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IoT Based Supervision of Urban Climate Using Raspberry Pi

A R Aswatha, Thanusha K M, Shivangini Kant, R. Meenakshi* and Rashmi S. Shirolkar

Department of Telecommunication Engineering, Dayananda Sagar College of Engineering, ShavigeMalleshwara Hills, Kumaraswamy Layout, Bangalore-560078, India.

Corresponding author: *R. Meenakshi, Department of Telecommunication Engineering, Dayananda Sagar College of Engineering, ShavigeMalleshwara Hills, Kumaraswamy Layout, Bangalore-560078, India.

Abstract

Air pollution is one of the leading mortality causes in the world, contributing to 5 million deaths per annum. 9% of deaths worldwide are due to air pollution. This is one of the risk factors for the burden of illness, too. Through this project we use the Internet of Things to perform the task of measuring and curbing the pollutants in the environment. IOT is a network of physical objects comprising of embedded technologies for interacting and sensing or transforming man into computer or software for communication with machines. This paper focus on providing a complex datasheet on parameters of the city climate as a whole. Here we employ alowpower, lowcost, ARM i.e. uses raspberry pi in the network qualifies to communicate through an external Wi-Fi module or a Local Area Network (LAN). Python is the language used to program user commands at the Raspberry Pi end. In addition, Internet connected terminal devices such as laptops, cell phones etc. can be used to access the data. This operating system will be providing access to real- time data time data on urban\city environment that include toxic contaminants such as: carbon dioxide, carbon monoxide, and use the appropriate sensors to track air, temperature and humidity.

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

I.INTRODUCTION:

IoT stands for Internet of Things, which is the inter- networking of physical devices, vehicles, buildings, and other items with sensors, software, network communication and actuators that allow these items to collect and share information. IOT is one of the technology which is rising fastest. Internet of Things has big potential, additionally, the internet of things will benefit all types of industries by reinventing the industries. This framework has been recommended and designed for promoting people a decent quality of life, a safe and healthy environment. The resulting quality of life, a safe and healthy environment. The resulting IOT principle plays a critical role in helping to attain the project’s goal. Here IOT can help us take inputs in real-time and only give outputs in real-time to help create knowledge. The definition of IOT is a bit complicated because it includes many layers of data connections but the benefit is its simplicity that allow us to read, get information about the city environment with the aid of internet Here we program a Python-language in tandem with a number of sensors that as a whole allow data to help us track and build awareness about climate change.

The sensor is a type of system that detects certain feedback obtained from physical environment and then responds accordingly. The input can he heat, light, sound, moisture, movement and other environmental factors, in any shape. Then on the collected data, the sensorsy stemper forms some processing and produces an output in a human-readable form.

There are different types of sensors which have different types of applications in everyday uses. The sensors rely on certain physical phenomena such as resistance, conductivity, temperature, heat transfer, capacitance etc. This machine therefore includes Raspberry Pi, Replay Board, LCD, Humidity sensor, Light intensity sensor, Sir quality sensor, Arduino Nano, HDMI, LAN, Power supply, USB modem, Adafruit server,MQTT.

II.METHODOLOGY

Hardware:

This system helps all the wireless sensor networks that will remain valid and use the data to improve the accuracy in the urban environment. The model users find ways to test innovative concepts and improve the environmental situation of their community. There are many sensors used in this system, like, temperature, humidity, pressure, MQ135,MQ7,lightintensitysensorset together various values given as outputs from various sensors and send it to the microcontroller which in turn logs and sends the data to the server as shown in the figure below.

