IoT-BASED AIR QUALITY SENSING NETWORK

Minor project-II report submitted
in partial fulfillment of the requirement for award of the degree of

Bachelor of Technology
in
Computer Science & Engineering

By

E. RISHIKA	(21UECS0170)	**(VTU20040)**
N. SAI SHUSHANKA	(21UECS0416)	**(VTU20068)**
K. SURYA PRAKASH	(21UECS0275)	**(VTU20048)**

Under the guidance of
Dr. M. GURU VIMAL KUMAR, B.Tech., M.E., Ph.D.,
ASSOCIATE PROFESSOR

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
SCHOOL OF COMPUTING

VEL TECH RANGARAJAN DR. SAGUNTHALA R&D INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University Estd u/s 3 of UGC Act, 1956)
Accredited by NAAC with A++ Grade
CHENNAI 600 062, TAMILNADU, INDIA

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CERTIFICATE

It is certified that work contained in the project report titled ”IoT BASED AIR QUALITY SENSING NETWORK” by ”E. RISHIKA (21UECS0170), N. SAI SHUSHANKA (21UECS0416), K. SURYA PRAKASH (21UECS0275)” has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

Signature of Supervisor	**Signature of Professor In-charge**
Computer Science & Engineering	**Computer Science & Engineering**
School of Computing	**School of Computing**
Vel Tech Rangarajan Dr. Sagunthala R&D	**Vel Tech Rangarajan Dr. Sagunthala R&D**
Institute of Science & Technology	**Institute of Science & Technology**
May, 2024	**May, 2024**

DECLARATION

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

(E. RISHIKA)
Date: / /

(N. SAI SHUSHANKA)
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(K. SURYA PRAKASH)
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APPROVAL SHEET

This project report entitled ”IoT BASED AIR QUALITY SENSING NETWORK” by E. RISHIKA (21UECS0170), N. SAI SHUSHANKA (21UECS0416), K. SURYA PRAKASH(21UECS0275) is approved for the degree of B.Tech in Computer Science & Engineering.

Examiners **Supervisor**

Dr. M. Guru Vimal Kumar, B.Tech., M.E., Ph.D.,

Date: / /

Place:

ACKNOWLEDGEMENT

We express our deepest gratitude to our respected **Founder Chancellor and President Col. Prof. Dr. R. RANGARAJAN B.E. (EEE), B.E. (MECH), M.S (AUTO),D.Sc., Foundress President Dr. R. SAGUNTHALA RANGARAJAN M.B.B.S.** Chairperson Managing Trustee and Vice President.

We are very much grateful to our beloved **Vice Chancellor Prof. S. SALIVAHANAN,** for providing us with an environment to complete our project successfully.

We record indebtedness to our **Professor & Dean, Department of Computer Science & Engineering, School of Computing, Dr. V. SRINIVASA RAO, M.Tech., Ph.D.,** for immense care and encouragement towards us throughout the course of this project.

We are thankful to the our **Head, Department of Computer Science & Engineering, Dr.M.S. MURALI DHAR, M.E., Ph.D.,** for providing immense support in all our endeavors.

We also take this as a opportunity to express the deep sense of gratitude to our **Dr. M. GURU VIMAL KUMAR, B.Tech., M.E., Ph.D.,** for his cordial support, valuable information and guidance, he helped us in completing this project through various stages.

A special thanks to our **Project Coordinators Mr. V. ASHOK KUMAR, M.Tech., Ms. U.HEMAVATHI, M.E., Ms. C. SHYAMALA KUMARI, M.E.,** for their valuable guidance and support throughout the course of the project.

We thank our department faculty, supporting staff and friends for their help and guidance to complete this project.

