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

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Abstract— As air pollution is the major problem in the world which increases day by day due to the emission of harmful gases from industries, vehicular emission and so on, due to which many health issues is faced by the human, animals and plants as well. This creates a requirement for the activity and analysis of real time air quality observation so applicable selection are often taken during a timely amount. This paper presents a air quality monitioring system which includes various components such as microcontrollers, wifi module, semiconductor gas sensors. This system measures a concentration of gases in environment such as carbon monoxide, carbon dioxide, sulphur dioxide & nitrogen dioxide with the help of semiconductor sensors. The data which is gathered by the sensors is displayed on Raspberry pi 3 based web server.

Key words: Air Quality Detector, IoT

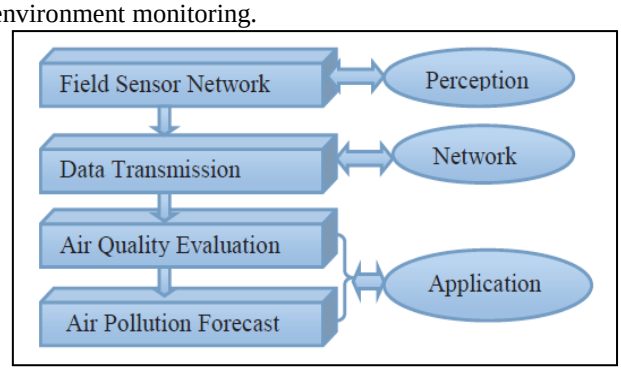
I. INTRODUCTION

Air pollution happens once harmful or excessive quantities of medicine additionally as gases, particles, and biological molecules square measure introduced into Earth's atmosphere. It may cause diseases, allergies and even death to humans; it should conjointly cause hurt to different living organisms like animals and food crops, and should harm the natural or built environment. Both human action and natural processes will generate pollution. Indoor pollution and poor urban air quality square measure listed as 2 of the world's worst hepatotoxic pollution issues within the 2008 smith Institute World's Worst contaminated Places report. According to the 2014 World Health Organization report, pollution in 2012 caused the deaths of around seven million individuals worldwide, associate degree estimate roughly echoed by one from the International Energy Agency. An air waste may be a material within the air that may have adverse effects on humans and therefore the system. The substance will be solid particles, liquid droplets, or gases. A waste will be of natural origin or artificial. Pollutants are classified as primary or secondary. Primary pollutants square measure typically made by processes like ash from a eruption. Other examples embrace CO gas from car exhausts or pollutant free from the factories. Secondary pollutants are not emitted directly. Rather, they kind within the air once primary pollutants react or move. Ground level gas may be a distinguished example of secondary pollutants. Some pollutants could also be each primary and secondary: they're each emitted directly and shaped from alternative primary pollutants.

Due to human activities substance emmited into the atmosphere include :- CO2, SO2, NO2, CO, VOLATILE ORGANIC MATTER, CHLOROFLURO CARBON, AMMONIA, ODORS, RADIOACTIVE POLLUTANTS.

Secondary pollutants include: Particulates created from volatilized primary pollutants and compounds in chemical science air pollution. Smog is a kind of air pollution. Classic air pollution results from massive amounts of coal burning in a section caused by a combination of smoke and dioxide. Modern air pollution doesn't sometimes come back from coal however from transport and industrial emissions that area unit acted on within the atmosphere by actinic ray from the sun to make secondary pollutants that additionally mix with the first emissions to make chemical science air pollution. Ground level gas (O3) fashioned from Nox and VOCs. Ozone (O3) may be a key constituent of the layer. It is additionally a crucial constituent of bound regions of the layer normally called the ozonosphere. level gas (O3) fashioned from Nox and VOCs. Ozone (O3) may be a key constituent of the layer. It is additionally a crucial constituent of bound regions of the layer normally called the ozonosphere. Peroxyacetyl nitrate (C2H3NO5) – equally fashioned from Roman deity and VOCs.

Using laboratory analysis, standard air automatic observance system has comparatively advanced instrumentality technology, large bulk, unstable operation and high cost. High cost and large bulk make it impossible for large-scale installation. This system can only be installed in key monitoring locations of some key enterprises, thus system data is unavailable to predict overall pollution situation. To overcome defects of traditional monitoring system and detection methods and reduce test cost, this paper proposes a method combining IOT technology with environment monitoring.



By replacing monitoring equipment in traditional empirical analysis with sensor network in IOC technology, through which inexpensive sensors can be laid out flexibly in the whole area to monitor omni-directionally to provide data support for prediction. According to IOT design, the system is especially composed of perception layer, network layer and application layer. The system's integral design architecture is shown in figure 1. In practical application, current weather conditions (temperature, humidity, wind direction, wind speed, etc) and geographical conditions have significant effect on air pollution degree and polluting source diffusion. In the process of system implementation, therefore, a full

consideration should be taken to the influence of environmental factors on monitoring and prediction effect.

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.