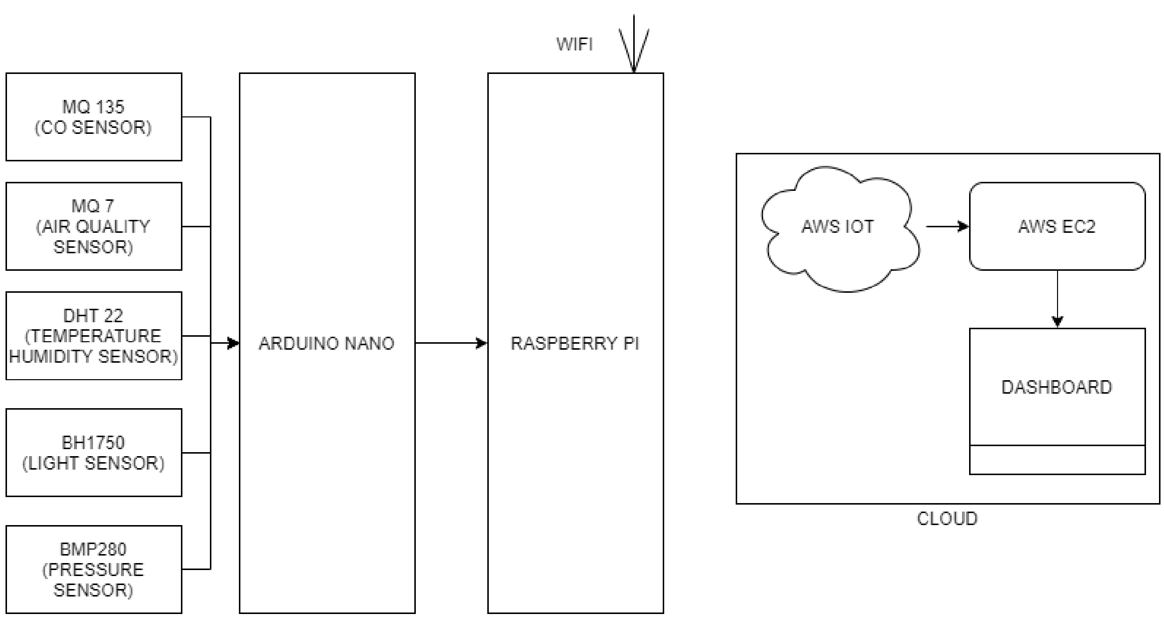

Fig.1. Block Diagram of proposed system

The figure depicts all the sensors connected to the raspberry pi. The light intensity sensor,pressure sensor, temperature and humidity sensor, airquality sensorand CO sensors are connected to the Arduino nano first and then to the raspberry pi where analog output to the nano is converted to its digital value by the analog to digital convertor. Hence, all the sensor outputs given to the raspberry pi as inputs must be digital values which then using MQTT, concept helps establishing communication between the sensors and the raspberry pi. The cloud comprises of AWS IoT, AWS EC2 and dashboard. The web server used is Amazon Web Services (AWS).

The data from raspberry pi is sent to the AWS EC2. AWS EC2 is the used to host the web server. MQTT which implements publish/subscribe concept, the user who wants to access the data is required to subscribe to the particular topic on AWS EC2 and the information is sent continuously to the user who has subscribed to it.The values noted by the sensors can be viewed on the dashboard as all of this is stored in the cloud.

Raspberry Pi Board:

Raspberry Pi 3 Model B is an 85*56mm device belongstothirdgenerationRaspberryPiwithARMv7 processor. This powerful single board computer has more applications than Raspberry Pi Model B+ and RaspberryPi2ModelB.WirelessLANandBluetooth connectivity makes this model more ideal for designs. It consists of BCM2387 chipset,1.2GHz Quad-Core Cortex-A53,1GB RAM,64 Bit CPU,802.11bgn 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 Compositevideoport,andamicroUSBpowersource. The Raspberry Pi 3 Model B uses a Broadcom BCM2837SoCwitha1.2GHz64-bitquad-coreARMCortex-A53processor, with 512 KiB shared L2cache. The Model A+ and B+ are 1.4GHz.

The RaspberryPi3, with aquad-core ARM CorteA53 processor, is described as having ten times the performance of a RaspberryPi1. Benchmarksshowed the Raspberry Pi 3 to be approximately 80% faster than the Raspberry Pi 2 in parallelizedtasks.

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). The service used here is IOTcore.

