A Raspberry Pi Controlled Cloud Based Air and Sound Pollution Monitoring System with Temperature and Humidity Sensing

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***Abstract*— In recent day scenario, the incessant increase in air and sound pollution prove to be an alarming problem. It has become mandatory to control and appropriately monitor the situation so that the required steps to curb the situation can be undertaken. In this project, an IOT-based method to monitor the Air Quality Index and the Noise Intensity of a region, have been proposed. The recommended technology comprises of four modules namely, the Air Quality Index Monitoring Module, the Sound Intensity Detection Module, the Cloud-based Monitoring Module and the Anomaly Notification Module. Firstly, the Air Quality Index is measured considering the presence of the five criteria air pollutants. Then the sound intensity is detected using respective sensor. After that, the Cloud-based Monitoring Module ensures the process of acquiring the data with the help of Wi-fi-module present in Raspberry Pi which fulfils the objective of analysis of information on a periodical basis. Finally, the Anomaly Notification Module alerts the user in case of an undesired condition.**

Keywords—Raspberry Pi 3B; MQ -135; LM 393; Air Quality Index;Sound Intensity.

I. INTRODUCTION

Air and sound pollution is a growing issue these days. It is necessary to monitor the air and sound pollution levels to ensure a healthy and safe environment. With the rapid increase in infrastructure and industrial plants, environmental issues have greatly influenced the need of smart monitoring systems. Due to its low cost, high efficiency and versatility, Internet of Things (IoT) has become very popular now these days. Internet of Things (IoT) allows interaction between devices and humans. It forms a communication medium from human to machine. Previously, data collectors had to travel long distances to the various locations to collect data after which the analysis was done. This was lengthy and time consuming. But now, sensors and microcontrollers connected to the internet can make environmental parameter monitoring more flexible, accurate and less time consuming. When the environment merges with sensors and devices to self -protect and self - monitor it forms a smart environment. Embedded intelligence makes the environment interact with the objects. In this model, we are using a Raspberry Pi 3B microcontroller, which will have gas sensors and noise sensors connected to it, to monitor the fluctuating environmental parameters.

II. RELATED WORK

First, L.Ezhilarasi et al. have proposed a monitoring technique using a Zigbee wireless sensor network to monitor the various environmental parameters. It uses RFID means to store and retrieve data through electromagnetic transmission to an RF integrated circuit. The WSN gateway method is used to conveniently collect the data at any time and place. [1]

Mahantesh B Dalawai et al. in their paper have used a GPRS/GSM module and a web server to efficiently monitor the various pollution levels. In the module the smoke sensor and noise sensor will upload the data to the server or cloud at every instant of time so that the pollution level can be monitored using the internet. [2]

Arushi Singh et al. have proposed a system which uses air and sound sensors to monitor the data constantly and then transmit the data. A raspberry pi module interacts with the sensors and processes the data thereby transmitting it to the application. [3]

Dr. A Sumithra et al. have proposed the concept of a smart city. Technology and communication is the basis of this smart city. Various sensors and modules have also been used to monitor the various environmental parameters. This system uses air and sound sensors to monitor the data and then upload the data on the cloud server as digital data. The cloud storage managers analyze the data and notify accordingly. [4]

Mohannad Ibrahim et al. have proposed the design of a cost effective environmental monitoring device using Raspberry pi. The information is collected by the sensors and uploaded to the internet where it could be accessed anytime. The system was found to be accurate in terms of measuring humidity, temperature etc. [5]

Giovanni B. Fioccola et al. have proposed Polluino, an Arduino based air pollution monitoring system. The data is

then uploaded to a cloud based platform which manages the data coming from the sensors. [6]

SRM. ArthiShri et al. have proposed the idea of monitoring the parameters using a PIC microcontroller which senses the atmosphere signals. Gas sensors are used to measure the pollution level. This data is uploaded on the internet and can also be viewed through an app. [7]

Seung Ho Kim et al. have designed a monitoring system that uses an environmental parameter analyzer and sends the results in a server through a LTE communication network. The resulted data was compared with the data obtained by the National Ambient air quality Monitoring Information System (NAMIS). [8]

Somansh Kumar et al. have given the idea of a real-time air quality monitoring system including various parameters like P.M. 2.5, CO2, [9]

III. Sensors and Modules Used

A. LM393 Sound Sensor

In this project, to monitor the sound pollution, a sound sensor, LM393 is used. This device consists of two independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies also is possible if the difference between the two supplies is 2 V to36 V, and VCC is at least1.5 V more positive than the input common-mode voltage. When sensor detects sound, it processes the output signal voltage which is sent to Raspberry Pi which again performs the necessary processing required for monitoring the parameter.

