Smart Phone Based Real Time Air Pollution Monitoring System

Varsha B. Gaikwad and V.G.Puranik

Abstract--- This system consists of air pollution sensors array, Global Positioning system (GPS) of mobile phone, single chip microcontroller, bluetooth modem. Sensors are components that produce measurable response to a change in a physical condition of air pollution. The sensors generates analog signal which is digitized by an analog to digital converter & send to controller for further processing. CO, NO, Smoke and Temp. sensor senses the gas and communicate the data with microcontroller. Bluetooth modem is for transmitting the data to LPC2138 to mobile. GPS modem of the mobile itself is used to send the location information. The main motive of this system is to frequently monitor the pollution level provided by the different sensor via Bluetooth modem at the control section. Hence particular plan of action should be taken to control the air pollution.

Index Terms--- Air Pollution, Global Positioning System (GPS) of Smart Phone, Microcontroller, Embedded System, Wireless Mobile Networks and Sensors

I. INTRODUCTION

There is nothing quite like opening the door and breathing fresh and clean air. How clean and pure is the air for breathing now? Unless and until you are a scientist in chemistry lab[5] at your fingertips, there is no real way of knowing.[5] The gases you're take up through your nose could be slowly killing you: according to the survey done by World Health Organization, two million people die every year from the effects of polluted air .[4] Air pollution is a great problem—and not just applicable to people living in smog-choked cities: through such things as global warming and depletion of ozone layer, it has the potential to affect us all adversely.[3] So what exactly causes this great environmental issue is obvious when it pours from a smokestack (chimney), but it is not that easy to spot.[6] This smoke comes out of a coal-fired power plant and which carries with it pollutants like sulphur dioxide and "greenhouse gas" carbon dioxide.[5]

Air pollution causes plants and animals to die or alter them from growing properly, damage few other aspects of the environment (such as causing buildings to crumble), or cause some other type of nuisance (reduces visibility, perhaps, or an bad odour). As with water pollution and the land contamination, it is the quantity (or composition) of chemicals present in the air that concludes the difference between "harmless" and "pollution." Carbon dioxide (CO2) is present in the air around us at concentration level of less than 0.05 percent and breathing it usually do not harm (you can breathe it out all the day long); but air having extremely high concentration of carbon dioxide (say, 5–10 percent) is toxic and could kill us in a matter of minute.

Fig. 1: Air Pollution

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The environmental air pollution monitoring system measures CO, NO, smoke and Temp. Carbon Monoxide (CO) – Carbon Monoxide obstruct the uptake of oxygen by the blood[2] that can lead to a significant reduction in the supply of oxygen to the heart, generally people suffering from heart disease, there is also an increasing evidence for adverse effects of air pollution not only on the respiratory system of human body, but also on their cardiovascular system.[4]

In this system a temperature sensor in LPC 2138 is used for measuring temperature of the locality. LM35 is a pre-cession IC temperature sensor with its output proportional to the temperature (in °C). The sensor circuit is sealed and therefore it avoids oxidation and other processes [3]. With LM35, temperature can be measured more precisely than with a thermistor.[4] It also inherits low self heating and does not cause more than 0.1 °C temperature rise in still air.[4] The operating temperature range is from -55°C to 150°C.[6] The output voltage varies by 10mV in response to every °C rise/fall in the ambient temperature, i.e., its scale factor is 0.01V/ °C. Along with it their is a variable resistor output that can also be set for voltage output.[3]

Most of the above air pollution and quality monitoring systems are sensors based, that report the levels of pollutants to a server by wired modem, router, or short-range wireless access points.[2] In this paper, we propose a system integrates a single-chip microcontroller, several air pollution sensors (CO, NO, and SO2) General Positioning System (GPSs) module and Bluetooth module [1]. The integrated unit is a smart phone and a wireless data acquisition unit that uses the wireless mobile public networks.[2] This unit can be kept on the top of any moving device for example, a public transportation vehicle.[4] As the vehicle moves microcontroller generates a frame which consist of the acquired air pollutant level from the sensors array as well the physical location that is reported from the attached GPS module.[5] The pollutants frame is then uploaded and transmitted to the Server by using public mobile network.

