IOT Based Supervision of Urban Climate Using Raspberry Pi

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***Abstract*: -The very cause of environmental issues is air pollution, which should be considered as a factor that should be monitored and controlled. A recent survey informs us that nearly 5 million deaths were caused in 2017 due to air pollution. It causes many diseases like diabetes, heart attacks, chronic lung cancer, and various respiratory disorders. In this project, we are making an effort to measure and control the same pollutants using Internet of Things (IoT).The web of physical objects containing the embedded technology that is developing man to machine or machine to machine communication is Internet of Things. This paper concentrates on providing a stand-alone system that can provide a dynamic datasheet about parameters of the entire city environment. A low cost power ARM based mini-computer, that is, Raspberry Pi is used in this system which is capable of communicating through an external Wi-Fi module or Local Area Network(LAN).Python language is used to take in and process the commands from user at the Raspberry Pi. Other terminal devices with internet facilities like laptop, mobile phones, etc can be used to access data. The above framework will be accessing real time data concentrated on Urban environments like – harmful pollutants in air, carbon monoxide, carbon dioxide, pressure, temperature and humidity.**

***Keywords:* - Amazon Web Services(AWS),Internet of Things(IoT) ,Monitoring, Message Queuing Telemetry Transport(MQTT), Raspberry Pi.**

I. INTRODUCTION

As of now, the quality of air is poor and this project focuses on benefitting these drawbacks by providing a slightly better environment. IoT is the basis of obtaining the end result as it is used to design the sensor nodes. The main principle of IoT is that objects identify, process, sense and communicates with each other without human intervention. IoT is one of the fastest growing technologies and is expected to do a lot better in the near future because of several reasons, one of them being, they help taking real time inputs to give real time outputs only helping create a smarter way of living. The architecture of IoT is a combination of several data link layers and thus is said to be slightly complex but, the data provided by it is easily accessible by anyone trying to access information about the city's environment just with the help of internet.

Raspberry pi is a microcomputer (approx. size of a credit card) that can be programmed for a particular purpose using languages like python or scratch, this board is used along with a few sensors which as a whole help in providing real time data that could help providing some awareness about climate changes. The system is efficient as it is not so expensive and uses less power in comparison to the existing systems, the microcontroller-based system happens to use an ethernet shield to provide internet but this is not required if we use raspberry pi because it's inbuilt.

This system includes Raspberry Pi, Relay Board, LCD, Humidity Sensor, Temperature and Pressure Sensor, Light Intensity Sensor, Air Quality Sensor, Arduino Nano, HDMI, LAN, Power Supply, USB, Modem, Amazon Web Services, MQTT.

II. METHODOLOGY

Hardware:

The block diagram for this system is shown in the following figure. The cardinal controlling node of this proposed system is the Raspberry Pi. Environmental parameters such as temperature, light intensity, humidity, pressure, carbon monoxide and pollutant gases are brought into focus in this paper. The sensors sense the respective data and send to Raspberry Pi. The sensors such as DHT22, BMP180 and BH1750 collect and direct the digital outputs from the GPIO pins of the Raspberry Pi. The sensors such as MQ7(gas sensor) for carbon monoxide (CO) and MQ135(air quality sensor) for gases such as gaseous ammonia (NH_3), benzene, ethyl alcohol and carbon dioxide (CO_2), send the data to the Arduino Nano analog pins that are connected to the Pi through USB cable. A cheap and compact module that can be used as an effective ADC is the Arduino Nano. To provide internet connectivity to the system, a wireless modem is used. To get access of the dashboard, the client will use the dashboard URL. Different feeds displayed on the dashboard provide dynamic data that is continuously fed into the server. MQTT protocol has a crucial role in communication between the clients and sensor nodes. The clients will not be able to alter any parameter values, but can only monitor them.

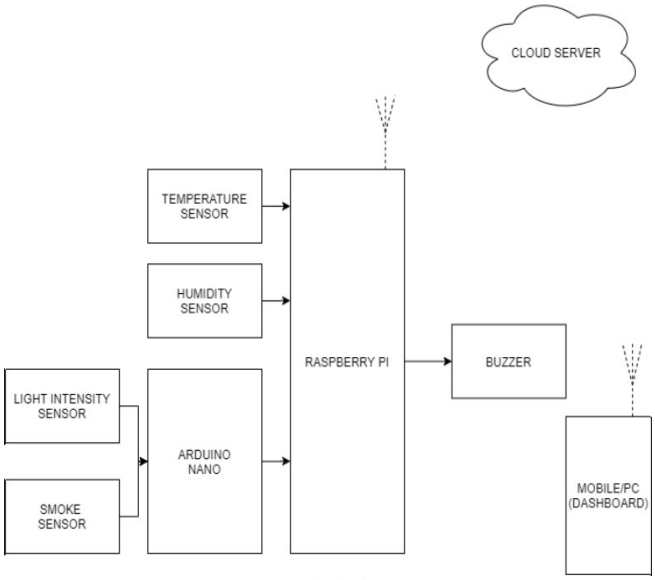


Fig 1. Block diagram

Raspberry Pi Board:

