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Design and Implementation of Geographically Pollution Monitoring System

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***Abstract*—**This In this paper, Wireless sensor nodes are described that consist a wireless zigbee technology use to communicate with the back end system. The main purpose of the wireless sensor network is to examine and check the air quality. Wireless sensor nodes are communicate with a system to relay their measurements in real-time. The system consists of sensor nodes that consist a number of sensors, a gateway use to provide a serial communication, and a back-end platform system through which sensing data can be stored in a database. The experimental results show that the proposed system provide air quality monitoring in real-time through the Wireless Zigbee technology.

Keywords-*Air quality monitoring; wireless sensor networks; real-time monitoring;Zigbee technology, Microcontroller*

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I. INTRODUCTION

The main purpose of pollution monitoring is not only to provide the collected data to the end user it may also help the planners, policy makers and scientist to take the decision on pollution level and make the effort to improve the environment. With the development of automotive industry and communication technology our daily live are largely infected and people tend to spend many time to the vehicle. And it may see that the next generation transportation system is more powerful. The main issue of this is to increasing the traffic and air pollution which may affect the human health. With the rapid development in the transportation system it may seen that the clean air get polluted rapidly. Modern technology is a combination of many techniques such as wireless communication, cloud computing, internet of thing etc... Increase in vehicle gives rise to increasing traffic related pollutant emission. Therefore, to track the effect of this pollution on environment and health of individual it is necessary to track the level of pollution in urban and sub urban area. WSN consist a number of stations. Each station collects the information of pollution level in their nearest locations where the sensors are deployed. Monitoring station contains the number of unit. Such as processing unit, sensing unit, power unit, communication unit. And each unit must be operate independently i.e. processing unit must process the information that are collected from the sensor. Sensing unit that produce the signal which may change in the physical condition such as humidity, pressure or temperature. Power that consume by each station must be low. Communication unit responsible to transfer the information from each unit to the world i.e. collected information store on the server from where this information get distribute to the internet and can easily access by the each individual user.

Air Pollution monitoring is though old but very useful concept in today's day to day life. Air pollution monitoring starts from traditional method to the most sophisticated computer has been used to monitor the air quality. Fresh air is necessary for all human being. however, the various technology has been used for monitoring air pollution. Some of these technologies are really useful that provide a real time data on air quality.

II. RELATED WORK

Wherever Air monitoring is a social as well as public experiment where the each user wants to know how much the environmental changes affect their daily life cycle. Teco envboard is an environmental sensing platform that carries a number of sensor such as temperature sensor, carbon dioxide sensor, humidity sensor etc.. To provide the information about the indoor as well as outdoor of the air quality [1].

Pimi air box is the other device which help to find the indoor air quality it detect the temperature as well as the matter concentration present in the air.[2]

Wearable device getting more popularity it monitor the personal inhalation information dosage of the air pollution. The individual activity such as driving, jogging, cycling has impact their dosage and develop the application to provide them personalized information.[3]

Distributed infrastructure consist a wireless sensor network and grid computing technology for air pollution monitoring as well as mining. Two layer architecture and peer to peer e-science grid architecture and distributed data mining algorithm are used to collect the data and tiny operating system used to examine the operation and performance of the wireless sensor network.[4]

To monitor the air quality in the city of Mongolia result shows that the dust concentration is more than its standard level it shows 50% of air pollution caused by the soil,30% by the raw coal burning,12% by the vehicle and 3% by the wood burning. From this result soil and dust is the main reason of pollution in the city of magnolia.PM 10 and PM2.5 techniques can be used to monitor and control the measurement for air pollution monitoring.[5]

monitoring stations are used to monitor the air quality these stations are largely deployed the sensor that collect the pollution information are send it to the these stations and back end platform controlled by the lab view program through which data can be stored in the database .the system deployed to the main road in the city to monitor the carbon concentration caused by the vehicle emission the main advantage of wireless sensor network is that it is easy to set up, inexpensive and provide the real time data.[6]

The daily activity in the cities around the world which is responsible to emit the 62% of the carbon emission. The relation between the pollution emission and traffic is a one of the most relevant problem faced by the future city. Crowed face the health related problem due to the low air quality in the cities. Due to this , there is a need of effective air quality monitoring programs that complement the current available system and traditional network to perform well in the case of any change in the physical parameter.[7] UrVAMM is the another revolutionary technology used to monitor the environment. it is a new open concept of the smart cities.