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ABSTRACT

Air pollution refers to any physical, chemical, biological changes in the air and it there biggest problem of every nation whether it is developed or developing. The system incorporates a network of sensors capable of measuring multiple parameters including the particulate matter (PM), gases like nitrogen dioxide (NO2), sulfur dioxide (SO2), and volatile organic compounds (VOCs). These sensors collect real-time data and transmit it to a central server via the internet. The collected information is then processed and analyzed to generate comprehensive reports and visualizations, providing insights into air quality trends and pollution levels in specific locations. By deploying these sensors across farmlands and livestock facilities, real-time data collection is facilitated, allowing continuous monitoring of air quality. The rapid urbanization and industrialization in recent years have led to heightened concerns about air pollution and its adverse effects on public health and the environment. Monitoring air quality in real-time has become imperative for effective policymaking and public awareness. The proposed IOT based air quality sensing network offers a cost effective, scalable, and efficient solution for a continuously monitoring and managing air quality in urban environments. The development of an Air Quality Sensing Network represents a crucial step towards building sustainable and resilient cities. By leveraging advances in sensor technology and data analytics. It contributes to efforts aimed at safeguarding public health and preserving the environment for future generations.

Keywords:

IOT, Nitrogen dioxide, Primary Contributor, Particulate Matter, Respiratory illness, Sulphur dioxide

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

HEPA	High Efficiency particulate air
IoT	Internet of Things
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCU	Micro-controller Unit
PPM	Parts per Million
RF	Radio Frequency
USB	USB Serial Bus
Vin	Input Voltage
Vout	Output Voltage
WIFI	Wireless Fidelity

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

1.1 Introduction

During past decades, as result of civilization and urbanization there is a huge growth in Polluting industries, open burning of refuse and leaves, massive quantities of construction waste, substantial loss of forests and vehicles (particularly diesel driven cars) on roads that give rise to health endangering pollution. Therefore, it is necessary to regularly monitor and report the hazardous impacts from air pollution. The primary contributor to air pollution is the particulate matter (PM2.5), causing human health issues, like asthma and other respiratory illnesses. A study has found out that the persons inhaling particulate matter in air are at more risk of lung cancer and comparable to non-smoker susceptible to secondhand smoke.

The parameters of the environment to be monitored are chosen as temperature, humidity, volume of Carbon monoxide(CO), detection of leakage of any gas -smoke, alcohol. There are many types of air purifier available in market but they are not sufficient enough to the working efficiency in public places like railway stations, bus stand, schools and colleges, traffic signals etc. Most of the institutions and organizations can't afford high maintenance and installation cost. So, the system is trying to develop such air purifier which can cost less and are highly efficient. Solar powered air quality monitoring and filtering system runs on solar energy with use of components such as ESP32 Module, sensors MQ 02, relays battery etc.

1.2 Aim of the Project

The main aim of the project is air quality monitoring and filtering system. It consists of different types of sensors which are used for measuring the different gases of the surrounding environment and HEPA (High Efficiency particulate air) filter is used to reduce small microns of virus dust, pollen, bacteria and any airborn particles. This system gives a smart air pollution monitoring that constantly keep track of air quality measuring on Liquid Crystal Display(LCD) screen.

1.3 Project Domain

The project domain of IOT-based air quality sensing network would involve developing a system that can track and monitor the air quality of a particular area or region using IOT sensors. The system would use various sensors to measure the concentration of pollutants in the air, such as carbon monoxide, nitrogen oxide, sulfur dioxide, and particulate matter. The data collected by these sensors would be transmitted to a central server or cloud-based platform, which would then analyze the data and provide real-time information about the air quality of the area.

This information could be used by the local authorities to take the appropriate measures to reduce the pollution levels and improve the quality of the air. The project domain focuses on specialized sensors, data analysis techniques, regulatory compliance, public safety, and sustainable industrial practices to address the challenges related to monitoring and mitigating chemical pollutants in the air using IOT-based systems.The project would involve hardware design,sensor integration, data analysis, and software development.

1.4 Scope of the Project

The project scope of an IOT-based air quality sensing network can include Hardware design and development: The first step in building an air pollution monitoring system using IOT is to design and develop the hardware components required for the system. This includes sensors for measuring air quality parameters such as PM2.5, PM10, CO2, CO, and NO2, microcontrollers for processing sensor data, and wireless communication modules for transmitting data to a cloud server.

