IRO Journal on Sustainable Wireless Systems (ISSN: 2582-3167)
www.irojournals.com/irosws/

Real-Time Air and Sound Pollution Monitoring System

Prakash J, Manigandan S, Nitya Narayanan, Raaja Vignesh S, Guru Prasath M, Shyam Sunthur

Dept. of Computer Science and Engineering, PSG College of Technology, Coimbatore, India.

E-mail: [1]jpk.cse@psgtech.ac.in, [2]manisaravanan11@gmail.com, [3]ninarayanan98@gmail.com, [4]iamraajavigneshs@gmail.com, [5]shyamsunthur99@gmail.com

Abstract

With the growing industry sectors, there is a huge increase in air pollution, and it is becoming a serious issue in the society, due to which most governments in the world have deployed many methodologies to monitor the daily air quality. Monitoring pollution levels is essential to ensure that people do not develop respiratory or pollution-related illnesses because, as a developing country like India, pollution can lead to environmental degradation. Monitoring and forecasting of air quality has also become an important issue to improve the quality of people's lives as many people have started to take advantage of this situation and build devices such as air purifiers and other end-user products with regards to providing comfort to users with diseases caused by pollution such as Lung Cancer, Stroke, Ischemic Heart Disease and etc. Air and sound pollution dashboard is a tool that helps people to visualize the data collected from sensors. In this research, a solution is provided to monitor the air and sound pollution levels in indoor environments by using wireless technology and Android-based application for upbringing a versatile dashboard. Air quality can be measured using relevant pollution indicators such as humidity level, temperature level, dust level, CO level, smoke level, etc. The main motive of the Pollution Monitoring System is to make it possible to monitor and check data points and insights to quality in a particular area through IoT using Arduino.

Keywords: Menu Module, Login Module, Register Module, Display Chart Module, Sensor Statistics Module, Indicator Level Module, Sensor Value Change Module.

1. Introduction

Pollution is the introduction of contaminants into the natural environment that cause adverse change to it and cause harmful effects to various organisms. Pollution can be of various forms like air, water, noise, heat, or light. Pollution if not identified and reduced, its effect will be adverse. As per record in 2015, pollution has killed 9 million people worldwide. The most

DOI: https://doi.org/10.36548/jsws.2023.1.002
Received: 10.02.2023, received in revised form: 10.03.2023, accepted: 25.03.2023, published: 06.04.2023

common form of pollution is air pollution. The Internet of Things (IoT) provides a huge platform to work in a domain where there is a never-ending improvement to functionality and power of consumer electronics and sensors. Since the birth of smart cities, many people increase their quality of life and provide a communication infiltrated environment. Hence, IoT has helped with aspects that come with the consequences of industrial growth i.e., monitoring air and sound using dashboards. Ideally, this interconnected community of monitoring systems can be accessed by any computing device that has a chip through which it can connect to the Internet. Pollution has come under the radar for being the sole reason of inducing various diseases. In recent years, pollution especially air pollution has increased exponentially and thus increasing toxic gases in environment. Gases like carbon monoxide (CO is colorless and odorless), smoke, and dust can be commonly found which are not only harmful for humans but also for pets and plants; so, there is a need for pollution monitoring system which monitors these toxic gases along with humidity, temperature and sound and take necessary action for healthy living [5],[6].

The proposed system has three main modules which work in tandem. Firstly, an ESP8266 Wi-Fi module [8] and sensor modules in an Arduino UNO Microcontroller board. Secondly, the data from the sensors that is to be sent to the cloud for further computation. Finally, the data from the cloud which would be updated into an Android application in the form of a dashboard. The data provided in the app can be visualized by the user in his/her preferred way. Embedded Computing is a vital part of this work as sending data through the Internet requires modification and processing Wi-Fi Commands and their parameters; hence, this research focuses on Embedded Technology, which is part of IoT. Devices in the mesh of an IoT platform should be able to take appropriate actions to the influx of data coming from monitoring systems. Air and sound monitoring systems provide provision to acquire data from within neighboring environments and account for that data in a dashboard to end user. This system shows the results of the monitoring system in a real time environment.