With the fast development of automotive industry as well as Information and Communication Technology (ITC), our daily lives have been largely influenced and people tend to spend more and more time relevant to vehicles. It can be foreseen that the next generation transportation system will become a more powerful system by utilizing existing communication, network and computer infrastructure. Currently one of the challenging issues to the road transportation system is the traffic congestion, which causes huge amount of financial and human life cost.

Many air pollution systems in urban and rural areas that utilize smart sensor networks and wireless systems were reported in recent literature. Environmental air pollution monitoring system that measures CO, NO2, and SO2 was reported. The system is based on a smart sensor micro converter equipped with a network capable application processor that downloads the pollutants level to a personal computer for further processing. A wearable and wireless sensor system for real-time monitoring of toxic environmental volatile organic compounds was developed in. An air pollution geo-sensor network consisting of 24 sensors and 10 routers was installed to monitor several air pollutants in. The system provides alarm message depending on the detected pollution types in the field.

III. COMPONENT USED FOR MONITORING

A. Sensor Nodes

Zigbee Technology

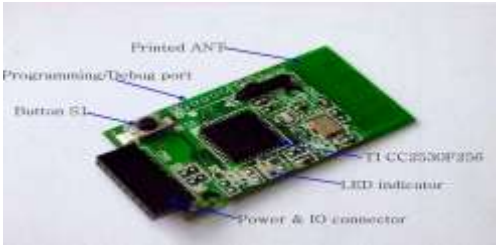

Figure 1 Zigbee Chip

ZigBee is an IEEE 802.15.4 standard similar to the RF Zigbee transceiver. It easily allow the designers to add ZigBee / IEEE 802.15.4 wireless potential to their products without any need of RF or antenna designer skill. The module contains plug-in or surface mount module, including integral antenna ,all RF circuitry, and controller in a simple-manner,. A 4-wire serial pin interface port interfaces to a microcontroller baseband. The physical layer includes an integral antenna and impedance matched balun. Options include a external antenna connector or shielding The Media Access Control layer includes security, encryption and authentication, signal energy detection, clear channel assessment..

Gaseous Pollution Sensors

A gas detector is a device that senses the presence of gases in an area, as part of a safety system. This type of equipment is used to detect a gas leak and interface with a control system so a process can be automatically stop. A gas detector can sound an alarm to operators in the area where the leak is find, giving them the opportunity to depart. This type of device is important because there are many gases that can be harmful to organic life, such as animals or human.

Figure 2 Gas Sensor

Sensitive material of MQ-6 gas sensor is Sodium dioxide sensor, with the lower conductivity in air. When the target gas exist, the sensor's conductivity is higher along with the gas concentration increasing. Use the simple electronic circuit, Convert change of conductivity to corresponding output signal of gas concentration. MQ-6 gas sensor has high consideration to Butane and LPG and propane, also response to Natural gas. The sensor could be used to detect different especially

Methane; combustible gas it is with low cost and suitable for different application.

Temperature Sensor

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in ºC). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With this sensor, temperature can be measured more accurately than with a thermostat. It also possess low self heating and does not interest to go more than 0.1 ºC temperature rise in still air.

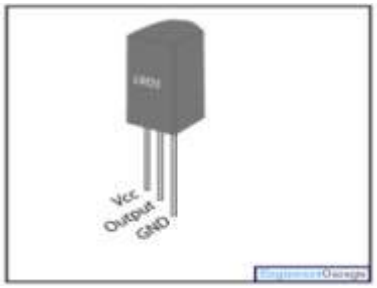

Figure 3 Temperature Sensor

The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every ºC rise/fall in ambient temperature.

B Gateway

A gateway is used to control the sensor nodes, collects data from the nodes, and transmits the data to the database through the short message service by GSM. Wireless sensor network is a wireless network consisting of spatially dispersed and dedicated autonomous devices that use sensor to monitor physical or environmental condition. a usual wireless sensor network system is formed by combining these autonomous devices, or nodes with router and gateway. The dispersed measurement nodes communicate wireless to a central gateway, which provide connection to a wired world where you can use router to gain a additional communication link between end nodes and a gateway for extend distance and reliability in a wireless sensor network. The wireless sensor is networked and variable, require very little capacity, it is also smart and software programmable and also capable of fast data acquisition, accurate and reliable over the long term. but cost little to buy and install, and require nearly zero upkeep.