AWS EC2, The cloud has resizable compute capacity which is secure. This is amazon EC2.It stands for Amazon Elastic Cloud Compute. This EC2 makes the work of developers very easy. The web service interface of EC2 very smoothly allows us to configure and obtain the capacity. The Amazon EC2 in one of the leading infrastructures in providing cloud service.

Operating system used is Raspbian, Raspbian is a Debian- based computer operating system for Raspberry Pi. There are several versions of Raspbian including Raspbian Buster and Raspbian Stretch. We will be using Raspbian Buster Lite for this particular project. It’s stable and robust, and certain security changes have made Buster hard to hack.

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. Pubsub architecture is event driven where messages are pushed to the clients continuously and handles all the messagesthatare 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.

Nodered, IoT is built using nodered. Node-Redisanew and an interesting programming tool for interconnecting the hardware devices, APIs (Application Program Interface) and online services. It brings together both the physical and digital events that make up the Internet of Things. The three basic types of nodes are, inject node, which is used to allow triggering of flows manually and injection of events at regular intervals of time. Debug node, shows content of object, message orp ayload. Template node, shows the output on the basis of moustache template

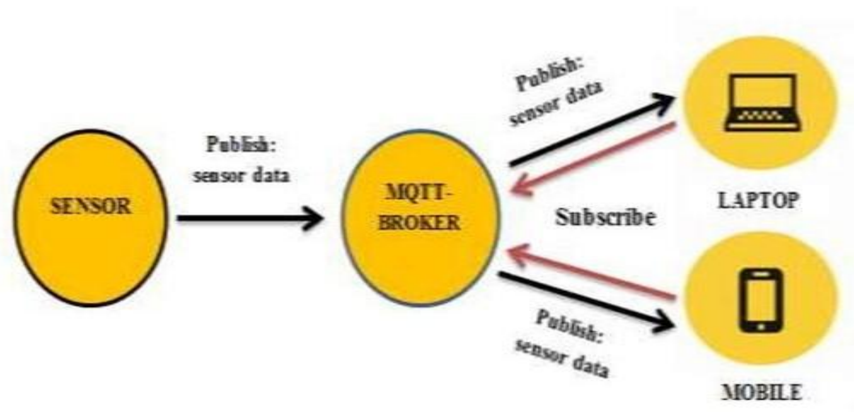

Fig. 2. Publish/Subscribe architecture of MQTT

The figure above portrays the communication between the sensor clients, that is the Raspberry Pi with Sensor node via MQTTwiththeuser.Whentheusersubscribesforaspecific information, it is published through the MQTT broker accordingly.

Internet of things is built using Node-RED.

Node-Red is a new and an interesting programming tool for interconnecting the hardware devices, APIs (Application Program Interface) and online services.
It brings together both the physical and digital events that make up the Internet of Things. The advantages of Node-RED are:

- It is very simple to extend new capabilities and different types ofintegration.
- We can get an application compositionexperience.
- It is easy to use for simple tasks. It is capable of creating back-end glue between socialapplications.