Fig. 1. LM393 Sound Sensor

B. MQ135 Gas Sensor

In this project, to monitor the air pollution and to determine the air quality index, a gas sensor, MQ135 is used. MQ135, gas sensor operates at 5V voltage and 40 mA current. It efficiently detects the Nh3, NOx, smoke and CO2 level in air. This sensor is chosen for its wide detecting scope, fast response, high sensitivity, stable and long life and lastly, a simple drive circuit. It is used in air quality monitoring devices in buildings and homes.

Fig. 2. MQ135 Gas Sensor

C. DHT11 Temperature and Humidity Sensor

DHT11 is a humidity and temperature sensor. It can be used to monitor the temperature and humidity levels in a region. It can be interfaced with a Raspberry Pi module and can give immediate results. In this project, we are using this sensor to monitor the varying humidity and temperature levels.

Fig. 3. DHT11 Temperature and Humidity Sensor

D. Raspberry Pi Model 3B

In this project we are using a Raspberry Pi 3B module. It is an ARM based credit card sized SBC (Single Board Computer) created by Raspberry Pi Foundation. A Wi-Fi and Bluetooth module is already present in the Raspberry Pi 3B. Using this module, we can send the acquired converted digital counterparts of the parameters, over the internet, to a Cloud based storage area. The saved data is not only used for monitoring purposes, but for analyzing the information acquired, on a periodical basis.

Fig. 4. Raspberry Pi Model 3 B

E. GPRS Module

It stands for Global Packet Radio Service. It is used to establish a communication channel between the computer and GPRS/GSM system. It is an advanced version of the GSM module which enables high data transmission rate. It requires a SIM (Subscriber Identity Module) to activate a connection with the device. In this project we add the GPRS system to the Raspberry Pi module to connect to the internet using mobile data.

Fig. 5. GPRS Module

IV. METHODOLOGY

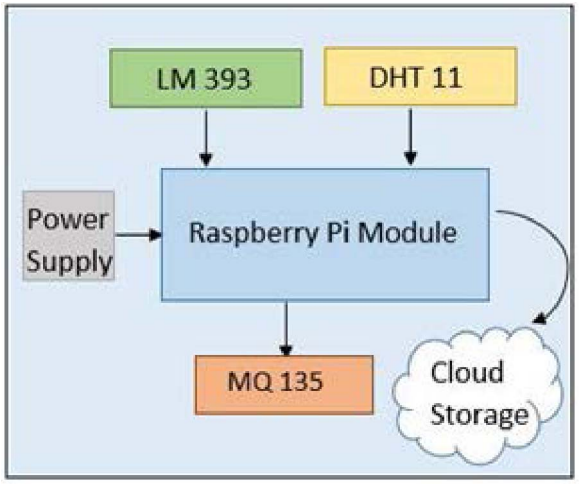

Fig. 6. Block Diagram of the System

A. Air Quality Index

It is a value that is communicated by the government to the public as to how polluted the environment is or will become. As the AQI increases, various health hazards come up. The AQI can be computed by calculating the average pollutant concentration over a specified period. The formula for calculating AQI is,

$$I = \frac{I_{high} - I_{low}}{C_{high} - C_{low}}(C - C_{low}) + I_{low}$$

I= Air Quality Index
C= The Pollutant Concentration
C_{low}= Concentration breakpoint that is ≤ C
C_{high}= Concentration breakpoint that is ≥ C
I_{low} = Index breakpoint corresponding to C_{low}
I_{high} = Index breakpoint corresponding to C_{high}

The air quality index and its impact on health as prescribed by the government is given below with proper color code

TABLE I. AIR QUALITY INDEX, HEALTH IMPACT AND COLOR CODE

Air Quality Index	Health Impacts	Color
Good (0-50)	Minimal Impact	
Satisfy (51-100)	Mild Breathing Distress	
Moderately Polluted (101-200)	Breathing Distress and discomfort to people with heart disease	
Poor (201-300)	Breathing discomfort to people on prolonged exposure	
Very poor (301-400)	May cause respiratory illness	
Severe (401-500)	Severe respiratory impact on people with lungs and heart disease	

B. Noise Pollution Level

Noise pollution has the most harmful impact on human or animal life. Noise pollution generally occurs due to the sound coming from honking cars, industries, factories, heavy machinery etc. Certain noise standards are prescribed by the government that need to be maintained.

