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AN ENVIRONMENTAL AIR POLLUTION MONITORING AND ALERTING SYSTEM BASED ON SENSOR ARRAY AND RENEWABLE POWER SOURCE

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Abstract—Air pollution has significant effect on the concentration of constituents in the atmosphere leading to effects like global warming and acid rains. To avoid such things an air pollution monitoring system is very important. The aim of the this paper is design and development of air pollution monitoring and alerting system based on wireless sensor network and comparison of the data based on real time acquisition and communication of air pollutants such as SO2, NO2, CO2, CO etc. System integrates a Development board(Ardunio), Air pollution sensors array (NO2, SO2, CO2 Sensors), Global positioning system Module (GPS-module) for location management, General packet radio services Module (GPRS- module) for data transmission with low power consumption, Liquid crystal display (LCD), Global System for Mobile communication Module (GSM-Module), renewable power source(Solar battery). When this device is placed in any other moving or unmovable system it automatically gets charge battery with the help of solar energy. System measure the pollutant level (NO2, SO2, CO2 level) and combine data with location, date, time and upload to the GPRS-Modem and transmit it to the server through any network and an Alert message via GSM module is sent to Area Pollution Control organization if the pollutant level is above threshold value (which is defined by government). Data(Pollutant Level) is stored in server for further usage by various clients such as Pollution control agencies, vehicles registration authorities , research teams tourism companies etc. The main objective is achieved by interfacing various sensors along with LCD to display common air pollutant in Real Time basis. The measured data is displayed on the server and an alerting message is sent to related area pollution agencies so that they can take necessary action to short out the problem.

Index Terms— Index Terms—Air pollution, general positioning systems (GPSs), embedded systems, GPRS Module.

I. INTRODUCTION

Air pollution has been defined as the presence of a substance in the environment due to which chemical composition or quantity prevents the functioning of natural processes and produces undesirable environmental and Health effects. There are various pollutants in air these are classified as primary or secondary. Primary pollutants are substances that are directly emitted into the atmosphere in any from of sources. Main primary pollutants known to cause harm in high enough concentrations such as Carbon compounds (CO and Co2) etc, Nitrogen compounds (NO and NO2) and many of its compounds, Sculphurate compounds (H2S and SO2) etc. Secondary pollutants are not directly emitted into atmosphere from any sources, but instead form in the atmosphere from primary pollutants. Main secondary pollutants in atmosphere are NO2 and HNO3 formed from NO, Ozone (O3) formed from photochemical reactions. There are various problems originates because of air pollution. Air pollution cause many health issue such as, aggravation of respiratory and cardiovascular disease, decrease lung function, increased frequency and severity of respiratory symptoms such as difficulty breathing and coughing. Air pollution also damages our environment. Ozone can damage vegetation, adversely impacting the growth of plants and trees. This acid deposition can be either dry or wet. Wet deposition is more commonly known as acid rain. Acid rain can occur anywhere and in some areas, rain can be 100 times more acidic than natural precipitation. Acid deposition can be a very serious regional problem, particularly in areas downwind from high SO2- and NO2 - emitting sources (e.g., coal burning power plants, smelters, and factories). Acid deposition can have many harmful ecological effects in both land and water systems. While acid deposition can damage tree foliage directly, it more commonly stresses trees by changing the chemical and physical characteristics of the soil. In lakes, acid deposition can kill fish and other aquatic life. Air pollution can also impact the Earth's climate. Different types of pollutants affect the climate in Different ways, depending on their specific properties and the amount of time they stay in the atmosphere. Any pollutant that affects the Earth's energy balance is known as a "climate forcer." Some climate forcers Absorb energy and lead to climate warming, while others reflect the sun's rays and prevent that energy from reaching the Earth's surface, leading to climate cooling. Generation and transport of Air pollutant materials are governed not only by the distributions of their sources but also by the dynamics

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of the atmosphere. Pollutant clouds are sometimes observed traveling along the wind directions [2].