Mobile app development: A mobile app can be developed to provide real-time air quality data to end-users. The application can also be used to set up alerts and notifications when air quality levels fall below a specified threshold. Maintenance and support: The air pollution monitoring system requires regular maintenance and support to ensure that it functions properly. This includes software updates, sensor calibration, and hardware maintenance.

Chapter 2

LITERATURE REVIEW

[1] A. Sharma et al., (2018) published in the International Journal of Innovative Technology and Exploring Engineering (IJITEE) in January 2018, the authors present a literature review focusing on the utilization of wireless sensor networks (WSNs) for forest fire detection and early warning systems. The paper appears to be a literature review discussing the use of wireless sensor networks for forest fire detection and early warning systems. This topic is quite relevant as WSNs offer potential solutions for detecting and monitoring forest fires, providing early warnings to mitigate their impact.

[2] C Santos et al., (2019) published an Effect of Event-Based Sensing on IoT Node Power Efficiency: Case Study - Air Quality Monitoring in Smart Cities in IEEE, the authors likely delve into a literature review that examines the impact of event-based sensing on the power efficiency of IoT (Internet of Things) nodes, with a specific focus on air quality monitoring in smart cities. This topic is significant as it addresses the challenge of optimizing power consumption in IoT devices while ensuring effective data collection for air quality monitoring, which is crucial for smart city initiatives aiming to improve urban living conditions.

[3] K. Raghava Rao et al., (2014) published in the International Journal of Electronics and Communication Engineering Technology (IJECET), the literature review likely explores previous research related to air pollution monitoring systems, particularly those employing Zigbee-based wireless sensor networks (WSNs). The review may cover various aspects of air pollution monitoring, including sensor technologies, communication protocols, data processing algorithms, and system architectures. It could discuss the advantages and limitations of Zigbee technology for environmental monitoring applications, as well as comparisons with other wireless communication standards.

[4] L.Ezhilarasi et al., (2020) proposed an Association Between Consecutive Ambient Air Pollution and Chronic Obstructive Pulmonary Disease Hospitalization.In this system Machine learning has the aptitude learning preceding expertise and updating its features. According to the propensity, Air pollution speaks to a significant point to contemplate people and expressions. Air contamination can cause sicknesses, asthma, cardiovascular disappointment, cellular breakdown in the lungs, stroke, viral diseases. Consequently essential to propose particular procedures for clustering balance data, the Air pollution dataset, and RFM model certainty.

[5] Ms. Sarika Deshmukh et al., (2020) introduced an Mapping Air Quality in IOT Cities: Cloud Calibration and Air Quality Inference of Sensor Data.In this paper developed a systematic mapping study defined by a five step methodology to identify and analyze the research status in terms of IOT. The paper likely presents a systematic mapping study employing a five-step methodology to identify and analyze the research status concerning IoT applications in air quality monitoring. This methodology likely involves reviewing existing literature, identifying key themes or trends, and providing insights into the current state of research in this domain.

[6] M Tahseenul Hasan et al., (2022) developed an Air Pollution Comparison RFM Model Using Machine Learning Approach. In this paper developed models to predict indoor PM(2.5) concerntations for pregnant women who werw part of randomised controlled trial of portable air cleaners.Used multiple linear Regression and RFM. Since my training data only includes information up until January 2022, I don't have specific details about the paper you mentioned. However, based on the title you provided, "Air Pollution Comparison RFM Model Using Machine Learning Approach," I can provide a hypothetical outline for what the literature review in such a paper might cover

[7] Navreetinder Kaur et al., (2022) enhanced a Design and Execution of an Internet of Things Based Air Pollution Monitoring Device. In this research ,the device was designed to measure a concentration of aerosol, VOC, CO, CO2, and temperature-humidity to monitor the air quality. Then, the device was successfully tested for reliability. This section would provide an overview of the importance of

air quality monitoring and the role of IoT devices in this domain. It would introduce the need for comprehensive monitoring of various air pollutants and environmental parameters.

