IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Special Issue-15, May 2019 E-ISSN: 2347-2693

Implementation of Web Based Environmental Pollution Monitoring System Using Raspberry Pi 3 Model

[1*]Aishwarya S, [2]Apoorva M J, [3]Divya Vani M, [4]Indushree S, [5]Prasanna Kumar M

[1,2,3,4,5]Dept. of Computer Science ,East West Institute of technology, Vishveswaraya Technological University, Bangalore, India

DOI: https://doi.org/10.26438/ijcse/v7si15.4348 | Available online at: www.ijcseonline.org

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.

Keywords **-** MQTT Protocol, Noise Pollution Level

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.We propose 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. Some of the Advantages

- Monitored Air and Sound pollution
- Ensures a healthy and safe environment

The project have an Objectives of:

- To design and develop the Air quality index module to measure the air quality index considering the presence of the five criteria air pollutants
- To design and develop the Sound intensity module to detect the sound intensity using the respective sensor.
- To design and develop the Cloud-based Monitoring Module to ensure the process of acquiring the data with the help of Wi-fi-module present in Raspberry Pi

MQTT Protocol

- The basic concepts of it is publish/subscribe and client/broker and its basic functionality is connect, publish, and subscribe. Also it has several good features like quality of service, retained messages, persistent session, last will and testament and SYS topics. MQTT decouples the space of publisher and subscriber. So they just have to know hostname/ip and port of the broker in order to publish/subscribe to messages.
- The broker is able to store messages for clients that are not online. MQTT is also able to decouple the synchronization, because most client libraries are working asynchronously and are based on callbacks or similar model. So it won't block other tasks while waiting for a message or publishing a message.
- But some libraries have synchronous APIs in order to wait for a certain message. MQTT is really the essence of pub/sub when using a client library and that makes it a light-weight protocol for small and constrained devices
- MQTT protocol used at session layer in IoT protocol stack. In order to utilize IoT paradigm, interconnected devices need to communicate using lightweight protocols which do not need extensive use of CPU resources. For this, C, Python, Java and MQTT scripting languages are preferable choices used by IoT applications. **Internet of Things**

- The Internet of Things is a novel paradigm shift in IT arena. The phrase "Internet of Things" which is also shortly well-known as IoT is coined from the two words i.e. the first word is "Internet" and the second word is "Things". The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite (TCP/IP) to serve billions of users worldwide. It is a network of networks that consists of millions of private, public, academic, business, and government networks, of local to global scope, that are linked by a broad array of electronic, wireless and optical networking technologies. Today more than 100 countries are linked into exchanges of data, news and opinions through Internet. According to Internet World Statistics, as of December 31, 2011 there was an estimated 2, 267, 233, 742 Internet users worldwide (Accessed data dated on 06/06/2013: from the Universal ResourceLocationhttp://www.webopedia.com/TERM/I/Internet.html).

This signifies 32.7% of the world's total population is using Internet. Even Internet is going into space through Cisco's Internet Routing in Space (IRIS) program in the coming fourth years (Accessed on 10/05/2012:

(http://www.cisco.com/web/strategy/government/sp ace-routing.html). While coming to the Things that can be any object or person which can be distinguishable by the real world. Everyday objects include not only electronic devices we encounter and use daily and technologically advanced products such as equipment and gadgets, but "things" that we do not do normally think of as electronic at all—such as food, clothing; and furniture; materials, parts and equipment, merchandise and specialized items; landmarks, monuments and works of art and all the miscellany of commerce, culture and sophistication. That means here things can be both living things like person, animals—cow, calf, dog, pigeons, rabbit etc., plants—mango tree, jasmine, banyan and so on and nonliving things like chair, fridge, tube light, curtain, plate etc. any home appliances or industry apparatus. So at this point, things are real objects in this physical or material world.

Analysis is the process of breaking acomplex topicor substance into smaller parts to gain a better understanding of it. Analysts in the field ofengineeringlook at requirements, structures, mechanisms, and systems dimensions. Analysis is an exploratory activity.The Analysis Phase is where the project lifecycle begins. The Analysis Phase is where you break down the deliverables in the highlevel Project Charter into the more detailed business requirements. The Analysis Phase is also the part of the project where you identify the overall direction that the project will take through the creation of the project strategy documents. Gathering requirements is the main attraction of the Analysis Phase. The process of gathering requirements is usually more than simply asking the users what they need and writing their answers down. Depending on the complexity of the application, the process for gathering requirements has a clearly defined process of its own. This process consists of a group of repeatable processes that utilize certain techniques to capture, document, communicate, and manage requirements A software requirements specification (SRS) – a requirements specification for a software system– is a complete description of the behavior of a system to be developed. In addition to a description of the software functions, the SRS also contains nonfunctional requirements.