Raspberry Pi 3 Model B is an 85*56mm device belongs to third generation Raspberry Pi with ARMv7 processor. This powerful single board computer has more applications than Raspberry Pi Model B+ and Raspberry Pi 2 Model B. Wireless LAN and Bluetooth connectivity makes this model more ideal for designs. It consists of BCM2387 chipset, 1.2GHz Quad-Core Cortex-A53,1GB RAM,64 Bit CPU,802.11 bgn Wireless LAN and Bluetooth 4.1, 4 x USB ports, full size HDMI, micro SD port to load your operating system and to store data,4 pole Stereo output and Composite video port, and a micro USB power source.

This model is 10 times faster, we can run very powerful and bigger applications due to 1GB RAM, it enhances real world projects with the 40-pin extended GPIO, we can also store information and load operating systems using micro SD slot. Raspberry Pi can be connected via a USB Wi-Fi adapter or via Ethernet /LAN cable to the LAN.

Software:

The proposed system uses Amazon web services (AWS).It is a secure cloud services platform that offers functionalities like compute power, database storage and content delivery to help businesses grow and scale.AWS allows us to run web servers and application servers in the cloud to host dynamic websites. It stores all the files securely which can be accessed from anywhere. It uses databases such as MySQL, Oracle, PostgreSQL OR SQL server to store the data. It can also deliver static and dynamic files in a quick manner around the globe using a Content Delivery Network (CDN).

Python library is being used in this system for incorporating client-server model. The most widely used protocol in IoT projects is MQTT which stands for Message Queuing Telemetry Transport. This protocol is ideal for machine to machine communication due to its small size, low power usage, minimized data packets and ease of implementation. Based on PAHO-MQTT, MQTT client structure is used in this project that provides us an open source of different language libraries like C, JAVA, Python,.NET etc.

The client-server communication is done in an effective way in transmit-receive manner using this light weight protocol MQTT. Generally, any HTTP protocol uses the request/response architecture, whereas the MQTT doesn't follow this but uses a publish/subscribe architecture. Pub sub architecture is event driven where messages are pushed to the clients continuously and handles all the messages that are transmitted and received. When each client publishes a message to the broker, there is a topic included into the message. This topic gives routing information to the broker. Every client who wants to receive messages should subscribe to a specific topic. The broker then delivers the required messages with the matching topic to the respective clients. Topics are the base on which the client's communication is relied upon. The clients can very well communicate effectively without knowing each other. The transmitter and receiver are totally independent and thus the functionality is efficient. As the broker pushes the data continuously, there is no need for the client to request for the data every time. Hence each MQTT client must maintain a TCP connection to the broker. If the connection gets disturbed, there will be buffering of messages, which will be sent when the client is online again.

Topics are the main topics of MQTT. This protocol works as a tree structure which has different hierarchical levels. The topics define the different hierarchical levels which are separated by slash. The client can subscribe any data or even the entire subtree.

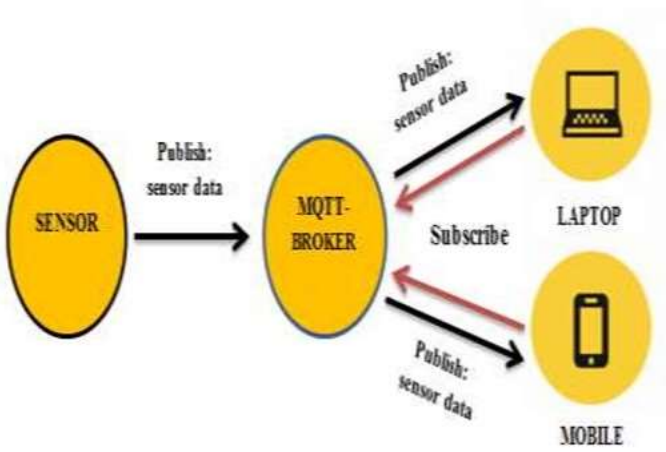


Fig. 2 Publish/Subscribe architecture of MQTT

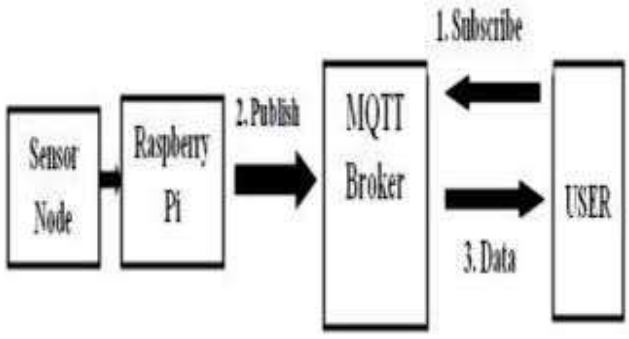


Fig.3 Communication model b/w user and server client using MQTT.