[8] Palaghat Yaswanth Sa et al., (2017) developed an Air Pollution Mapping with Sensor-based Methodology. In this research developed a sensor based methodology for mapping air pollution related to Gaseous Composition of the atmospheric, It uses drone equipped with sensors to identify the current composition of air. After self-identifying the locations automatically and obtain sensor readings related to the gas percentages at those locations. After that the data is then transmitted to a computer program which analyzes (cluster analysis methodology), the data and then maps the air pollution in that specific area.

[9] Sumeet Gupta et al., (2023) ”Differences of Performance Analysis of Single Channel LoRaWAN Network for Air Pollution Monitoring System Using IOT Platform in Smart City – A Review”, IEEE 13th Symposium on Computer Applications Industrial Electronics (ISCAIE). The paper likely conducts a performance analysis of single-channel LoRaWAN networks for air pollution monitoring systems using IoT platforms in smart cities. Specifically, it seems to focus on reviewing existing literature to highlight differences in performance metrics and outcomes related to this application. This review could provide valuable insights into the effectiveness and challenges of utilizing LoRaWAN networks for air pollution monitoring in smart city environments.

[10] Riteeka Nayak et al., (2021) ”Air Quality Prediction System using ML and DL Techniques”, IEEE North Karnataka Subsection Flagship International Conference (NKCon). Overview of the importance of air quality prediction in mitigating the adverse effects of air pollution on human health and the environment. Explanation of the need for accurate and timely prediction models to inform policymakers, urban planners, and the general public.

Chapter 3

PROJECT DESCRIPTION

3.1 Existing System

IOT-based air quality sensing network is used to monitor the air quality over a web server using Internet. It will trigger an alarm when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases present in the air like CO2, smoke, alcohol, benzene, NH3 and NOx. The existing systems of air quality sensing networks vary widely in terms of scale, technology, and purpose, but they all share the common goal of monitoring and managing air pollution.

3.2 Proposed System

The proposed system is a ecofriendly and budget free project by using arduino uno and air quality sensor and the values are displayed by the lcd display. It show the air quality advantages sensors are easily available. Simple, compact, easy to handle. Sensors have long life and less cost. Quality of air can be checked indoor as well as outdoor. Detecting a wide range of physical parameters including temperature, and carbon dioxide.

3.3 Feasibility Study

Feasibility Study may be a high-level capsule version of the whole process intended to answer variety of questions like: what's the problem? Is there any feasible solution to the given problem? Is the problem even worth solving? Feasibility study is conducted once the matter clearly understood. Feasibility study is important to work out that the proposed system is possible by considering the tech- nical, Operational, and Economical factors. By having an in-depth feasibility study, the management will have a clear-cut view of the proposed system.

3.3.1 Economic Feasibility

This assessment typically involves a cost/ benefits analysis of the project, helping organizations determine the viability, cost, and benefits associated with a project before financial resources are allocated. The economic feasibility of an air quality sensing network based on the Internet of Things (IoT) depends on various factors, including the cost of hardware, deployment, maintenance, data management, and the potential benefits derived from the network. It also serves as an independent project assessment and enhances project credibility helping decision-makers determine the positive economic benefits to the organization that the proposed project will provide.

3.3.2 Technical Feasibility

This assessment focuses on the technical resources available to the organization. It helps organizations determine whether the technical resources meet capacity and whether the technical team is capable of converting the ideas into working systems. Technical feasibility also involves the evaluation of the hardware, software, and other technical requirements of the proposed system. As an exaggerated example, an organization wouldn't want to try to put Star Trek's transporters in their building currently, this project is not technically feasible.

3.3.3 Social Feasibility

In this process, we verify different operational factors of the systems like man-power, time, social needs etc., whichever solution uses less resources, is that the best operationally feasible solution. The solution should even be operationally possible to implement. Operational Feasibility determines if the proposed system satisfied user objectives might be fitted into the present system operation. The methods of processing and presentation are completely accepted by the clients since they can meet all user requirements. The clients have been involved in the planning and development of the system. The proposed system will not cause any problem under any circum-stances. Our project is operationally feasible because the time requirements and personnel requirements are satisfied.