Purpose

The purpose of this document is to provide Software Requirement Specification for "Environmental Pollution Monitoring using Raspberry PI and MQTT Protocol".

Scope

The software product produced is an application by name "Environmental Pollution Monitoring using Raspberry PI and MQTT Protocol ".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.

II.RELATED WORK

"A System For Monitoring Air And Sound Pollution Using Arduino Controller With Iot Technology." , International Research Journal in Advanced Engineering and Technology (IRJAET) .This 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

"IOT Based Air and Noise Pollution Monitoring in Urban and Rural Areas, Important Zones like Schools and Hospitals in Real Time.", International e-Journal for Technology and Research-2017. [1]Here, the authors 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

"IOT based Air and Sound Pollution Monitoring System." International Journal of Advanced Research in Electrical, [2]Here, the authors 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. , "A Smart Environmental Monitoring System Using Internet Of Things." Here, the authors 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

"Internet of things based smart environmental monitoring using the Raspberry-Pi computer." Fifth International Conference on Digital Information Processing and Communications (ICDIPC), 2015 [4] Here, the authors 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. An efficient cloud-based management of IoT devices for air quality monitoring. Here, the authors 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.

Noise and Air Pollution Monitoring System Using IOT.[6] Here, the authors 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.

"Development of an IoT-based atmospheric environment monitoring system." International Conference on Information and Communication Technology Convergence Here, the authors 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 [7] Ambient air quality Monitoring Information System [8]," Air quality monitoring system based on IoT using Raspberry PiHere, the authors have given the idea of a real-time air quality monitoring system including various

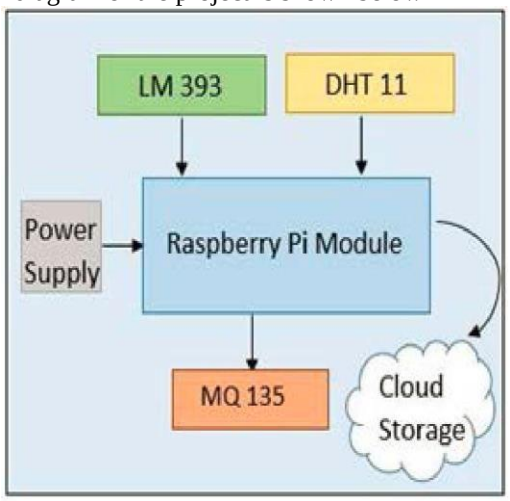
II. METHODOLOGY

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,

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

The block diagram of the project is shown below



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.

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.

Implementation is the realization of an application, or execution of a plan, idea, model, design, specification, standard, algorithm, or policy. In other words, an implementation is a realization of a technical specification or algorithm as a program, software component, or other computer system through programming and deployment. Many implementations may exist for a given specification or standard.Implementation is one of the most important phases of the Software Development Life Cycle (SDLC). It encompasses all the processes involved in getting new software or hardware operating properly in its environment,

including installation, configuration, running, testing, and making necessary changes. Specifically, it involves coding the system using a particular programming language and transferring the design into an actual working system.This phase of the system is conducted with the idea that whatever is designed should be implemented; keeping in mind that it fulfills user requirements, objective and scope of the system. The implementation phase produces the solution to the user problem.

This project is implemented considering the following aspects:

1. Usability Aspect.
2. Technical Aspect.

A.Usability Aspect

The usability aspect of implementation of the project is realized using two principles:

a.) The project is implemented as a Java application

There could be many ways of implementing the this project. We have chosen JAVA to come up with the required reader. The reason being many:

Firstly, Java provides a wonderful libraries which simplifies the implementation part of it.

Secondly, JAVA is platform independent, meaning the project can run on literally any platform which has JVM installed within it.

Thirdly, Oracle Corporation claims more than 70 billion devices run on JAVA which makes the end users used to it.

Lastly, it can be readily portable to any devices like mobile phones, ipads, PDA, and any hand held devices that are capable of running JAVA.

b.) The user-friendly interface using Java's view architecture The interface provided by this application is very user friendly and is developed using Java Swings.

B.Technical Aspect

The technical aspect of implementation of the project is realized as explained below: Servers

Apache Tomcat to develop the product

Apache Tomcat (or simply Tomcat, formerly also Jakarta Tomcat) is an open source web server and servlet container developed by the Apache Software Foundation (ASF). Tomcat implements the Java Servlet and the JavaServer Pages (JSP) specifications from Sun Microsystems, and provides a "pure Java" HTTP web server environment for Java code to run.Apache Tomcat includes tools for configuration and management, but can also be configured by editing XML configuration files

JBOSS Application server to host the product

WildFly, formerly known as JavaBeans Open Source Software Application Server (JBoss AS, or simply JBoss) is an application server that implements the Java Platform, Enterprise Edition (Java EE).