A database server is attached to the Server, which stores the pollutants level for further usage by interested clients such as environment production agencies, tourist, vehicles regeneration authorities, and insurance companies[1].The Server is further interfaced to Google maps to display real-time pollutants levels and their locations in large metropolitan cities. Adverse effects of air pollution are hazardous to environment as well to human health. Due Global warming, ozone layer is getting depleted & heat in the atmosphere is increasing thus this is the main problem that we are facing hence to control it we need to develop this system.[5]

II. HARDWARE ARCHITECTURE

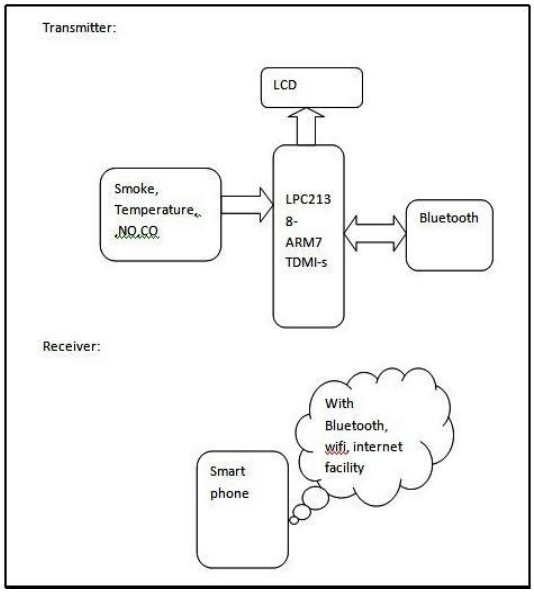

Fig. 2: Air Pollution Monitoring Unit

A. Wireless Sensor Node

A wireless sensor network (WSN) is an infrastructure which includes computing, sensing and communication elements which helps the administrator to monitor & control the specified parameters in the given network. Typical application of WSN includes monitoring, data collection, surveillance & medical telemedicine. It is also used in the irrigation system, Greenhouses for monitoring &

controlling parameters like water flow, humidity , temp, moisture, etc[1].

B. Sensors

Sensors are hardware devices that generates measurable response to a variation in the physical condition of air pollution. The sensors generates analog signal which is digitized by an analog to digital converter & send to the controller for its further processing. There are various types of sensors from which we can select the suitable & most appropriate sensor depending on our application.[2]

Sensor 1 (Carbon Monoxide sensor):- The CO sensor senses the gas and communicates the data to microcontroller.

Sensor 2 (NO sensor):- The NO sensors sense the gas and communicate the data to microcontroller.

Sensor 3 (Smoke sensor):- Smoke sensor senses the gas and communicates the data to microcontroller.

Sensor 4 (Temperature sensor):- The temperature sensor senses the temperature and communicates the data to microcontroller.

C. Bluetooth Module HC-06

In the proposed system, we are using Bluetooth modem which transmits the data to LPC2138 to mobile. These small size Bluetooth TTL transreceiver modules are designed for serial communication (SPP - serial port profile).[7] It allows target device to send or receive TTL data by Bluetooth technology without connecting a serial cable to your computer.[6]The modules with the HC-06 firmware are the modules which are factory set to be Master or Slave modules.[7] Master and slave mode cannot be switched from factory setting.[8] HC-06 is a commercial grade product.[6]

- Built-in Bluetooth chip of CSR company BC417143 [7]
- Bluetooth® Technology v2.0 + EDR
- TTL data transfer is between a host Bluetooth device
- It is compatible with most of the Bluetooth adapters that support SPP
- Coverage up to 30 ft / 10 m
- Built in antenna
- Power input: +3.3VDC (bluetooth module)
- It can be set to the module control parameters and control commands via AT commands [6]
- The max. serial baud rate is 1382400 bps which support for hardware flow control transfer
- Provides seven input and output ports
- Connection and non-connection status indicators[5]

D. Microcontroller unit

Microcontroller like ARM (LPC2138) processes data, performs the allocated tasks and controls the functionality with other components in the sensor node.The ARM7 based microcontrollers runs on load-store RISC architecture with a 32-bit registers and a fixed opcode length. The architecture provides linear 4GB memory address space. The ARM7 core is simple to use, cost-effective, and support the modern object-oriented programming techniques.