2. LITERATURE SURVEY

The system mentioned in [1] considered air quality as the main parameter to be measured. It also measured temperature and humidity. For measuring these parameters, IoT takes a major role of assembling data from electronic sensor and system is designed to transmit the sensor generated data and store it in cloud so that the information can be analyzed in different applications. The drawback of this work is that the alert signal does not depend on

ThingSpeak, but on Arduino; as soon as the sensor picks its data, the signal is produced. The system used primitive version of Wi-Fi module.

In [2], the authors discussed IoT platform -based system on ThingSpeak and Arduino which was developed and tested to meet the needs of farmer to control the irrigation by using a computer or smart phone from anywhere anytime, by monitoring the water parameter. This reduces farmers need for physical presence and it also allows farmers to use the water optimally. It takes sensor value on soil condition, water level, and it also imports data from weather which helps farmer to decide on whether to irrigate or not. The main drawback is that it does not speak about the safety of sensors that are deployed in extreme condition on field, however it is not mentioned how to protect these components or about the safety measures to be taken for deploying these components.

Research work in [3] was designed to monitor the quality of air and noise in any environment. The model was built using Xmega 2560, AVR UNO, sensors, MATLAB and supporting packages. Wi-Fi module, temperature, humidity, gas, and dust sensors were interfaced with the Xmega 2560. The sensor data was collected and matched with API key and finally displayed in the channel. The drawback in this work is that sensors used were high end sensors and hence their durability is low.

The proposed model in [4] used air sensor MQ2 to detect the presence of harmful gases in the air and used the sound sensor module to detect the sound level in the surrounding. The sensors detected air pollution, and transmitted data through a remotely located Wi-Fi modem by the Arduino after processing, and a buzzer immediately beeps. While detecting noise pollution, the same process is carried out and the LED blinks. The draw back in this work is that the system components and construction are not given in detail.

3. METHODOLOGY

The main motive of this work is to obtain data from sensors, store it in an IoT friendly cloud, and transfer cloud data to a mobile application for end user access. The flowchart below shows the events that take place in order to implement the air and sound monitoring system.

Basic architecture used in this research consists of sensors that are attached to an Arduino board. Using a serial communication interface and Wi-fi module, data collected from sensors is sent to a cloud through the internet. This data can go through several more steps so

as to become more refined and can be carried to an Android application through native APIs provided by Application Development platform [10].

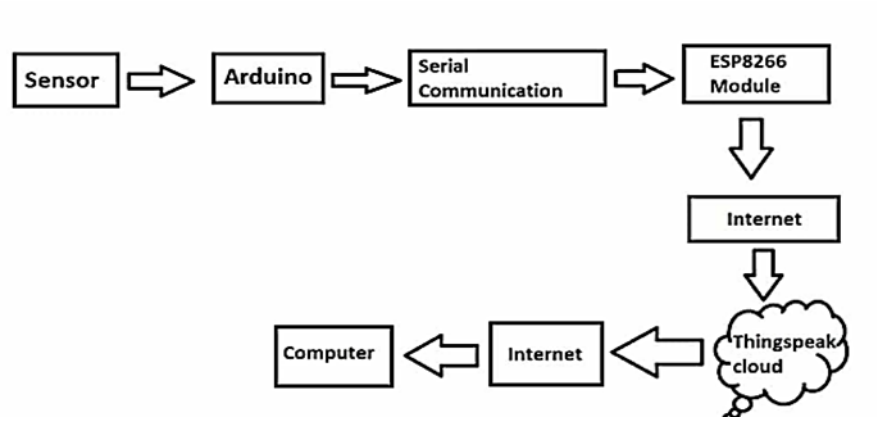

Figure 1. Architecture of the proposed system

3.1 ESP8266 Microcontroller with Wi-Fi Module

ESP8266 is a Wi-Fi system on chip and provides full internet connectivity. It has been used as an external Wi-fi module and uses AT Command set firmware by connecting it to a microcontroller using UART communication.

3.2 Sensors

Sensors incorporated are Big Sound, Dust (GP2Y1010AU0F), Temperature and Humidity (DTH11), Carbon Monoxide (MQ-7), and Smoke (MQ-135).