JBoss is written in Java and as such is cross-platform: usable on any operating system that supports Java. JBoss was developed by JBoss, now a division of Red Hat. Licensed under the terms of the GNU Lesser General Public License, JBoss is free and open source software. The renaming to WildFly was done to reduce confusion. The renaming only affects the JBoss Application Server project. The JBoss Community or the Red Hat JBoss product line all retain their names. **Database**

MySQL officially, but also called /maɪ ˈsiːkwəl/ "My Sequel") is (as of 2008) the world's most widely used open source relational databasemanagement system (RDBMS) that runs as a server providing multi-user access to a number of databases. It is named after co-founderMichael Widenius' daughter, My. The SQL phrase stands for Structured Query Language.

The MySQL development project has made its source code available under the terms of the GNU General Public License, as well as under a variety of proprietary agreements. MySQL was owned and sponsored by a single for-profit firm, the Swedish company MySQL AB, now owned by Oracle Corporation.

MySQL is a popular choice of database for use in web applications, and is a central component of the widely used LAMP open source web application software stack (and other 'AMP' stacks). LAMP is an acronym for "Linux, Apache, MySQL, Perl/PHP/Python." Free-software-open source projects that require a full-featured database management system often use MySQL.

For commercial use, several paid editions are available, and offer additional functionality. Applications which use MySQL databases include: TYPO3, Joomla, WordPress, phpBB, MyBB, Drupal and other software. MySQL is also used in many high-profile, large-scale World Wide Web products, including Wikipedia, Google (though not for searches), Facebook, Twitter, Flickr, Nokia.com, and YouTube.

III.RESULTS

Unit Testing

Unit testingis a method by which individual units of source code, sets of one or more computer program modules together with associated control data, usage procedures, and operating procedures, are tested to determine if they are fit for use. Intuitively, one can view a unit as the smallest testable part of an application. In object-oriented programming a unit is often an entire interface, such as a class, but could be an individual method.

For unit testing first we adopted the code testing strategy, which examined the logic of program. During the development process itself all the syntax errors etc. got rooted out. For this developed test case that result in executing every instruction in the program or module i.e. everypath through program was tested. Test cases are data chosen at random to check every possible branch after all the loops.

Error Handling

In this system, we have tried to handle all the errors that occurred while running the application. the common errors we saw were reading a tuple with an attribute set to null and database connection getting lost. For Testing we used Top-Down design a decomposition process which focuses as the flow of control, at latter strategies concern itself with code production. The first step is to study the overall aspects of the tasks at hand and break it into a number of independent modules. The second step is to break one of these modules further into independent sub modules. One of the important features is that each level the details at lower levels are hidden. So unit testing was performed first and then system testing.

Integration Testing

Data can be lost across an interface, one module can have an adverse effect on the other sub function, when combined may not produce the desired functions. Integrated testing is the systematic testing to uncover the errors with an interface. This testing is done with simple data and developed system has run successfully with this simple data. The need for integrated system is to find the overall system performance.