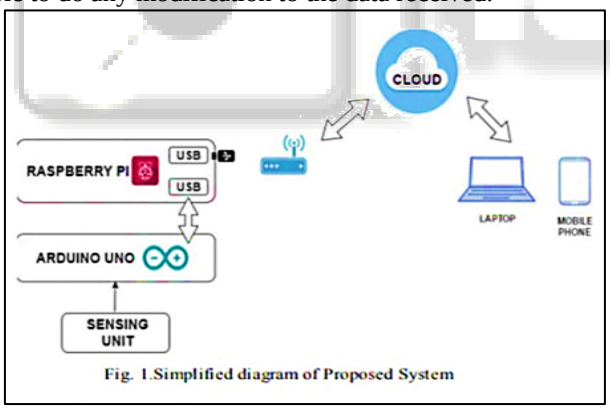
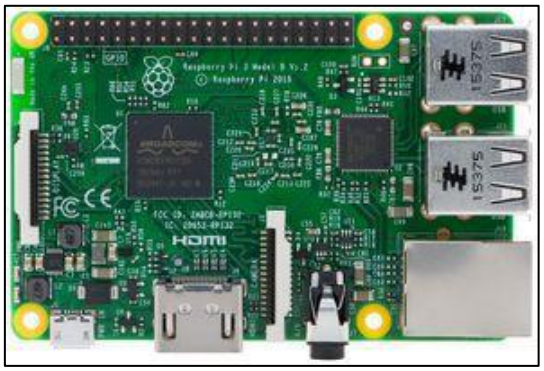


Fig. 1: Simplified diagram of proposed system

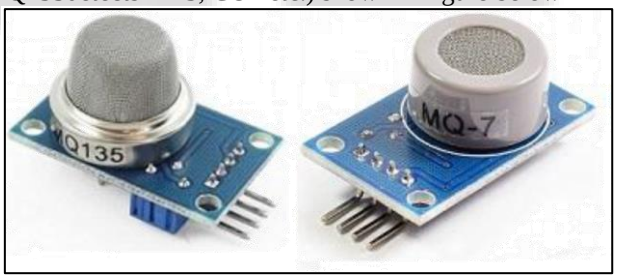
A. *Raspberry Pi*

We have used Raspberry Pi as a Base Station in our system. Raspberry Pi is configured as credit size microcomputer based on Raspbian Linux Operating System. It offers less complexity and more affordable solutions for wireless monitoring. The Raspberry Pi 3 Model B features a quad-core 64-bit ARM Cortex A53 clocked at one. 2 GHz, 1 GB SDRAM with built-in Wi-Fi and Bluetooth. The board also provides user with ETHERNET which is advantageous to our system. This results in remote access management through SSH login by putting IP address in it.



B. *Gas Sensors*

These form the front end of the laboratory IOT systems. These are so called "Things" of the system. Their main purpose is to collect environmental data from surrounding (sensors) or give out data to their surroundings (actuators).The low cost semiconductor sensors are suitable to use in Associate in nursing array type for low price atmosphere pollution monitoring systems. Such associate in nursing array may well be increased with extra temperature, pressure, and ratio sensors to live the waste material concentrations beside alternative physical parameters, with the advantage of higher calibration of the gas sensors Yet, no gas sensors are present that are 100% discerning to a single gas. Hence, it is necessary to use instruments that employ analytical techniques to identify gases. Examples of such instruments are Fourier transform infrared (FTIR) instruments, gas chromatographs, and mass spectrometers .In proposed Work we are using two low cost semiconductor gas sensors one is MQ7 while the other one isMQ135 (MQ7 is a carbon-mono-oxide sensor and MQ135detects NH3, CO2 etc.) shown in figure below



C. *Software architecture*

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

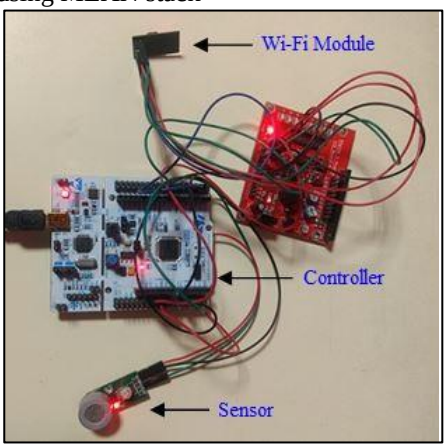
code into the binary code. IDE is platform independent acting as the base for Arduino hardware. It is a very powerful for programmers, project development professionals and researchers to develop various Arduino projects employing different kind of sensors. Arduino IDE is an open source design/ software 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.

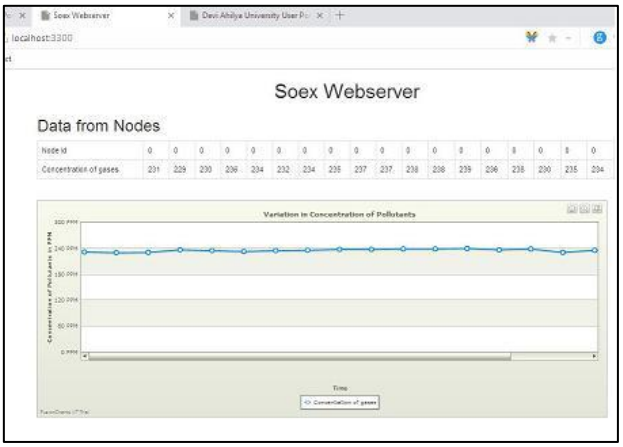
3) MQTT Protocol

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 main principle 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

We start with the Raspberry pi model as base station .Raspberry pi's inbuilt Wi-Fi is configured in such a way that it acts as a coordinator .A TCP server is implemented over raspberry pi usingNode.js in JavaScript. While gas sensors MQ7 and MQ135 with a Wi-Fi Module (ESP8266) each is interfaced with Nucleo F401RE to form two client nodes. Fig 6 below shows a client node (simple node). These Client nodes send sensor data wirelessly from sensor node (Nucleo) to Gateway (Raspberry pi) in the form of packets. These data packets contain id of the node data and the time of packet created. To save and analyze data we have installed a No Sql database (Mongo DB) in raspberry pi. The data saved in JSON format (JavaScript Object Notation) .So, it is simple to render the webpage with JSON formatted data. For data visualization we have designed a webpage using MEAN stack .We have assigned a DNS to the static IP of Raspberry pi and forwarding the port over internet. So, that it can accessible from anywhere in the world. Fig 8 shows webpage designed using MEAN stack





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