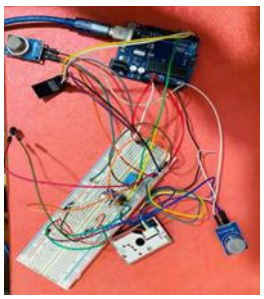

Figure 2. Sensor Connections

4. EXPERIMENTAL SETUP

The software specifications required to build the system is ThingSpeak Cloud platform, which is used for sending and extracting the sensor data. Arduino 8.1 IDE is used for configuring Arduino, sensors and ESP8266. Android studio is used for creating Android application that import data from ThingSpeak cloud and display it to the user. Firebase is used for authenticating android application user and to connect the app with database.

The hardware components required to build this system are as follows.

1. Arduino UNO
    - Operating Voltage: 5Volts
    - Input Voltage: 7 to 20 Volts
    - DC current per I/O pin: 20 mA
    - DC current for 3.3V pin: 50mA
    - Flash Memory: 32KB of which 0.5KB used by bootloader
2. Laptop
    - Windows 10
    - 8GB RAM
    - 64 bits system
3. Mobile Phone
    - Android 8.0
    - 64GB Storage
    - 4GB RAM
4. USB Cable
5. Dust Sensor
6. Big Sound Sensor
    - Voltage range: 4V-12V

- Low quiescent current drain: 4mA
- Current: 20mA (max), 11mA
- Voltage: 7VDC

7. DTH11 (Humidity and Temperature)
   - Operating voltage: 3.5V to 5.5V
   - Operating current: 0.3mA
   - Temperature Range: 0 degree Celsius to 50 degree Celsius.
   - Humidity Range: 20% to 90%
   - Accuracy: 1%
8. ESP8266 Wi-fi Module
   - 8Mbit external QSPI flash memory (1MByte)
   - 3.3V supply
9. MQ-7 Sensor
10. MQ-135 Sensor

5. IMPLEMENTATION ON THINGSPEAK

An IoT system provides an easy-to-use platform for retrieving and storing sensor data, along with providing several functionalities accessible through APIs. These services are used to distribute messages to end users, and ThingSpeak allows the same. The ThingSpeak's functionalities are built on a Matlab framework for analyzing and visualizing data. Sensor data is sent to the ThingSpeak cloud through a NODE MCU ESP8266 Wi-Fi module. This research discusses the environmental parameters associated with air such as temperature, humidity, smoke, dust, carbon monoxide and sound with variations within a particular location using data obtained from sensors and visualized through ThingSpeak [11].

5.1. Cloud

The data retrieved from the sensors in real time are uploaded to the cloud using ThingSpeak. A public channel with a required number of fields is created for this purpose. Data is represented in its respective field in the form of a graph.

5.2. Application

After data is sent to the cloud, this data can be accessed by Android applications through APIs, and it can be broadcasted to all networking devices connected in this IoT platform.

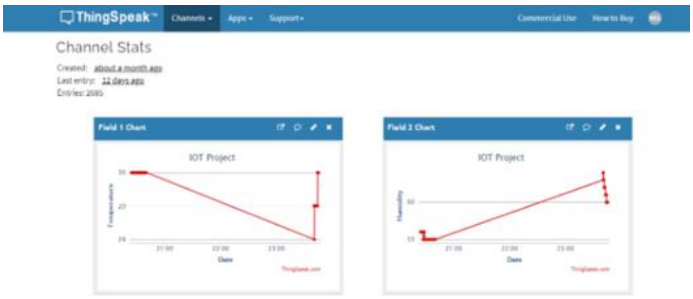

FIG 5.2- Thingspeak Channel(i)

Figure 3. ThingSpeak Setup

6. IMPLEMENTATION ON ANDROID STUDIO

An android application is developed which helps the user to have a private monitoring system. The application provides the following functionalities.

6.1. Register Module

A new user can register / create a new account. The application is supported with an authentication system developed using Firebase. It allows the user to have a private and

secure monitoring system. This functionality is implemented in the application using the Register credentials.