3.4 System Specification

3.4.1 Hardware Specification

The Hardware specification consists of some components
1) ESP32 Module: SpecificationsProcessor: Tensilica LX6 Dual-Core, Wi-Fi: 802.11 b/g/n standards, Input Vlotgae:2.2to3.6, Flash Memory:4MB, SRAM:512 KB, Clock Speed:240 MHz Bluetooth v4.2 BR/EDR and BLE (Bluetooth Low Energy) standards.
2) Lead Acid Battery Specifications
Brand-ExpertPower
Voltage-12 Volts
Battery Cell Composition-Lead Acid
Item Weight-4.3 Pounds
Item Dimensions LxWxH-15.2 x 6.4 x 9.4 Centimeters
3) Led light
4) MQ-02 Sensor

3.4.2 Software Specification

Operating system : Windows 10
Package : Arduino uno,Visual studio
Coding Environment : Embedded C

3.4.3 Standards and Policies

Project standards are the rules and conventions governing the way in which a project will be conducted. A policy guideline and documented procedures for how projects are planned, executed and delivered based on proven project management methodologies, to ensure projects are completed on time and on budget.

Chapter 4

METHODOLOGY

4.1 General Architecture For Air Quality Sensing Network

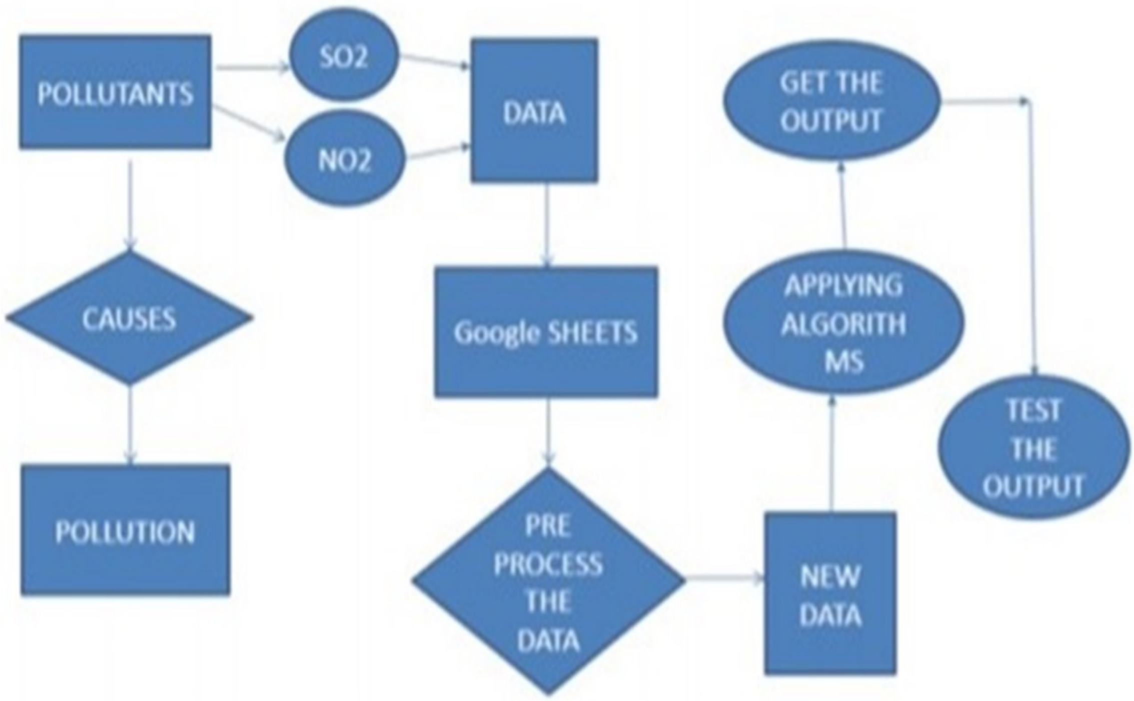


Figure 4.1: **Architecture Diagram**

The Figure 4.1 explains the IOT based air quality sensing network and their relationship. An Architectural diagram is a diagram of a system that is used to abstract the overall outline of the software system and the relationships, constraints, and boundaries between components. It is an important tool as it provides an overall view of the physical deployment of the software system and its evolution roadmap. The architecture for an IoT-based air quality sensing network involves several components and considerations to ensure reliable data collection, transmission, and analysis.