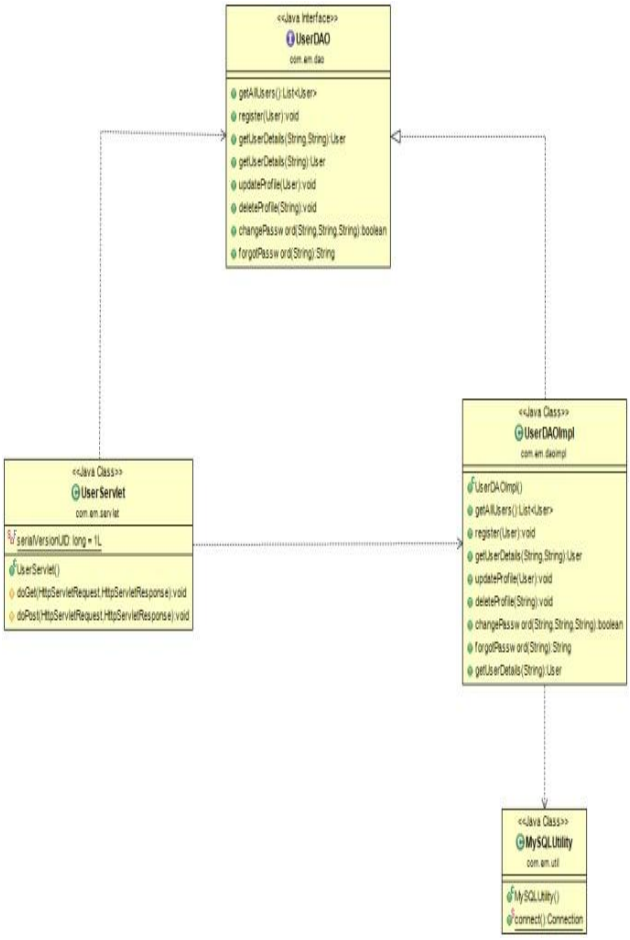
System testing

Ultimately, software is included with other system components and the set of system validation and integration tests are performed. System testing is a series of different tests whose main aim is to fully exercise the computer-based system. Although each test has a different role all work should verify that all system elements are properly integrated and formed allocated functions.

Validation Testing

At the culmination of black box testing, software is completely assembled is as a package. Interfacing errors have been uncovered and the correct and final series of tests, i.e., validation tests begins. Validation test is defined with a simple definition that validation succeeds when the software function in a manner that can be reasonably accepted by the customer.

Class diagram



ACKNOWLEDGMENT ***(HEADING 5)***

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression, “One of us (R. B. G.) thanks . . .” Instead, try “R. B. G. thanks”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

CONCLUSION AND FUTURE WORK

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 project. The concept of IoT helps improve the quality of air, monitor the level of noise, temperature and humidity. 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.

In future, we work towards integrating our project with Hadoop analytical tools to perform the detailed analysis of the data we have collected so far.

REFERENCES

[1] L.Ezhilarasi, K.Sripriya, A .Suganya, K.Vinodhini, " A System For Monitoring Air And Sound Pollution Using Arduino Controller With Iot Technology." , International Research Journal in Advanced Engineering and Technology (IRJAET)

[2] Mahantesh B Dalawai, Siva Yellampalli, Pradeep S.V, "IOT Based Air and Noise Pollution Monitoring in Urban and Rural Areas, Important Zones like Schools and Hospitals in Real Time.", International e-Journal for Technology and Research-2017.

[3] Arushi Singh, Divya Pathak, Prachi Pandit1, Shruti Patil, P Priti. C. Golar , "IOT based Air and Sound Pollution Monitoring System." International Journal of Advanced Research in Electrical,

[4] A. Sumithra, J.Jane Ida, K. Karthika , S. Gavaskar, "A Smart Environmental Monitoring System Using Internet Of Things." International Journal of Scientific Engineering"

[5] Mohannad Ibrahim , Abdelghafor Elgamri , Sharief Babiker . Ahmed Mohamed, "Internet of things based smart environmental monitoring using the Raspberry-Pi computer." Fifth International Conference on Digital Information Processing and Communications (ICDIPC), 2015

[6] Giovanni B. Fioccola , Raffaele Sommese, Imma Tufano, Roberto Canonico, Giorgio Ventre, " Polluino: An efficient cloud-based management of IoT devices for air quality monitoring." IEEE 2nd International Forum on Research and Technologies for Society and Industry Leveraging a better tomorrow (RTSI), 2016

[7] SRM.ArthiShri, NB.Keerthana, S.Sandhiyaa,P.Deepa, D.Mythili," Noise and Air Pollution Monitoring System Using IOT." SSRG International Journal of Electrical and Electronics Engineering– (ICETM-2017) - Special Issue- March 2017.

[8] Seung Ho Kim ; Jong Mun Jeong ; Min Tae Hwang ; Chang Soon Kang, "Development of an IoT-based atmospheric environment monitoring system." International Conference on Information and Communication Technology Convergence (ICTC)., 2017

[9] Somansh Kumar, Ashish Jasuja," Air quality monitoring system based on IoT using Raspberry Pi.", International Conference on Computing, Communication and Automation (ICCCA), 2017.

[10] Himadri Nath Saha, Nilan Saha, Rohan Ghosh, Sayantan Roychoudhury, "Recent trends in implementation of Internet of Things — A review", IEEE 7th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON), 2016

[11] Himadri Nath Saha, Abhilasha Mandal, Abhirup Sinha, " Recent trends in the Internet of Things", IEEE 7th Annual Computing and Communication Workshop and Conference (CCWC), 2017

[12] Himadri Nath Saha, Supratim Auddy, Subrata Pal, Avimita Chatterjee, Shivesh Pandey, Rocky Singh, Rakhee Singh, Debmalya Ghosh, Ankita Maity, Priyanshu Sharan, Swarnadeep Banerjee, "Pollution Control using Internet of

[13] Things(IoT).", 8th Annual Industrial Automation and Electromechanical Engineering Conference (IEMECON), 2017