Gsm module

Figure 4 Gsm module

A GSM modem is a specialized type of modem which accepts a Subscriber Identity Module card, and operates over a subscription to a operator, just like a cell phone. From the mobile operator perspective, a GSM modem looks just like a cell phone. When a GSM modem is attach to a computer, this keep the computer to use the GSM modem to communicate over the mobile network. these GSM modems are most frequently used to give the mobile internet connectivity, many of them can also be used for to send as well as to receive MMS and SMS messages.

System Architecture

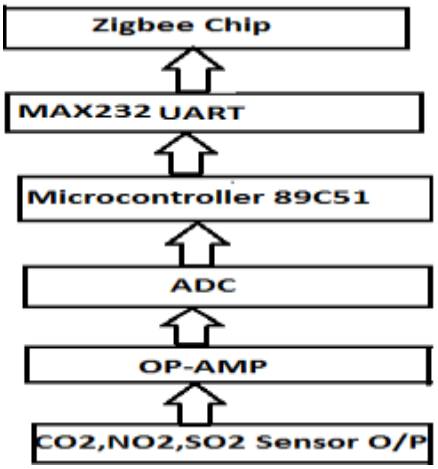

Figure 5 System Architecture

Fig shows the system architecture. In order to find out the pollution level of each & every square it requires to place the sensor on every square. Collection of nearest sensor creates a sensor node. Each sensor sense the level of pollution and all collected data are uploaded to the main server of the monitoring station. Microcontroller is used to fetch the data from the sensor node. Because of data from the every node are giving the analog reading which is not easily readable by the human being. Microcontroller Ic is used to fetch the data. This ic is used to fetch the pollution data from the sensor which is located on each square. Microcontroller is another name of computer which consist a number of input and output. Sensor that allow the microcontroller to determine the present of harmful gas present in the atmosphere. It uses the analog to digital conversion port of microcontroller because whatever the output of sensor is analog in nature which generates the different gas level value.
Microcontroller passes these collected data to the computer by using URL port and then uploaded all the collected data to the cloud dataset. The cloud consist a past and recent history of pollution level so it can be viewed as the current and future use. All the uploaded data are manage in the database management system over the centralize warehouse. Where the huge collection of pollution data are systematically manage along with the area code and time stamp. so it can be better analyze from which area and on what time the rate of pollution will be more and user can search the pollution record as per their requirement whether it may be current record or the previous record.

Microcontroller AT89C51

It is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash programmable and erasable ROM. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 and 80C51 instruction set and out pin. The on-chip Flash keep the program memory to be reprogrammed in-system or by a conventional nonvolatile memory program writer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel 89C52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

UART for Serial Communication

The MAX232 from Maxim was the first IC which in one package contains the necessary drivers (two) and receivers (also two), to adapt the RS-232 signal voltage levels to TTL logic. It became famous, because it just needs one voltage (+5V) and generates the necessary RS-232 voltage levels (approx. -10V and +10V) internally. This greatly simplified the design of circuitry. designers no longer need to design and build a power supply with three voltages (e.g. -12V, +5V, and +12V), but could just provide one +5V power supply.

Figure 6 Sensor Node 1

In Node 1 CO2, SO2 and Temperature Sensor are used while in Node 2 NO2, SO2 and Temperature Sensor is used.SO2 sensor and Temperature sensor are common in both the node.

C System Working

System work in a following phases:

Phase 1: This phase deals with implementation of proposed hardware model a implementation with testing of air pollution reading monitoring. The sensor such as CO2,NO2,SO2 and Temperature sensor are mounted on the PCB with microcontroller(IC 089C51),Zigbee chip,UART(max 232) ,ADC(IC 0808/0809),OP-AMP(IC 555).

Phase 2: This phase deal with uploading of data over database using network level communication between hardware, system and database. This communication done via. Base station which has Zigbee chip on it. System will fetch the reading of pollution level at from different sensors and save it to database along with node identity and the time stamp.

Phase 3: This phase consists of the implementation and performance evaluation of the proposed approach. Effectiveness of our proposed approach will be measured in terms of accuracy. System that show the reading comes from each sensor and plot the graph against the actual value from each sensor over the time.