TABLE II. STANDARD NOISE LEVEL LIMIT IN DIFFERENT AREA

Code	Area	Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

The objective of our work is monitoring the air quality of a region and the detection of noise intensity to curb the problem of sound pollution. The proposed method involves cloud based monitoring of the required parameters with the help of internet. The alert system ensures that the user is notified about any unfavorable condition which demands instant action.

The proposed model consists of the following modules, namely, the Air Quality Index Monitoring Module, the Sound Intensity Detection Module, the Cloud-based Data Monitoring Module and finally the Anomaly Notification Module.

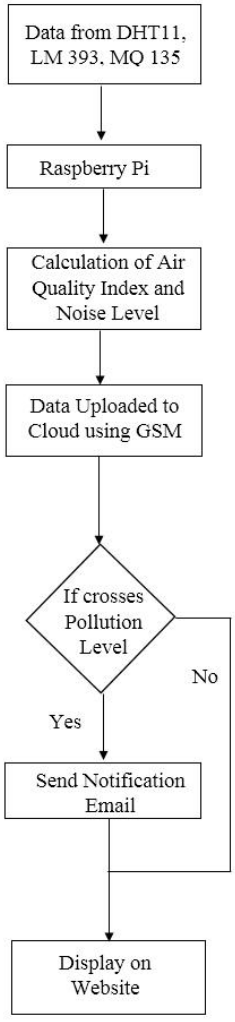

Fig. 7. Data Flow Diagram

1) Air Quality Index Monitoring

Air Quality Index is measured depending on five criteria pollutants, namely, ground-level ozone, particulate matter, Carbon monoxide, Sulphur Dioxide and nitrogen dioxide. In this project we are using MQ -135 AIR QUALITY or GAS DETECTION SENSOR. It efficiently detects the NH_3, NOx, smoke and CO_2 level in air. This specific sensor is chosen for its expansive detecting scope, fast response, reliability and long-term stability.

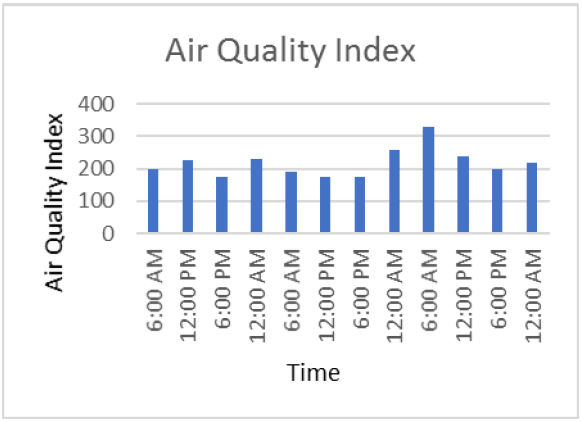

Fig. 8. Air Quality index at a fixed Position for 72 hours

2) Sound Intensity Detection

LM393 Sound Detection Sensor is utilized to measure sound intensity with the motive to monitor Sound Pollution in an area. When sensor detects sound, it processes the output signal voltage which is sent to Raspberry Pi which again performs the necessary processing required for monitoring the parameters.

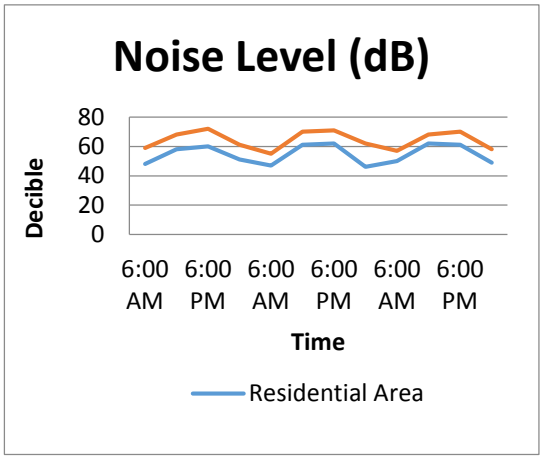

Fig. 9. Noise level in Decibel in two different places for 72 hours

3) Humidity and Temperature Detection

DHT11 Sensor is utilized to measure humidity and temperature in an area. The sensor detects the humidity levels and processes the output signal voltage, which is sent to the Raspberry Pi module. A simple python script has been implemented to read, display and send the reading to cloud.