4.2 Design Phase

4.2.1 Data Flow Diagram

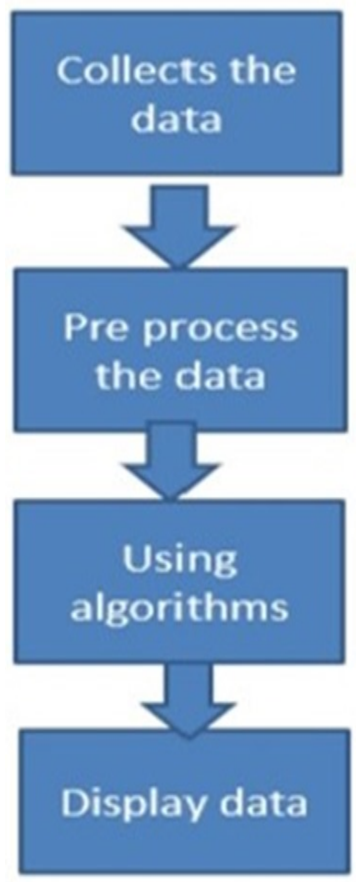


Figure 4.2: **Data Flow Diagram**

The Figure 4.2 explains the IOT based air quality sensing network and their dataflow. A Data Flow Diagram (DFD) is a graphical representation of the "flow" of data through an information system , modeling its process aspects. Often it is a preliminary step used to create an overview of the system that can later be elaborated. This data flow diagram illustrates the flow of air quality data from the sensing nodes to the central server/cloud platform, where it undergoes processing, analysis, and visualization before being presented to users through the user interface.

