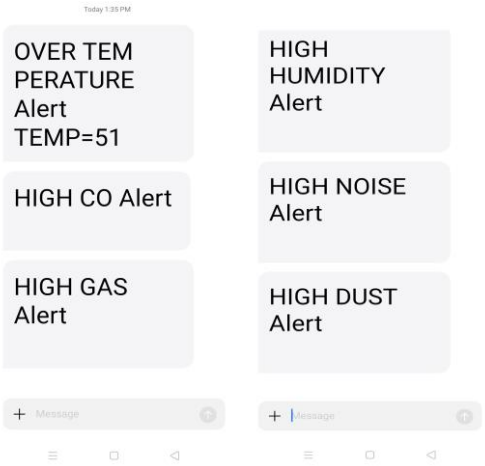

Fig -26: Alarming messages sent to the user's Mobile SIM.

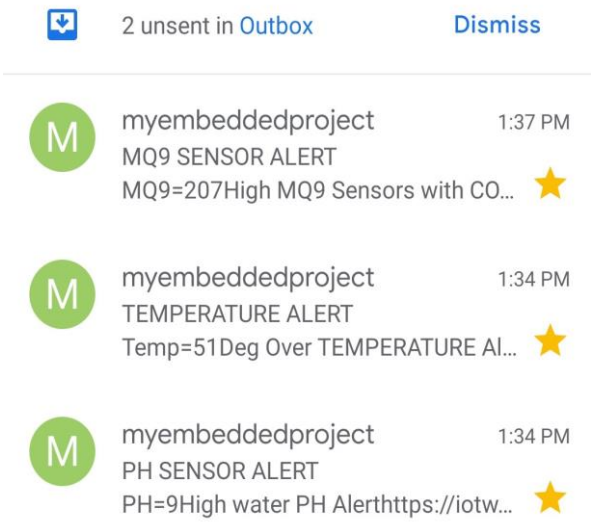

Fig -27: Alarming messages sent to the user's E-mail.

As shown in the above figures the system continuously monitors the level or quantity and provides real-time information about the pollutants released by different industries in various locations using GSM and GPRS. The system collects various analog data like level of pH (fig-23) in industry effluents, level of CO (fig-19), CO2,

combustible gas(fig-20), humidity in the air (fig-21) and the level of minute optical dust particles (fig-24) released during the industrial manufacturing process and also the intensity of noise produced by the industries(fig-22) using various sensors like PH sensor, MQ-6, MQ-9, temperature sensor, humidity sensor, dust density sensor, and noise sensor respectively. The system also records the values of pollutants released on a particular date and time on the webpage spreadsheet as shown in the fig-25 and also sends both SMS and E-mail alerts to the environmental pollution monitoring authorities as shown in the fig-26 and 27, when there is an increase in the emissions in compared to preset industrial standards where these results are analyzed and necessary actions can be taken further to control the release of pollutants.

12. OVERALL OUTLOOK OF THE PROJECT

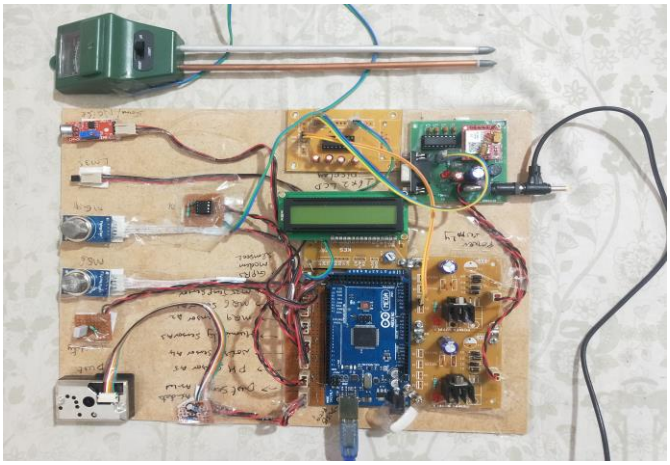

Fig -28: Final outlook of the project.

13. CONCLUSION

The "Iot based industrial Air, water, and Noise pollution monitoring system" is designed to monitor and control the pollution caused by the release of harmful, untreated industrial pollutants in a cost-effective and highly secured manner. This system is more effective than the existing system since it helps the environmental pollution control authorities in monitoring the industrial environmental conditions with the help of 7 sensors interfaced to the advanced controller which collects and records the real-time data of various pollutants released by the industries through various means, which helps the authorities to keep control and decrease Air, Water, Thermal, and noise pollution caused by the industries. Also, the project webpage continuously records the data in detail along with its data and time of capture which cannot be erased or deleted and can get accessed to the sensor data on any date and time and Based upon the collected data, the respective action can be taken on controlling the environmental pollution.

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