E. Global Positioning System

GPS receivers are used for navigation, positioning, locating, surveying, and determining the time and are used by both private individuals and companies. During development of the GPS system:

- It has to provide users with the capability of determining time, position and speed, whether in motion or at rest.[3]
- It should have continuous global 3 dimensional positioning capabilities with a high degree of accuracy, irrespective of the weather changes.[3]

Global Positioning System is important standard used for navigation, tracking and determining location aware data logging. Board can be interfaced with a microcontroller through UART. Data such as longitude,

latitude of the area where vehicle located are received. Board features connector are compatible with antennas. It can work on a 3.3V power supply only.[3]

F. LCD Display

Liquid Crystal Displays are the best interface between man and machine that gives impressive visual information, displaying Icons, Symbols, Alphabets, Numerical, and Characters. We have used ODM's 16x2 LCD Digital Display.

Mobile Data-Acquisition (Mobile-DAQ)

This system consists of Mobile Data-Acquisition Unit (Mobile-DAQ) and fixed Internet Enabled Pollution monitoring Server.Mobile-DAQ consists of a 32-bit single-chip microcontroller integrated with a sensor array using analog ports. The Mobile-DAQ is connected to a mobile phone and Bluetooth module using RS-232 interface.[4]

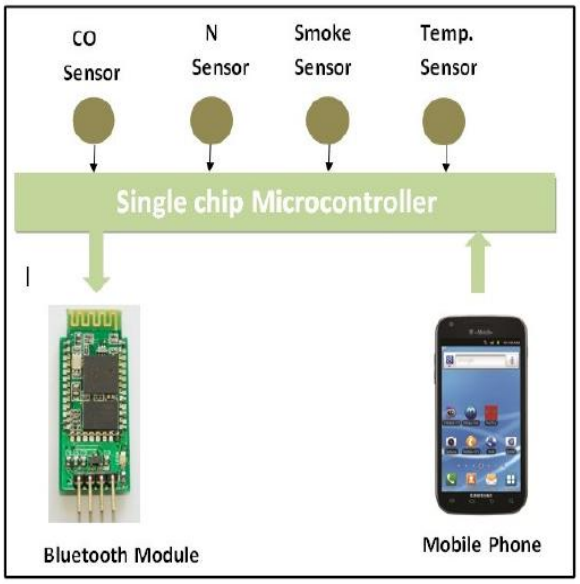

Fig. 3: Mobile- DAQ

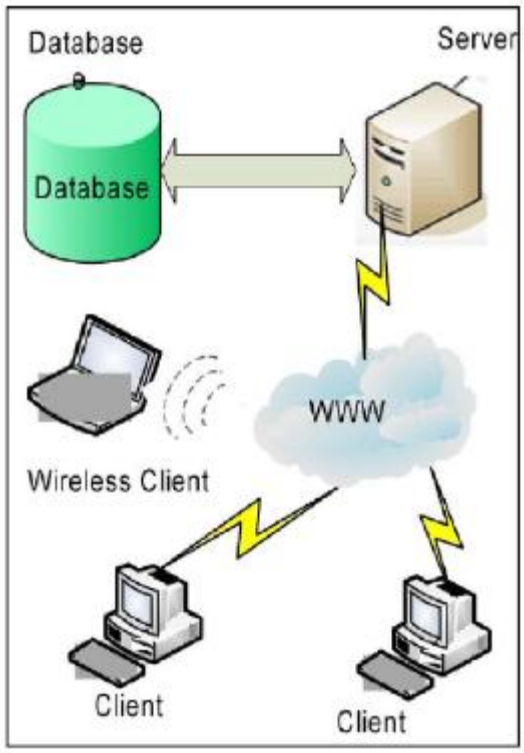

Fig. 4: Web Server

Web Server

It connects to a database management system via (LAN) Local area network. The server connects to the Bluetooth module by TCP/IP through internet and public mobile network. Clients like insurance companies, travel agencies, tourist companies, municipality, environmental protection agencies connect to the server via Internet and check the real time air pollutants level using a normal browser on a standard PC or a mobile phone.[1]

