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A Review Study of Air Quality Detector using Iot in Streets and Automobiles

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Abstract: ***A prototype for an Environmental Air Pollution Monitoring System for monitoring the concentrations of major air pollutant gases has been developed. The system uses low cost air-quality monitoring nodes comprises of low-cost semiconductor gas sensor with Wi-Fi modules. This system measures concentrations of gases such as CO, CO2, SO2 and NO2 using semiconductor sensors. Realization of data gathered by sensors is displayed on Raspberry pi 3 based Webserver. A MEAN stack is developed to display data over website.***
Keywords: Internet of Things, Pollution Monitoring, ARM Microcontroller, Nucleo F401RE, Raspberry pi-3, MEAN Stack

I. INTRODUCTION

Air pollution is caused due to the presence of particulate matter, harmful materials and biological molecules in earth atmosphere. It has adverse impact on living organisms such as humans, animals, food crops and can also damage have built and natural environment. It may result in allergies, harmful diseases such as cardio vascular diseases, lungs diseases and can also cause death. The environment group Greenpeace in January released a report that has estimated every year nearly 1.2 million Indian die because of air borne pollutants.

Particulate matter is liquid or solid matter which is microscopic and suspended in Earth's atmosphere. We are exposed to this particulate matter which is continuously affecting our heart and lungs. Till now several studies have been done in environment monitoring domain using IoT, Researchers have monitored environmental parameters like Temperature, Humidity, Barometric air pressure, carbon monoxide, sulfur dioxide but the least attention is paid to the measurement of particulate matter. Air quality monitoring without knowing the concentration of particulate matter in the atmosphere is incomplete. Thus, to address this problem, a system consisting of DSM501A which a PM sensor is is being used for monitoring the particulate matter along with the sensors employed for sensing carbon monoxide, carbon dioxide, Temperature, Humidity and barometric air pressure using raspberry pi which is a low power, less expensive, highly flexible minicomputer is designed. It is a good platform for interfacing with many devices at the same time. Internet of Things and cloud computing are the most emerging technologies. Internet of Things is a concept or a paradigm in which without human interruption devices sense, identify, process and communicate with each other. Cloud computing is a practice of consuming the resource of remote servers such as storage, virtual machines, applications and utilities that are hosted on internet rather than building and maintaining infrastructure for computing in house. Internet of Things becomes very powerful when converges with Cloud computing. IoT cloud system provides a view on accessing Iot resources and capabilities.

II. SYSTEM DESIGN

The simplified diagram of the proposed system is demonstrated in Fig.1. Raspberry pi is the major node controlling our system. The sensors are being used for detecting different environmental parameters like particulate matter, Carbon Monoxide, Carbon Dioxide, Temperature, Humidity and Pressure. The sensors are connected to Arduino Board and Raspberry pi is interfaced with Arduino Uno through USB cable. The data sensed by the sensors are continuously transmitted through Raspberry pi to the cloud over the internet because of its good network connectivity. The sensors DSM501A is a PM sensor whose output is PWM, used for measuring the particulate matter i.e. smoke and dust present in our environment, DHT22 and BMP180 are having digital outputs used for measuring temperature, humidity and pressure. The sensors, MQ9 (Gas sensor) as well as MQ135(air quality sensor) are analog sensors used for measuring Carbon monoxide and carbon dioxide. Arduino Uno is a low-cost microcontroller board based on ATMEGA-328P which can be easily interfaced with Raspberry pi and has a very effective ADC. Since Raspberry pi 2 model B does not have built in Wi-Fi adapter therefore Wi-Fi adapter is used for providing the internet to the complete system. The light weight protocol MQTT (Message Queuing Telemetry transport). MQTT plays an important role in establishing communication between the sensors and the clients. The client can access the data that is being displayed on the dashboard by using the device id but the client will be not able to do any modification to the data received.

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A. Raspberry PI

Raspberry Pi is a single board computer. It has ARM Cortex A7 CPU and 1 GB RAM which makes it a faster and powerful than the previously available models. It has Broadcom BCM2836 quad core processor which is running at 900 MHz, but it can be overclocked. It has 4 USB ports, 40 GPIO pins, 1 full HDMI port, 1 Ethernet port, 3.5 mm audio jack and composite video, camera interface (CSI), the display interface (DSI) [6]. It has a separate slot for Micro SD card slot which is used for storing operating system as well as other software's and drivers needed. Raspberry Pi can support different operating systems such as Raspbian, Windows 10, Ubuntu etc. Raspbian operating system is used for implementation of system. Node Red is a visual programming tool for IoT which is very easy to use. Node Red has an inbuilt library consisting of thousands of flows and nodes which enable the users to connect all kind of devices and services. Once the flow is made it can be deployed and data can be seen on the dashboard.