II.   LITERATURE REVIEW

For avoiding these entire things a pollution monitoring system is necessary. Much air pollution system in urban and rural areas that utilizes smart sensor networks and wireless system were reported in recent literature. An Air pollution monitoring system that measures CO, CO2 and SO2 was reported. This is based on smart microcontroller monitoring system [3]. A mobile GPRS Sensor Array for air pollution monitoring is also designed and developed [4]. It is based on single chip microcontroller along with GPRS module for transmitting pollutant data frame to the web server, so anybody can easily access these data from server using internet [4]. The Development Board can be connected to network via a wired modem or wireless Wi-Fi connection. A wireless mesh network based on embedded microprocessors consists of many gas sensors and multi hopes wireless communication system, which is designed to cover an area [6]. The system monitors and transmits parameters atmospheric environment to a command center. For peer to peer communication NFC technology is used [7]. For real time monitoring An Air Impurity Measurement Monitoring system is developed [8]. In which a along with microcontroller a GSM module and a solar cell is used. In most of the papers data is transmitted using wired techniques and wireless technique but there is no alerting system. In this paper we have proposed an Real time Air pollution monitoring system in which some alerting sound is generated and an alerting message is sent to some organization.

III.   PROPOSED SYSTEM

In this pollution monitoring system We use a development board, some sensors Array(NO2,SO2,CO2), and a LCD for displaying Real time data, and a General Packet Radio Service(GPRS Modem) for Data transmission, and Global Positioning System(GPS- Modem) for providing Physical location of device. GSM is used for sending alert message to related organization as shown in fig.1. The integrated unit is placed in any movable or unmovable device. Development board collects all the pollutant level from sensors array and makes a frame along with his physical location which is reported from attached GPS module. . Then using GPRS module data is uploaded to server for further uses and an LCD is also attached for displaying Real time Data. Now when the pollutant value is above threshold value which is decided by government and automatic alerting message is sent to some feed authorities no, for taking any action and an Alarm is sounded at centre.

Now the rest of the paper is as follows:

- System Requirements and Specification,
- Hardware Design
- Software flow diagram
- Operation
- Flow Diagram
- Result
- Work in Progress
- Conclusion
- References

IV.   SYSTEM REQUIREMENT AND VERIFICATION

There are a large no system available but some of limitation are present in which is Size of system, cost, power usages etc. The main objective of this paper is to develop a system which is more efficient in compare to other. Its main function is low cost and low power usage, reliability and security etc.

1. The system's functional requirements are as follows.
2. System must support real time data collection and storing process.
3. System stores all the data with their location [4].
4. System having small size so it also supports mobility.
5. System usage renewable power source solar batteries, so always work in 24*7 days and battery easily get charge with the help of solar power.
6. System provide alert via SMS when pollutant value above threshold.
7. System display pollutants value in LCD for real time measurement.
8. No need any additional power supply
9. System is cost effective and more accurate.

V.   HARDWARE REQUIREMENTS

A. Development BOARD (Intel Galileo Gen 2)-

The Intel Galileo Gen 2 Development board is based on Intel Quark Soc X 1000, a 32 bit Pentium Processor, class system on a chip (SOC), and operating at a speed up to 400MHz. The Quark processor supports the yocto 1.4 Linux distributions. The board has built in Ethernet with support for Power over Ethernet (PoE), a USB 2.0 Host Port, micro-SD slot, 20 Digital input/output pins, a micro USB connection, an ICSP Header, a JTAG header, and 2 reset buttons. Galileo Gen 2 operated at 3.3v or 5v. Digital pin 0 to 13, Analog inputs 0 to 5, the power Header, ICSP header, and the UART port pins (0 and 1), are all in the same location as on the Ardunio UnoR3.
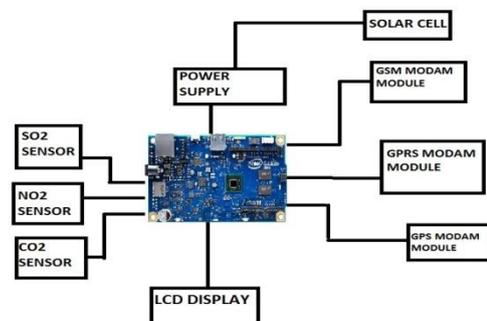
Fig.1 Proposed System Architecture Sensors Arrays –