Phase 4: We can easily analyze the value from each sensor by using the graph or from the Database maintained for the each sensor value along with the time and Node Id . GSM module is also used in case of high value comes from the each sensor to provide Alarm message to the administrator.

RESULT AND ANALYSIS

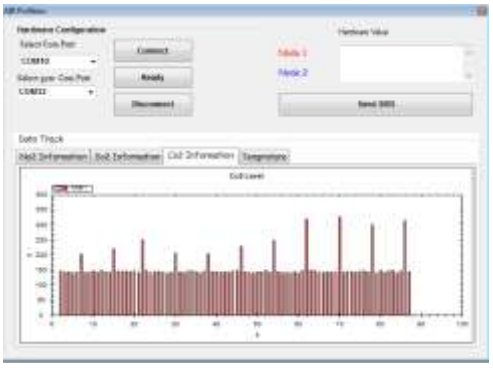

Figure 7 Monitoring Of CO2 Level

When select the Co2 information button on the Data Track it sense the value of Co2 sensor.Figure shows to monitor the CO2 level which is comes from the Node1.The graph plot along the Parts Per Milliom i.e ppm on y-axis and Time(ms) along the x-axis. from the above graph the value of CO2 goes beyond the 300ppm atmospheric CO_2 concentration has increased to 400 parts per million and continues to rise. This has main caused the phenomenon of global warming which is mostly attributed to human CO_2 emissions.

Figure 8 Monitoring Of NO2 Level

When select the No2 information button on the Data Track it sense the value of No2 sensor. Fig shows the NO2 level from node2 there is a variations in the value of NO2 level.NO2 in heavy traffic or on freeways can be two times as high as levels measured in residential areas or on lesser traveled roads. In pollution Monitoring studies have shown that within approximately 50 meters of freeways/heavy monitoring, NO2 concentrations may be 100 to 30 percent higher.

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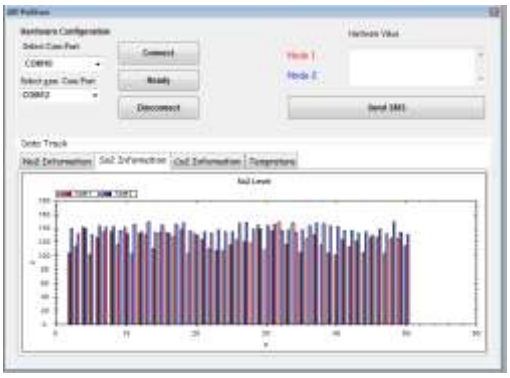
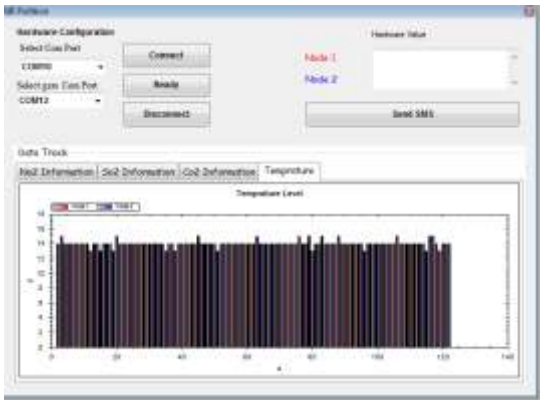


Figure 9 Monitoring Of SO2 Level

SO2 sensor is available in both the node i.e. in Node1 as well as in Node2.from the above graph we can show the value of So2 comes from the both Node. The value in the red color indicates that it comes from the first node and value from the node2 represent in the blue color. There is a little variation between both of the sensor value, otherwise the value is same from both node i.e. node1 and node2.



Temperature sensor is available in both the node i.e. in Node1 as well as in Node2.from the above graph we can show the value of temperature comes from the both Node. the value in the red color indicate that it comes from the first node and value from the node2 represent in the blue color. there is a little variation between both of the sensor value, otherwise the value is same from both node i.e. node1 and node2. Data comes from both node get compress which is indicated by the black line inserted between the values of both node.