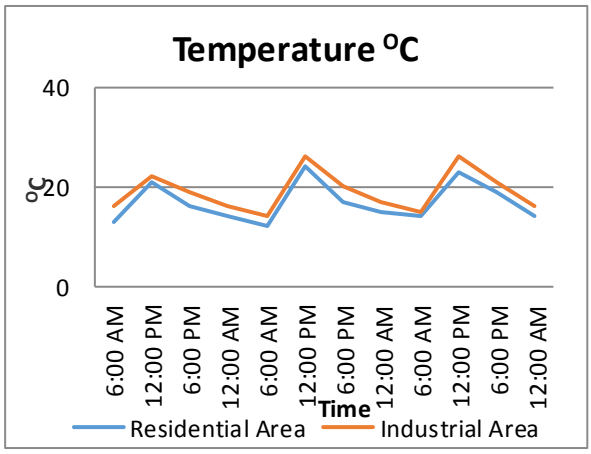

Fig. 10. Temperature of two difference places for 72 hours

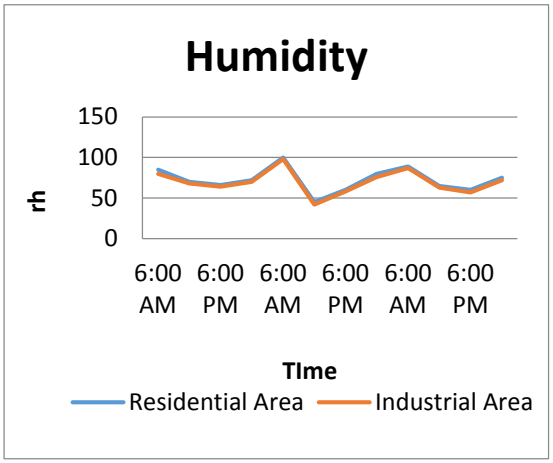

Fig. 11. Humidity of two different places for 72 hours

4) Uploading Data to cloud

For the incorporation of the cloud system we need internet access. We have added a GSM module to the system, so that the system can connect to the Internet using the mobile data. According to our needs we need to subscribe to a plan for the SIM we will be using in the GSM module.

We have a Wi-Fi module present in the Raspberry Pi 3B. Using this module, we also can send the acquired converted digital counterparts of the parameters, over the internet, to a Cloud based storage area. The saved data is not only used for monitoring purposes, but for analysing the information acquired, on a periodical basis.[10][11]

5) Anomaly Notification

It acts as an Alert System. In the Raspberry Pi IDE, we use control statements for the incorporation of anomaly notification. If one of the parameters exceeds the desirable range of its digital value, steps are taken to send an E-mail and SMS to the specific authorities involved. Inside the control statement we give the proper mail body or SMS body, which needs to be addressed for an anomaly. Thus, when any such anomaly occurs, addressing is taken care of, by the system itself.

V. CONCLUSION

Humans are considered responsible for this polluted and dangerous environment. This is a major concern for the whole world. Thus, a smart way to monitor the various environmental parameters using a Raspberry Pi module has been discussed in this paper. The concept of IoT helps improve the quality of air, monitor the level of noise, temperature and humidity [12][13].It is a low-cost, precise and efficient method of monitoring. The monitoring of accumulated data in the cloud storage helps to analyze the various patterns in the environmental parameters and accordingly notifies the public.

VI. FUTURE WORK

Many possible solutions have been highlighted in this paper, as to how we can monitor air and sound pollution levels along with humidity and temperature using Internet of Things. Our proposed model gives us real -time data so that we can analyze the environmental parameters. We would like to implement the concept of machine learning soon so that we can forecast the possible environmental data. It gives an estimate of the upcoming weather conditions and creates an awareness amongst the public.

VII. REFERENCE

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