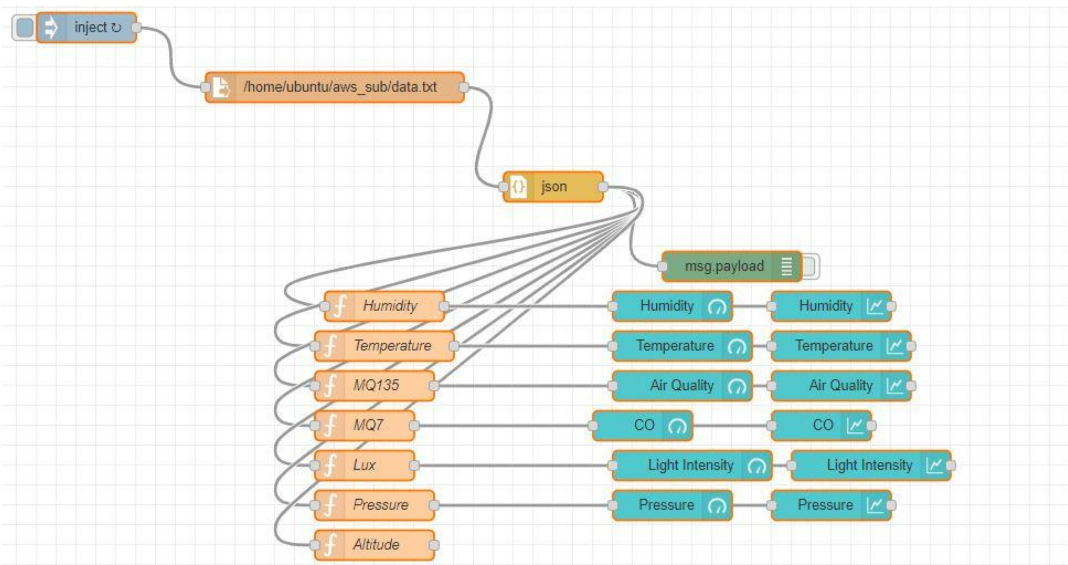

Fig.3. Flow formed using Node-RED

III. HARDWARE INTEGRATION- PROJECT SETUP:

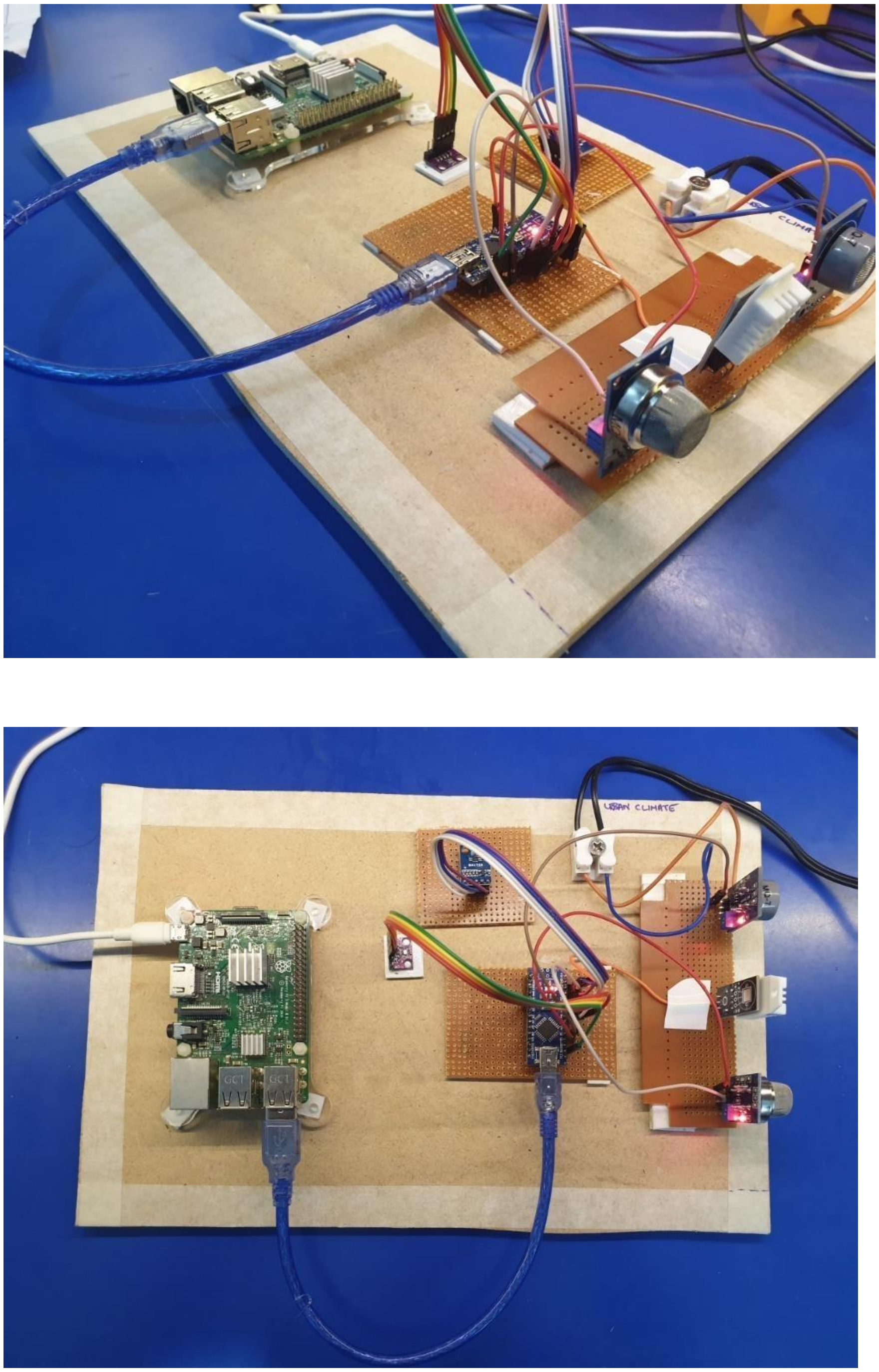

Fig.4. Hardware Integration Component Set-up (top and side view)

IV.RESULT

This is the Node-RED Dashboard which displays instantaneous data in the form of