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Ambient Air Quality Monitoring System for a City Using Wireless Gas Sensors

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ABSTRACT

Internet of Things enables the physical devices to embedded with software, sensors and network connectivity to sense, collect and exchange data for the direct integration of physical world into computer based systems. In this domain, a Wireless sensor network is deployed for air quality monitoring system. The objective of this paper is to investigate the concentration measure of the air pollution around the city and provide the quality level of the air to the end user. A sensor node includes a microcontroller for a data analysis, Global Positioning System device for location access and XBee transceiver to communicate with a server. Each sensor node is established at public spaces like traffic signal and periodic sensing and transmission is done. Users who use Smartphone with a special android application connect to the server through the internet and select a city and location the place listed. Through this the level of air pollution in the place is displayed.

Keywords: Wireless Sensor Networks, Global Positioning System, Sensor Nodes.

I. INTRODUCTION

The air is a precious resource that most of us take for granted. Air supplies oxygen which is essential for our bodies to live. A physical, biological or chemical alteration to the air in the atmosphere can be termed as air pollution. The world health organization defines air pollution as "the presence of material in the air" in such concentration which are harmful to man and his environment. In fact of air pollution is the occurrence or addition of foreign particles gases and other pollutant into the air which have an adverse effect on human being, animals and vegetation. The sources of air pollutants include vehicles, industries and natural sources. Air pollution is a real public health and environmental problem that can lead to among other things like global warming, acid rain and the deterioration of the ozone layer. The physical, biological or chemical alteration to the air in the atmosphere can be termed as pollution. The combustion of gasoline and other hydrocarbons fuels in automobiles, trucks and jet, airplanes produces several primary pollutants. The pollutants such as nitrogen dioxide, carbon monoxide and sulphurdioxide. Carbon monoxide is both odorless and colorless. A carbon monoxide emission from vehicle is about 62%. Sulphur dioxide is a colorless gas, and it is highly reactive. About 70% of sulphur dioxide emissions come from combustion at industrial power plants. It causes a respiratory problem. Nitrogen dioxide is an irritant gas, which at high concentrations causes inflammation of the airways.

II. METHODS AND MATERIAL

A. Existing System

The existing system for monitoring the pollutant level of the city is used only to make a survey about the air pollution in a city. Here they used two sensor nodes – stationary nodes and mobile nodes. The gas detectors (stationary node) which sense the concentration of gases in the environment are fixed at different areas of a city. It will continuously collect the data. Mobile nodes fixed with each public service buses. While the buses have been moves through the areas covered by the stationary nodes, it collects data from them. Finally, when Public transport vehicles reaches back to destination, the collected data which has been collected by routing nodes

deployed on metro bus service during the whole pathway of metro bus service. Then the collected information are analyzed and found where the concentration of smoke, carbon oxides and other gases and other dust particles were in concentration. This collected data has not been circulated to the public for awareness.

B. Proposed System

- ***Outline***

To monitor air quality index in attainment cities wireless sensor networks might be a great exposure. This paper proposes a self –sufficient air quality monitoring based on the WSN technology, to collect air quality parameters in the developing cities. The proposed system uses carbon monoxide, nitrogen dioxide and sulphur dioxide sensors to monitor the air quality indices of these three gases which are highly cause of air pollution. We present the design, Implementation and evaluation of air quality monitoring system at popular locations. The level of air quality indices are displayed through a android mobile application to the end-users. In the real time scenario level of air pollution has been updated periodically.

- ***Microcontroller***

Microcontroller is a solitary chip microcomputer fabricated from VLSI fabrication. A microcontroller is also known as embedded controller. Today various types of microcontroller are available with different word lengths such as 4-bit, 8-bit, 64-bit and 128-bit microcontrollers. In our proposed system we are using microcontroller.

Peripheral Interface Controller (PIC) provided by micro-chip technology to categorize its solitary chip microcontroller. These applications have been extremely. Successful in 8bit microcontrollers. The microchip technology has been constantly upgrading the appliances.

PIC microcontroller is very popular this is only cause of wide availability, low cost, large user base and serial programming capability. The PIC microcontroller has been categories in various levels but hereby using PIC16F877A because it has programmable code protection, power saving sleep mode, self-programmable under software control, selectable oscillator options.

- ***Gas Sensor***

Gas sensors are available in wide specifications on the sensitivity levels, type of gas to be sensed, physical dimensions and numerous other factors. This covers a co gas sensor that can sense gas such as co. when a gas interacts with a sensor; it is first ionized into its constituents and is then adsorbed by the sensing element.

This adsorption creates a potential difference on the element which is conveyed to the processor unit through output pins in form of current. In our system we are using three different types of gas sensors such as CO, SO_2 and NO_2.

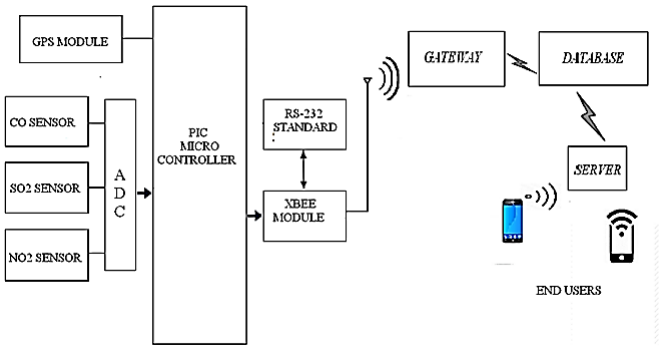

Figure 1 : Block diagram of the air quality monitoring system

- ***XBee***

XBee-pro 900 Hp embedded modules provide best-in-class range wireless connectivity to devices. It requires no programming can be configured easily using digi's free XCTU software via a AT command set .It supports RF-line-of-sight ranges up to 200kbps XBee modules are easy to use, share a common hardware footprint and are available in a variety of different protocols.