The figure above portrays the communication between the sensor clients that is the Raspberry Pi with Sensor node via MQTT with the user. When the user subscribes for a specific information, it is published through the MQTT broker accordingly.

Sensing Unit:

There are a total of 5 sensors in this system. The below table shows the desired specifications of the 2 air quality sensors. As the concentration of the gases differ or change, the conductivity of sensors varies. The information given in table 2 is about 3 sensors that measures temperature, light intensity, humidity and pressure. The system is reliable and contact due to the small size and low cost of sensors.

TABLE 1

AIR QUALITY PARAMETERS

Parameters Monitored	Operating Voltage	Measuring Range
Carbon Monoxide	5 Volts	10-10000ppm
Ammonia, Sulphide, Benzene, Smoke	5 Volts	10-10000ppm

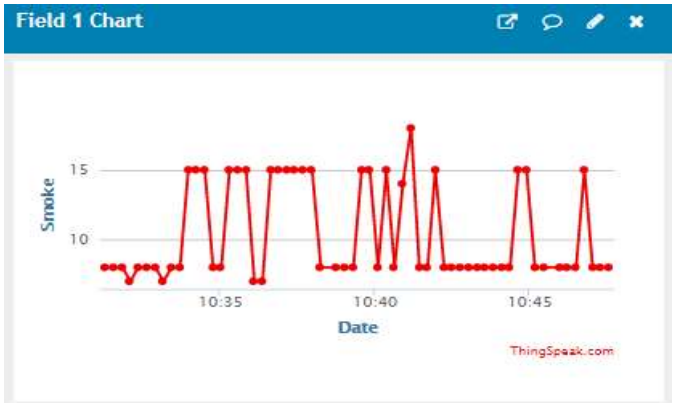
TABLE 2

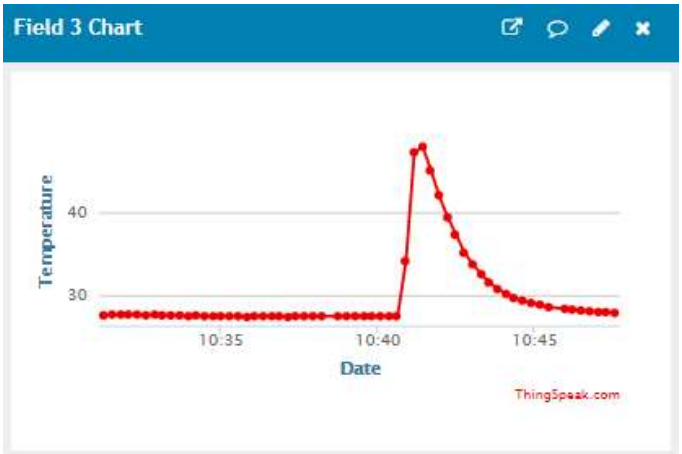
WEATHER PARAMETERS SENSING

Parameters Monitored	Operating Voltage	Measuring Range
Humidity	3.3-6 Volts DC	0-100% RH
Temperature	1.8-3.6 Volts DC	-40 to +85 degree Celsius
Pressure	1.8-3.6 Volts DC	300-1100hPa
Light intensity level	1.8-4.5 Volts DC	1-65535 lx

III. EXPERIMENTAL SETUP

The setup of the system can be seen in figure 1. All sensors are connected to the Raspberry Pi board, which in turn is connected to the Internet via Wi-Fi. The data is published to the cloud using MQTT protocol. The automatic graphs are generated for all the parameters shown via the dash board that in turn explains how these parameters are varying with respect to time. Figures shown below depict some of those graphs. Digital output can also be obtained in real time for various urban parameters and pollutants such as carbon dioxide, carbon monoxide, temperature, humidity and air pressure.





IV. CONCLUSION

The system is used to monitor data remotely and is portable, feasible and consumes less power which makes the monitoring of data easy. Another added advantage is the use of raspberry pi makes the system reliable. The system helps in providing better data related to pollution which in turns gives the citizens a better picture and help them improve their way of living. With the output being displayed in graphical form on the dashboard respective measures can be taken to control the increasing pollution levels. This system can be applied to find out the pollutants in an area that is considered to be overly polluted so that they can be controlled.

V. FUTURE SCOPE

The system bases on IoT bearing low cost empower giving feasible results. It makes the use of air quality better by detecting major pollutants like carbon dioxide, carbon monoxide, temperature humidity and air pressure to give detailed information about environmental condition. The system is very efficient and highly accurate. With this data, appropriate measures can be taken to regulate proper environmental conditions, for example, regulation of traffic, banning the use of firecrackers on any occasion, treatment of factory emissions, etc.

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