6.2. Login Module

The user after creating an account can return to the login page and enter the credentials for a secure access. The authentication is provided using Firebase. This helps in creating a private monitoring system

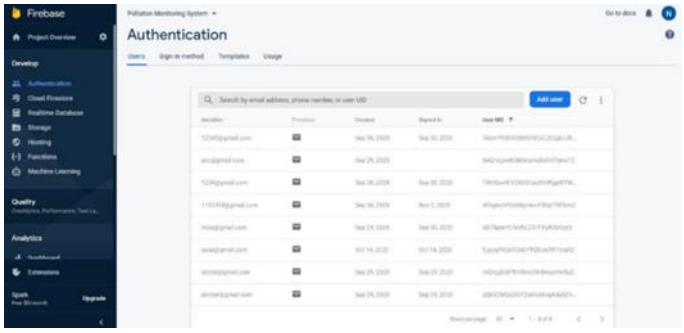

Figure 4. Authentication using Firebase

6.3. Display Chart Module

After a successful login activity, the application proceeds to the display page, where all the fields are displayed in the form of graphs. It also provides a Toast message stating the Login status. The Display page displays the different fields of data retrieved from the sensor in the form of graphs. The application allows the user to perform various actions on each data/sensor field. The user can click on a graph which proceeds to a menu page.

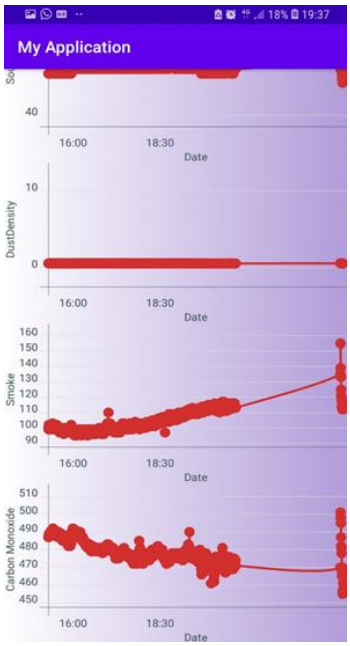

Figure 5. Chart Display module

6.4. Menu Module

The menu page displays the various functionalities that can be implemented on each field individually. The operations that can be carried out from the menu page are to check the sensor value change between two intervals, the sensor value indicator level, and sensor statistics which display an overall sensor level report. The logout option present in the menu page allows the user to return to the Login page.

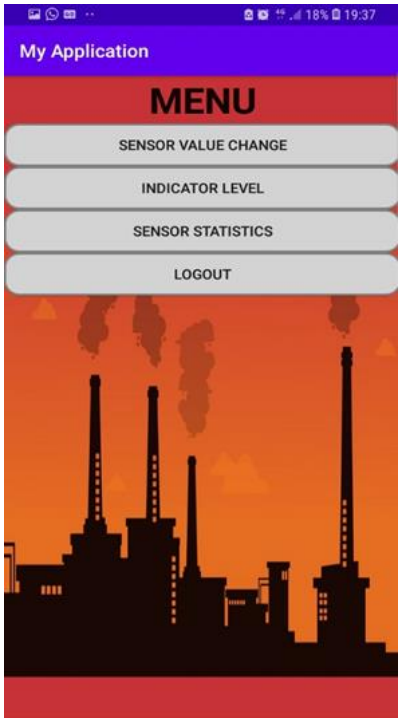

Figure 6. Menu Page

6.5. Sensor Value Change Module

This functionality allows the user to get the difference in values between two time periods. The user can manually select the start and end time, which results in display of the change between the sensor values during that period.

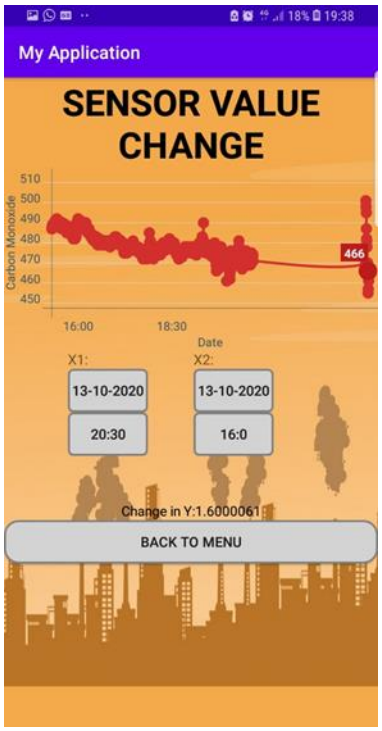

Figure 7. Sensor value change module

6.6. Indicator Level Module

This page displays the sensor level of the user specified point on the chart in terms of 'HIGH', 'NORMAL', and 'LOW'. Indicator level is found by Threshold values set by International Standards provided by Government organizations.