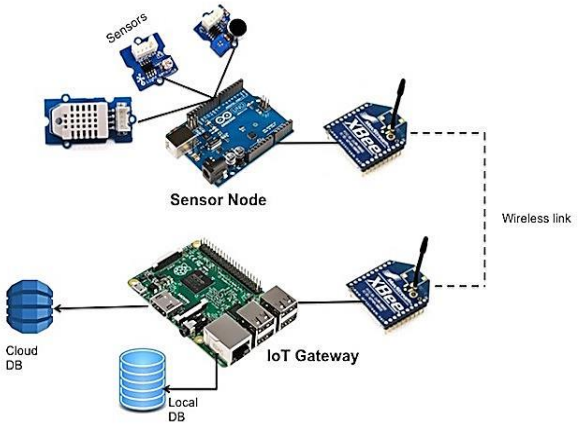

Figure 2 : Design of Wireless Sensor Communication

III. RESULTS AND DISCUSSION

IMPLEMENTATION

The process of monitoring and displaying of the air quality data are as follows. The sensor kit is fixed at the central urban area in a congested, downtown street surrounded by building where many pedestrian walk. Average daily travel on the street should exceed 10000 vehicles with average speed of less than 6.7 m/s. Monitoring probe is to be located 0.5 m from the curb at a height of 3 ± 0.5 m. The gas detectors which are used in this system are CO, SO_2, and N_2O sensors are connected with a PIC microcontroller. All analog signals from the gas detectors are converted by the analog to digital convertor (ADC). The digital form of the sensor data are calculated by the microcontroller. Calculation is done based on the AQI (Air Quality Index).

$$AQI = \frac{\text{POLLUTION LEVEL}}{\text{POLLUTION STANDARD}} \times 100$$

Each Nodes of this system includes the sensors, processing microcontroller and transmitting device. XBee Pro is used for communication between the devices. The XBee radios can all be used with the minimum number of connections — power (3.3 V), ground, data in and data out using Universal Asynchronous Receiver/Transmitter (UART). The processed data is transmitted between the XBee devices (nodes) through dynamic source routing protocol and reaches the gateway. The data is stored in the database through internet. An end user can access this data about the pollutant level of specified places listed in the mobile application. The data is sent to the end user through mobile data network available in the mobile.

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*...air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Figure 3 : Color indication of the AQI

This proposed system provides the continuous sensing, processing and transmission of the data to the database. So the user can get the real time values about the environmental conditions of the city. A mobile application provides the value of the pollutant air along with an indication and give suggestions for safe passing of the region. The suggestion indicates to divert from the high polluted zone to the less polluted zone.

RESULT ANALYSIS

We present this project for analysis the pollution less path for safer journey. We implemented in the Coimbatore city at first the sensor kit was placed in the singanallur area and absorb the air pollution level through it. According to the route map we find out three path to reach gandhipuram. The sensor kit placed in each area and the data value calculated for every 5mins.when the user select the particular path route to reach gandhipuram. It shows three alternative views and pollution value for each path. It also analysis and find the best path.

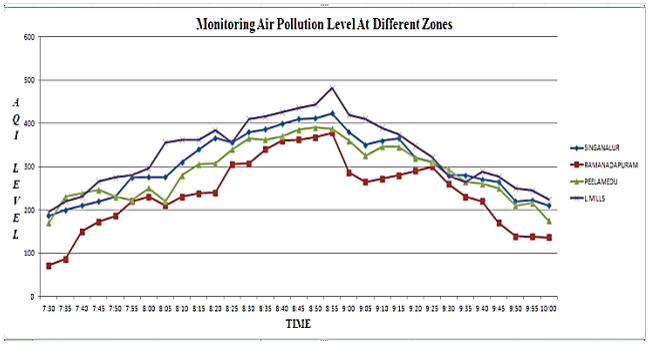

Figure 4 : Comparison of AQI levels at various areas

TIME	SINGANALUR	RAMANADAPURAM	PEELAMEDU	L.MILLS
7:30	186	72	170	193
7:35	200	86	230	220
7:40	210	150	238	230
7:45	220	173	246	266
7:50	230	186	230	275
7:55	275	220	222	280
8:00	276	230	250	296
8:05	276	210	220	356
8:10	310	230	280	362
8:15	340	238	305	362
8:20	366	240	307	384
8:25	356	305	340	356
8:30	380	307	365	410
8:35	386	340	362	416
8:40	399	360	370	426
8:45	410	362	385	436
8:50	412	368	390	444
8:55	423	378	388	481
9:00	380	286	360	420
9:05	350	265	325	410
9:10	360	272	346	389
9:15	365	280	345	374
9:20	320	290	320	348
9:25	310	300	310	321
9:30	280	260	293	278
9:35	280	230	265	265
9:40	270	220	261	289
9:45	265	170	250	277
9:50	220	139	210	250
9:55	222	138	216	245
10:00	210	137	175	224

Figure 5 : Data analysis in different locations

A. Future Works:

For estimating the air pollution with the periodic update, we implement this project for the Coimbatore city. We have an idea to use better technology for the collection of data, because here peer to peer topology has been used by us. At present, we are monitored the current level of air pollution and in the future, preventive measures also available in the application.

IV. CONCLUSION

In the above system we represent the level of air quality through a sensor along with Smartphone notification. The main focus of this paper is to analyze the level of air quality in the developing cities which have huge cause for air pollution. The current level of the air index data has been transferred via XBee devices. Hereby we consider two XBee devices one act as a data transmitter and other act as a receiver. The data are stored in the database and viewed periodically through android application.

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