histogramandchartsreadfromthesensors,namelyDHT22,BMP280,BH1750,MQ7,and MQ135sensors.

We can see the information related to Humidity, Temperature, Pressure, Carbon Monoxide, Air Quality and Light Intensity.

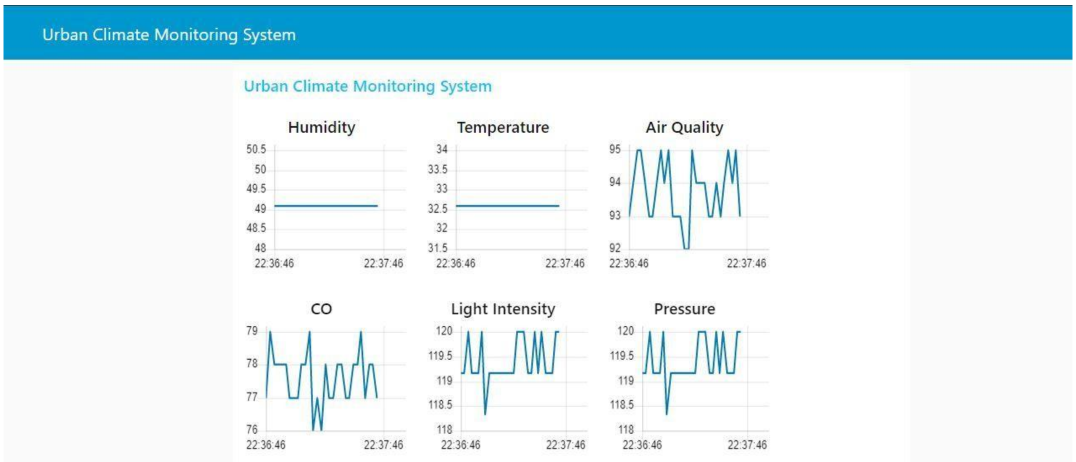

Fig.5. Dashboard View (Graphical monitoring over a period of time)