6.7. Sensor Statistics Module

This function displays various sensor level statistics based on the individual sensor data values. The sensor statistics like mean, median, mode, range, variance, and standard deviation are displayed for any time fed as input by the user.

Sensor Name	**Value Categories**		
	Low	**Normal**	**High**
Temperature	<20	20-25	>25
Humidity	<30	30-50	>50
Sound	<60	60-80	>80
Dust	<1.5	1.5-4	>4
Smoke	<100	100-400	>400
Carbon monoxide	<0.05	0.05- 1.12	>1.12

7. CONCLUSION AND FUTURE SCOPE

Pollution has been in talk for recent years and continues to be so for the upcoming years due to its exponential level in the world. Thus, the proposed pollution monitoring system being economical and user friendly, has the potential to become a common household system. This platform could be enhanced by making the application iOS friendly as well, so that the app can be installed in any device, irrespective of its operating system. Interoperability between different mobile platforms is crucial as clients of this mobile application could be using either Android or iOS. Allowing users to customize the system by allowing them to choose sensors from various available options according to their need can make another revolution in the market of air and sound monitoring systems. The air and sound pollution monitoring system is not void of challenges and opportunities of improvement. There are many issues concerning security, standardization, regulation, governance and many more that are capable of slowing

down the growth of the IoT system. Hence, measures must be taken to curate them. The system could also use a more versatile range of sensors that will give a wholesome picture of the pollution levels in a closed environment. Several other useful functionalities could also be added such that the user will get more insights from sensor data i.e., average sensor statistics from each day and much more. Since this system is an Internet of Things platform, it has a major advantage of incorporating other IoT supporting platforms into it. Hence, other IoT devices can act as actuators to sensor measured values and help in automating the IoT system to take measures. For example, if pollution levels jump arbitrarily high, the mobile application can trigger Amazon Alexa compatible air purifiers to turn on and adjust the power depending on the pollution level.

REFERENCES

[1] Mrs. Debapriya Parida, Asish Behera, Jagdish Kumar Naik, Soumyaranjan Pattanaik, Rajat Sekhar Nanda, "Real time environment monitoring system using ESP and ThingSpeak on Internet of Things platform", International Conference on Intelligent Computing and Control Systems 2019

[2] Hamza Benyezza, Mounir Bouhedda, Khaoula Djellout, Amina Saidi, "Smart Irrigation system based on ThingSpeak and Arduino", International Conference on Applied Smart Systems-2018

[3] Lalit Mohan Joshi ,"Research paper on IOT based air and sound pollution monitoring", International Journal of Computer Applications(Volume 178|| NO.7) – 2017

[4] Tanuja Borate, Meghalata Lipane, Madhuri Kale, Vaishnavi Pardeshi, Prof. Prashant Jawalkar, " IoT BASED AIR AND SOUND POLLUTION MONITORING, Open Access International Journal of Science & Engineering(Volume 3|| Issue 11)- 2018

[5] https://www.skyfilabs.com/project-ideas/latest-projects-based-on-ThingSpeak-

[6] https://www.hackster.io/ThingSpeak/projects

[7] https://www.electronicshub.org/connect-esp8266-to-ThingSpeak/

[8] https://electronics-project-hub.com/send-data-to-ThingSpeak-using-esp8266/

[9] https://www.youtube.com/watch?v=nMWwqcn7ofw

[10] https://www.instructables.com/id/ESP8266-IOT-Using-Arduino-and-ThingSpeak/

[11] https://community.ThingSpeak.com/tutorials/esp8266/building-the-internet-of-things-with-the-esp8266-wi-fi-module-and-ThingSpeak/

[12] https://iotdesignpro.com/projects/temperature-humidity-monitoring-over-ThingSpeak-using-arduino-esp8266

[13] https://thestempedia.com/tutorials/how-to-send-data-to-cloud-ThingSpeak-using-esp8266/