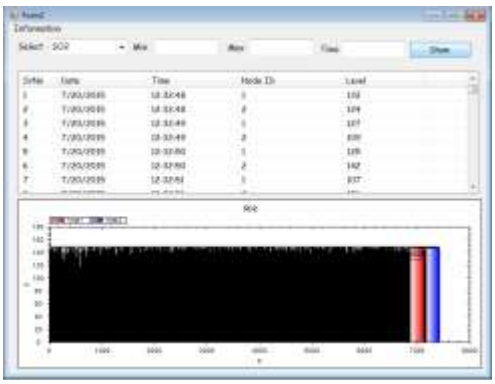
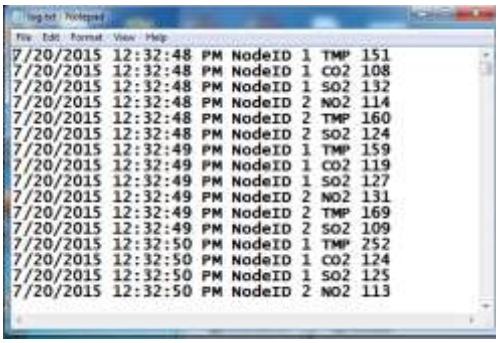


Figure 10 Data Analysis

It may also possible to analyze the data comes from both node. it show the date,time,node id and its level. so that we can easily analyze on which date and at what time level of particular sensor from both of the node is either more or less. Analysis of data is a process of cleaning, modeling data, inspecting, transforming with the goal of suggesting conclusions, discovering useful information, and supporting decision-making. Analysis is a process for obtaining raw data and converting it into information useful for supervisory by users. Data is collected and analyzed to test hypotheses, disprove theories or answer questions.



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7/20/2015 12:32:48 PM NodeID 1 TMP 151
7/20/2015 12:32:48 PM NodeID 1 CO2 108
7/20/2015 12:32:48 PM NodeID 1 SO2 132
7/20/2015 12:32:48 PM NodeID 2 NO2 114
7/20/2015 12:32:48 PM NodeID 2 TMP 160
7/20/2015 12:32:48 PM NodeID 2 SO2 124
7/20/2015 12:32:49 PM NodeID 1 TMP 159
7/20/2015 12:32:49 PM NodeID 1 CO2 119
7/20/2015 12:32:49 PM NodeID 1 SO2 127
7/20/2015 12:32:49 PM NodeID 2 NO2 131
7/20/2015 12:32:49 PM NodeID 2 TMP 169
7/20/2015 12:32:49 PM NodeID 2 SO2 109
7/20/2015 12:32:50 PM NodeID 1 TMP 252
7/20/2015 12:32:50 PM NodeID 1 CO2 124
7/20/2015 12:32:50 PM NodeID 1 SO2 125
7/20/2015 12:32:50 PM NodeID 2 NO2 113
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Figure 11 Database for Node1 and 2

Fig shows the database maintained for the different sensor along with its time, date, node id and its value. Database refers to a set of related data and the way it is organized. Retrieve this data is usually provided by a "database management system" (DBMS) consisting of an integrated set of computer software that allows users to interact with one or more databases and provides access to all of the data contained in the database (although restrictions may exist that limit access to particular data). The Data base provides lots of functions that allow admission, storage and recovery of large quantities of information as well as provides ways to manage how that information is organized. Databases are used to support internal operations of organizations and to underpin online interactions with customers and suppliers.

CONCLUSION

This project proposes a real time monitoring system based on wireless sensor network using Zigbee. The project describes detailed hardware and software designs. The low-consuming Zigbee-based wireless sensor network is becoming more and more popular, as it consumes less energy as compared to WIFI and its bandwidth is more than Bluetooth. With the help of sensor to monitor the environmental condition. if the most dangerous situation is occur it also provide the alarm message to the administrator in order to provide the alertness of particular area. Monitoring for environment sensor systems has been investigated in this project. The proposed approach can detect and recognize the abrupt event in environmental sensor systems quickly and accurately. The experimental results show that the proposed approach is more efficient for the monitoring of environmental systems with the help of different precise sensor.

Future Scope:

Nevertheless, the future seems bright for wireless sensor network. Many researchers have been done for monitoring of air parameters and classification of abrupt events.

- The work can be enhanced for other research area for monitoring of air pollution.
- The error detection can be used for other monitoring instruments.
- We can further implement clustering technique by grouping nodes with one cluster head per group

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