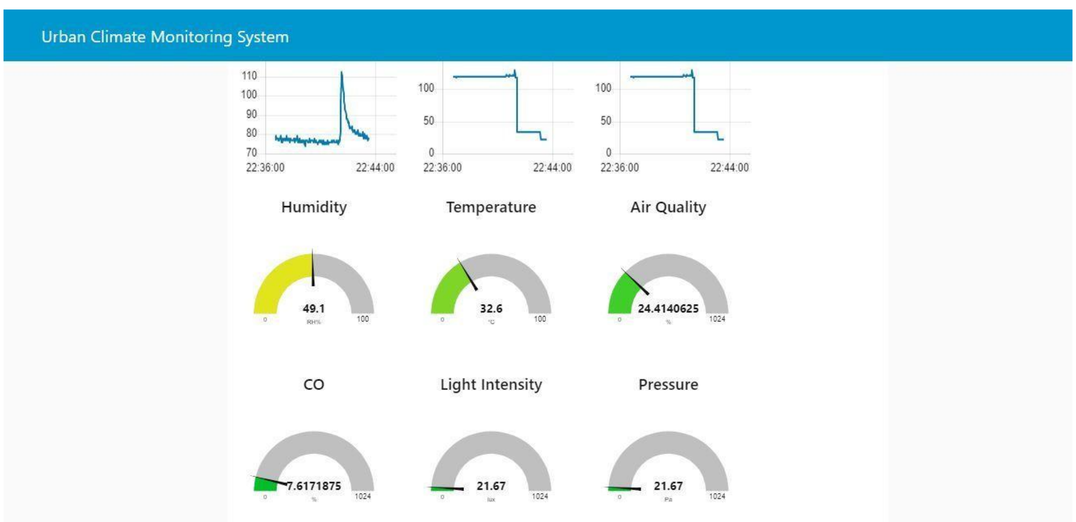

Fig.6. Dashboard View (Digital Values)

Fig.7. Overall Dashboard View part1

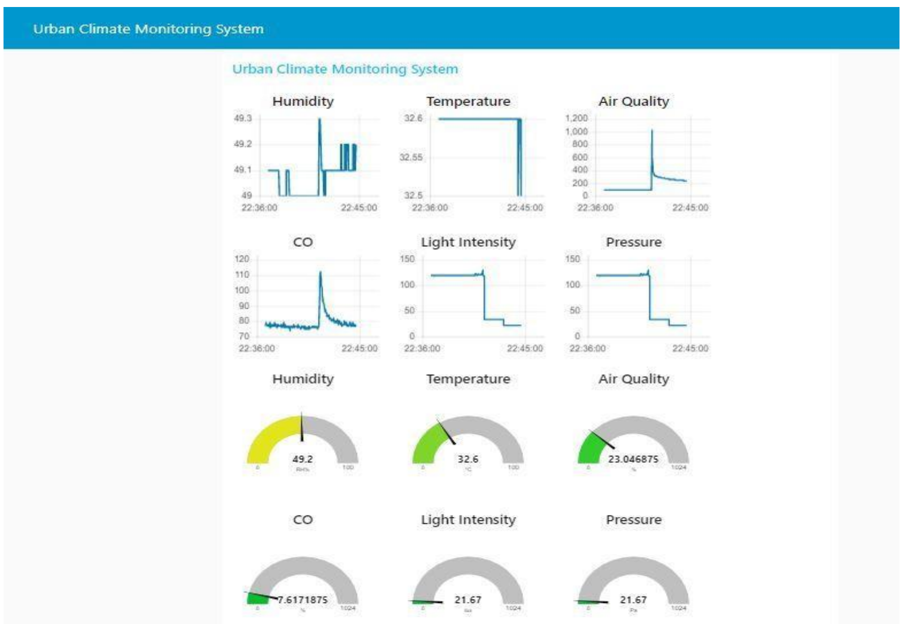

Fig.8. Overall Dashboard View part2

V.CONCLUSION:

The understanding from this study will, in the future, contribute to a number of other research opportunities, such as optimal urban network design, advanced sensor systems in smart cities and any micro-climate work. This work would assist Environment Departments, Urban Planning Authorities etc. in formulating their smart city policies. The proposed system provides the remote monitoring data witha lightweight, low power, and low-cost system. The use of the low-cost Raspberry Pimini-computer makes it powerful and effective. The program allows the city to expand sustainably and enhances people's lives. The ubiquitous availability of dynamic datasheets on the dashboard and the graphical representation from time to time will help to prepare control measures against increasing levels of pollution and build awareness among the people. The system is very hardware efficient and effective, since the sensors used are highly accurate. With the help of this data, appropriate steps can be taken timely to regulate the deteriorating environmental conditions.

VI.FUTURESCOPE:

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, banningtheuseoffirecrackersonanyoccasion,treatmentof factory emissions, etc.

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