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There are various type of sensor is available in the market. In this system we have three sensors, SO2, NO2, CO2 sensors [9]. Sensors are the type of transducer which generates its output in any form but always we it take in electrical and

optical form. Transducer is basically there are two type- Active transducer and passive transducer. Active transducer is those which do not require any power source for their operation and passive transducer is those which require additional power for their operation. They produce a change in passive electrical quantity.

Sensor	CO2	NO2	SO2
Resolution(PPM)	.1	0.1	1
Operating Range(PPM)	max	0 to 20	0 to 20
Response Time(T90)	<=25	<=30	<=25
Operating Life	>2	2 Year in Air	>2
Temperature Range(°C)	0 to 100	-20 to +50	-20 to 50

Table 1 sensors Quality

B. GPS module-

GPS data is displayed in different formats over a serial interface. There are standard and non standard (proprietary) formats. Nearly all GPS receiver outputs are NEMA data. The NEMA standard contains various bits of data organized in comma delimited formats [10]. NEMA formats includes the complete position, velocity, and time computed by a GPS receiver and Position is given in latitude and longitude.

1) Connecting GPS to any System:
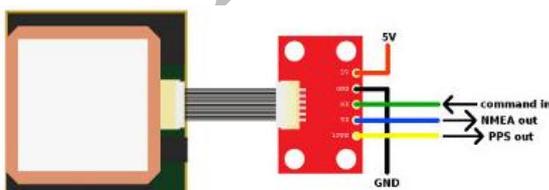
C. GPRS Module-

GPRS is general pocket radio services which is wireless technology. It is pocket based wireless communication technology which provides data rates from 56 up to 114 kbps and continuous connection to the internet for mobile phone users and computer users. It is packet based protocol on 2G and 3G cellular communication systems for Global System for Mobile Communication (GSM) and supports X.25 protocol. GPRS step toward Enhanced Data GSM Environment (EDGE) and universal Mobile Telephone Services (UMTS).

GSM module:-

GSM is global system for mobile communication. GSM used Time Division Multiple access (TDMA). GSM digitizes and compress the Data, then send it to a channel with two other stream of data, having its own time slot. Mainly used frequency band for GSM communication is either 900MHz or 1800MHz. GSM mainly include High Speed Circuit Switched data (HSCSD), General pocket Radio System (GPRS), Enhanced Data GSM Environment (EDGE), and Universal Mobile Communication (UMTS).

Pollutant Name	Annual mean	Daily Level Value	Limit value for Human Health	Nonattainment (Alert Threshold)
Particulate matter(µg/m3)	<= 20	> 20 <= 31	> 31 <= 40	> 40 <= 50
Particulate Matter(PM2.5) (µg/m3)	<= 10	-	> 10 <= 20	> 25 <= 30
Ozone(o3) µg/m3	<= 80	> 80 <= 100	> 100 <= 120	> 120 <= 140
Nitrogen oxide(No2) µg/m3	<=50	> 50 <= 100	> 100 <= 200	> 200 <= 400
Sulpher dioxide (SO2) µg/m3	<= 100	> 100 <= 200	> 200 <= 350	> 350 <= 500
Carbon Mono Oxide(CO) mg/m3	<= 1	> 1 <= 5	> 5 <= 10	> 10 <= 15

Table 2 Threshold values of Pollutant

II. OPERATION

The working of current model is totally based on installation on Galileo gen 2 boards. First install Galileo software in any Computer. Then after complete installation process of Galileo gen2 board a window is open in which write the code. Now after writing code, compile it and upload it at the development board. This is the software installation process.