III. SOFTWARE ARCHITECTURE

A mobile web server is a software which is similar to HTTP Server or Apache Jetty Server, which provides a mobile device, such as tablet, smart phone.[4] The capability to host web sites, web services and web applications.[6] Hosting web services on a mobile server brings convenience, potential, flexibility to the consumers. This will revolutionize the way we share data and communicate and also collects information.[5] Mobile web servers face unlimited possibilities in areas of enterprise mobile data access and sharing for lucrative markets such as

music, military and health care, are examples. Engineering mobile devices around the world as mobile web servers would change the internet landscape.[4] It would fundamentally alter the way we access web services such as maps with geo-location documents, medical records, information and news.[5]

The primary goals were to bring a full-fledged web server to Smartphone and to make a web-server running on a mobile phone accessible from the Internet using any web browser.[6] Which provides access to a mobile phone from the Internet and it is not straightforward, as operators frequently employ firewalls that prevent access from the Internet to phones inside that firewall. By producing a custom gateway we could circumvent that limitation and we are now able to provide a web-server on a mobile phone with a global URL than can be accessed from any of the browser.[6] In a way, the mobile phone has now finally become a full member of the Internet.

Web Server

Web server is used to communicate with Web Browsers as its clients and the communication protocol used in this case is HTTP (HyperText Transfer Protocol).Therefore Web Server is also called an HTTP Server.

The client (i.e., the Web Browser) and the server (i.e., HTTP/Web Server) should be able to communicate with each other in a distinct way. This pre-defined set of rules form the basis of the communication that are normally termed as a protocol.

The mechanism that enable this application are the following:

- An android server which allocates users to host web-sites.
- An android application that will be responsible for HTTP protocol
- Communication
- Most of the communication to the platform occurs over the TCP port connected to the Android Device Communication Server. Communication commands consists information such as ports used for streaming the video, user login information, session identification, play and terminate commands. Sign up and forgot password dialogs take advantage of the functions already implemented on the server side web page by using the java built in HTTP client to fetch web pages using GET by including required information in the GET URI.

Android

Android is a complete set of software for mobile devices such as tablet, notebooks, smartphones, electronic book readers, set-top boxes etc.It includes a Linux-based Operating System, middleware and key mobile apps.

It can be thought of as a mobile operating system. But it is not inadequate to mobile only. which is currently used in various devices such as smartphones, tablets, televisions etc.

It is developed by Google and later the OHA (Open Handset Alliance). Java language is mostly used to write the android code eventhough other languages can also be used.

The goal of android project is to produce a successful real-world product that improves the mobile experience for end users.

IV. IMPLEMENTATION

Algorithm

- Start
- Initialize all the devices
- Read the inputs from sensors
- Display it on LCD
- Send it to the android phone
- All the values that can be seen from anywhere as it displays on web page.
- Go to step 3.

Software used:

- Keil Micro Vision:
- Regarding the compiler and IDE used we have used Keil Micro Vision 3 which is provided by KEIL for development on ARM controller.
- It supports the USB boot loader enabled controller, on-chip debugging and programming tool.
- It currently supports all ARM family devices. That even facilitates the download of program to the ARM ISP board.

System Specification:

Hardware:

Microcontroller(LPC 213x)

Gas sensors

Bluetooth module

Software:

Keil micro vision 4: for LPC2138

Languages used: embeddec c, JAVA for the mobile

Mobile application will note down the coordinates of the area with sensor values all the values are store in the form of database.

Person will be able to view the sensor wise air pollution area wise due to the GPS facility.

One more system feature is our system will show all the values of the sensor on the monitor window as well as these values are compared with threshold value of the air pollution.