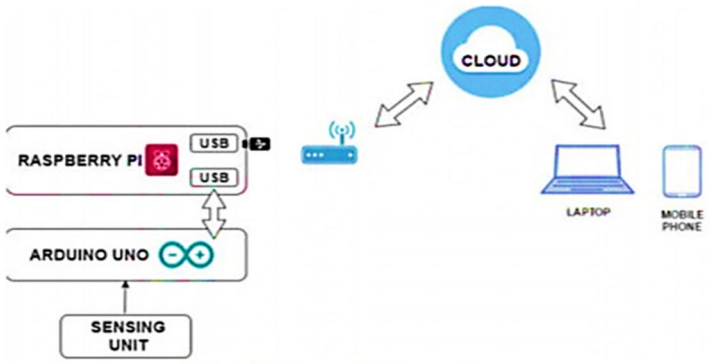

Fig. 1.Simplified diagram of Proposed System

B. Sensing Unit

Sensing Unit comprises of five sensors for monitoring the air pollution. Table 1 shows the technical specifications of the three air quality sensors, Temperature, Humidity and pressure sensors. DSM501A is a low-cost dust sensor module has a very high sensitivity as it can even detect the fine particles having the diameter greater than 1 micron. MQ9 is highly sensitive to carbon monoxide / combustible gases. It has a simple drive circuit and has a prolonged life. With the rise in concentration of the gases in air, conductivity of the sensors also increases. MQ135 has wide scope for detection of NH3, alcohol, CO2, smoke, etc. with a very low response time. DHT22 is a four-pin, resistive type having digital output relative humidity and temperature sensor. BMP 180 is a low-cost sensor used for monitoring barometric air pressure and can also be used as an altimeter as the pressure changes with the variations in altitude.

Table. 1: Air Parameters Sensing

Parameter	Operating Voltage	Measuring Range
Particulate Matter	5V	10 to 10000ppm
Carbon Monoxide	1.5V	10 to 10000ppm
Carbon Dioxide	5V	10 to 10000ppm
Temperature	3.3V	-40 to +80-degree Celsius
Relative Humidity	3.3V	0 to 100% RH
Pressure	5V	300 to 1100 hpa

C. Software architecture

It involves Node-Red and Integrated Development Environment.

1) *Node-RED:* Node-RED is an easy to use, fundamental and an open source programming tool for IoT applications. It is highly used visual programming tool which help IoT developers to integrate Hardware devices, APIs and online services in a very interesting and creative manner. Built in Library of Node-Red consist of thousands of flows and nodes that enable the user to connect all kind of devices and services. Flows can be run at the edge of network on the hardware like Raspberry pi or in the cloud since node-red runtime includes node.js. Node-Red provides a simple click mechanism to deploy the flows by the IoT developers to a light weight runtime environment.

2) *Integrated Development Environment:* Arduino programs can be written in any programming language that has a complier for a conversion of program code into the binary code. IDE is platform independent acting as the base for Arduino hardware. It is a very powerful for programmers, project development professionals and researchers to develop various Arduino projects employing different kind of sensors. Arduino IDE is an open source design/ software which has originated from the integrated development environment for the languages processing and wiring projects. As IDE is platform independent, it can run on Windows, Linux based operating system as well as Mac OS [9]. Some of the key features of IDE include a text console, message area, toolbar for common functions. A program for Arduino using IDE platform is known as sketch, languages like C, C`++ are supported by Arduino IDE for programming.
3) *MQTT Protocol:* MQTT is extremely light weight connectivity protocol for internet of things applications. It is designed for devices and high latency, low bandwidth, unreliable network. Its mainprinciple is to minimize device resource requirement and network bandwidth. IANA reserved TCP/IP port 1883 for use with MQTT over SSL [12]. Unlike HTTP protocol it does not follow request/response architecture instead it follows publish/subscribe architecture.

III. EXPERIMENTAL SETUP

As shown in fig.2 the complete setup for the system consisting of sensors, Arduino, Raspberry pi has been showny

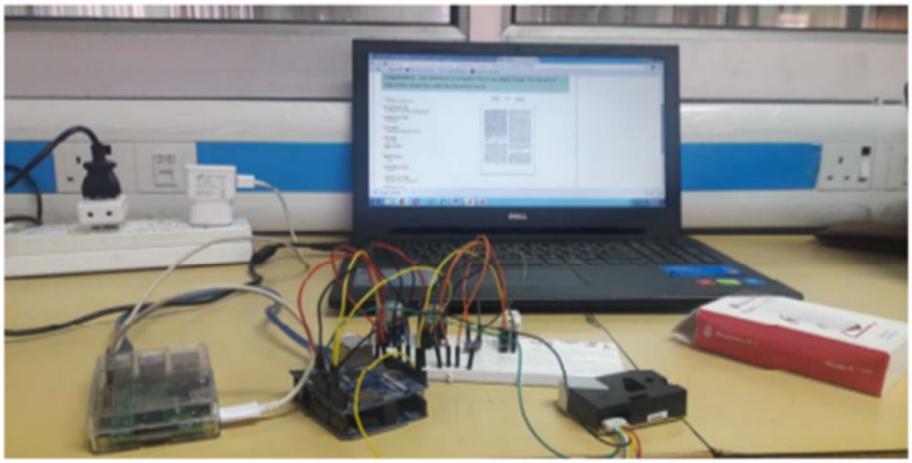

Fig. 2. Experimental Setup

IV. CONCLUSION AND FUTURE WORK

The proposed system provides low cost, low power, compact and highly accurate system for monitoring the environment with the dedicated sensors remotely from any place in this world. A perfect trade-off between accuracy and cost is achieved by making use of single board minicomputer Raspberry pi and appropriate sensors leading to a well-grounded system. Datasheets available on the dashboard of IBM Bluemix account will help in framing good policies against the increasing level of pollution to ensure healthful environment. Air quality monitoring system can be more advantageous if pollutants like Sulphur dioxide, nitrogen dioxide, ground level ozone etc. are also monitored. Furthermore, long-term pollution patterns can be discovered and certain relationships between the air pollutants can be found.

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