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Now in hardware part a complete interfacing of component at Galileo gen 2 board pins. Interfacing diagram is shown in Fig.2.In current working circuit a gas sensor is interfaced and its result is shown at the Serial port.

Fig-2 Interfacing diagram of gas sensor with Galileo gen 2 board

A.   Proposed system consist of following phase

1)   System based pollution level sensing

In this phase different type of gas sensors are used which will generate the different gas level values then development Board will convert it into Digital form which is read form of computer.

2)   Uploading data to pollution level for reading purpose:
Once the data has been fetched by development board it will be than passed to the computer in digital form by using data cable. Now by using some communication protocols this data is uploaded to the cloud so that it can be viewed and analyzed by authorities, agencies and people for further and current uses.

3)   Alert Message
Now after that when the data is uploaded to server and an alerting message is sent if the value of pollutant is above threshold level which is defined in the Table 2. Then an alerting SMS is sent to some Area authorities' phone numbers. To send an SMS, we set GSM module to Text mode and this is achieved by writing AT command "AT+CMGF=1". We write this command at software port. After setting the GSM module to Text mode, we write the mobile number whichever we want to send SMS. This is achieved by using AT command "AT+CMGS=\"+91xxxxxxxxxx\"\r. In this command x is receiver mobile number. Now authority will get an SMS and do further reaction.

4)   Managing the Database in Cloud:-
All the uploaded data will be managed in DBMS format over the centralized data in cloud. In this phase the system will provide user to search the data as its requirement. Either it may be current record or previous record.

5)   Google mapping or monitoring:-
 Now in this phase user will able to view the data live or real time basis. So for all this Google Mapping API and a live map will create so that it can show the different pollution level with different colors according to their level as a Geographical representation.

flow diagram
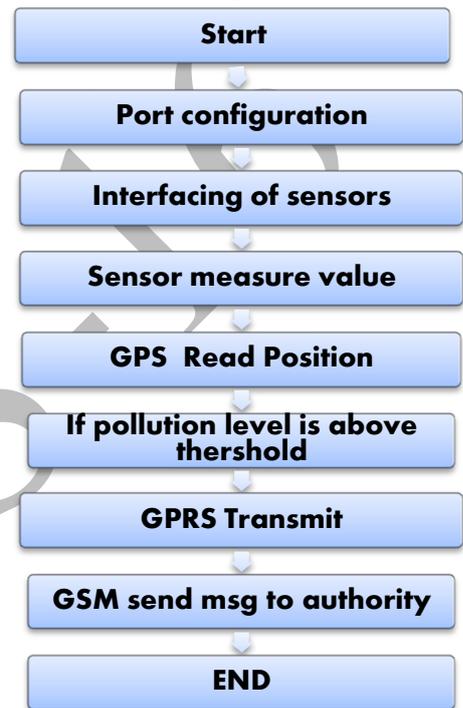
RESULT:-

Result is shown in serial port of development Board and LCD. First write the program at software of Galileo Gen 2 Board then compiles it and now then upload the program at development board. Interfacing of pin is according to program then gas sensor will work properly and the value of particular gas is measured and displayed at the serial port as shown in figure. The same result is also displayed on the LCD. That is interfaced on the Gen 2 board.

Fig 3 LCD Display

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Fig 4 Serial Port Result

III. WORK IN PROGRESS

The system that was described has been in working conditions. Complete proposed work is under progress. In proposed system there are many sensors and communication modules are attached. We are currently worked to complete the proposed model .There is also some challenges faced during the work; these are com port selection and sensor interfacing. After interfacing all components to the development board attached the development board to the Computer through RS 232 USB Cable then check its port before uploading the program otherwise uploading of program is failed or generated error. If the com port is not selected then wait till the time whenever port is not detected and many other challenges faced during the working process.

VI. CONCLUSION

System measure Air Quality with the help of sensors and also its location using GPS module. As the same way we can made many nodes and monitor the pollution level of a large area using wireless sensor network. GPRS technique is helpful for data transmission over the server.

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