If any value goes above the threshold then the system will send the message to the administrative part or the engineer.

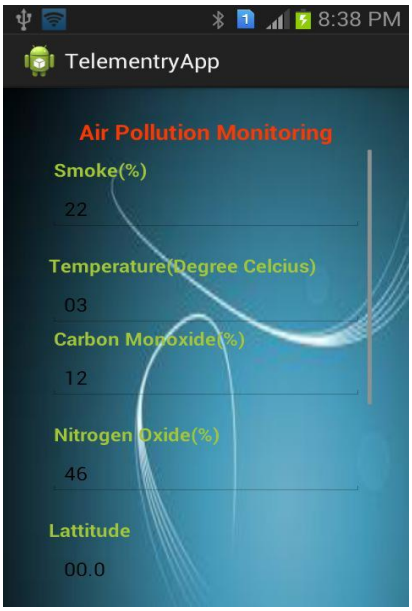

Fig 5

V. RESULT

Table 1: Results of Air Quality Parameters

Sr.No.	Parameters	Values
1	CO	11%
2	NO	44%
3	Smoke	3%
4	Temp	24◦C

Web Page of Pollution Monitoring System

Pollution Monitoring System

Temperature	Smoke	Carbon Monoxide	Nitrogen Oxide	Lattitude	Longitude	Date And Tim
24	03	11	44	00.0	00.0	2015-01-20 20:3
22	03	12	46	00.0	00.0	2015-01-20 20:3
24	03	11	54	00.0	00.0	2015-01-20 20:3
25	03	11	61	00.0	00.0	2015-01-20 20:3
22	02	11	57	00.0	00.0	2015-01-20 20:3
24	03	11	47	00.0	00.0	2015-01-20 20:3
23	03	11	43	00.0	00.0	2015-01-20 20:3
24	03	11	47	00.0	00.0	2015-01-20 20:3
24	03	11	56	00.0	00.0	2015-01-20 20:3
24	03	11	61	00.0	00.0	2015-01-20 20:3
23	02	11	58	00.0	00.0	2015-01-20 20:3
24	03	11	53	00.0	00.0	2015-01-20 20:3
24	03	11	48	00.0	00.0	2015-01-20 20:3

Our system have ARM7 LPC2138 is the heart of the system. Sensors like Temperature,Smoke ,Carbon Monoxide ,Nitrogen Oxide are interfaced with microcontroller which is used for the environmental

monitoring air pollution. All the parameters of the sensors are display on LCD. All the values are sending to the nearby mobile by Bluetooth.

At the mobile side by using Android web server is designed to show the parameters worldwide .This values are displayed on the mobile window as well as worldwide mobile or PC.

Data will be viewed by any Engineer from any end of the world by our system. Our system will have one more facility as all the values are send by microcontroller to the Mobile.

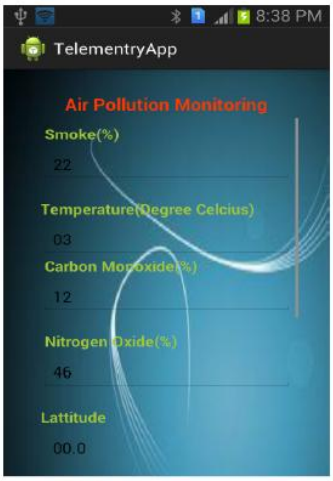

Fig. 6: GUI at Mobile Side

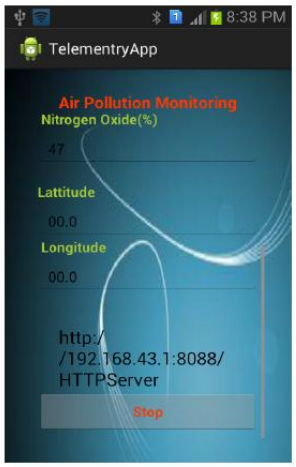

Fig. 7: Location at Android Phone

VI. CONCLUSION

The system utilizes city buses to collect pollutant gases such as CO,NO, smoke and temperature. The data shows the pollutant levels and their conformance to local air quality standards

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