4.2.2 Use Case Diagram

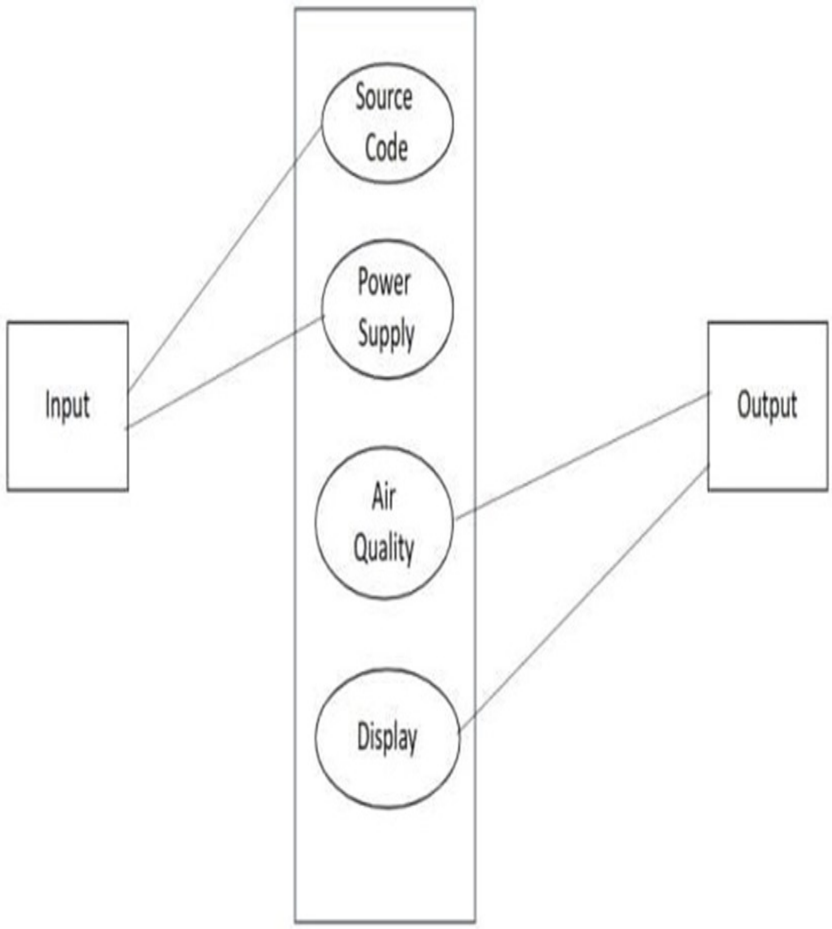


Figure 4.3: **Use Case Diagram**

The Figure 4.3 explains the use case diagram for IOT based air quality sensing network there are five actors, the general source code, power supply, air quality,, which have different roles that the system responds to accordingly. Use case diagrams are behavioural diagrams that visualizes the interaction between actors and the system. Actors, can be users or other systems, are entities that control the functionality of the system. Use cases diagram provides a simplifies view of what the system does by identifying system functionalities and how they interact with internal and external actors.

4.2.3 Class Diagram

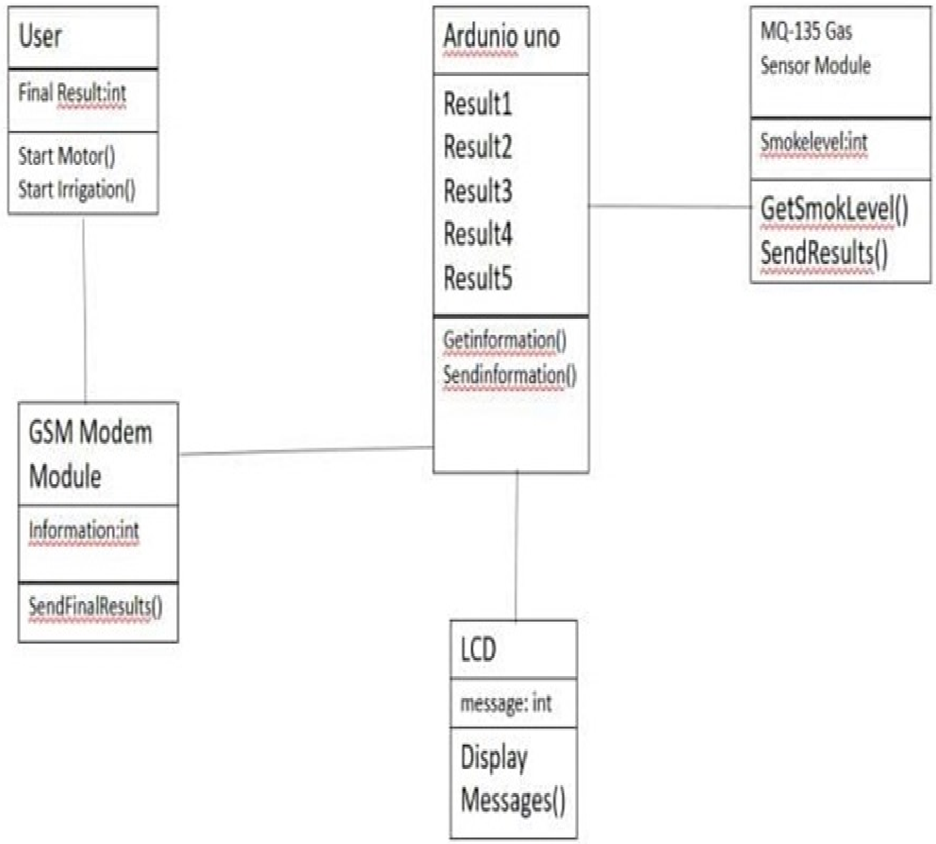


Figure 4.4: **Class Diagram**

The Figure 4.4 stores a "Data Collection" class which would be responsible for collecting data from the sensors and storing it in a database. The class diagram would have a central class called "Air quality sensing network" which would be responsible for coordinating all the different classes and objects in the system. Other classes would include "Sensor" which would represent the physical sensors that are installed to monitor air quality. Each sensor would have attributes such as location and type of pollutant being monitored.

4.2.4 Sequence Diagram

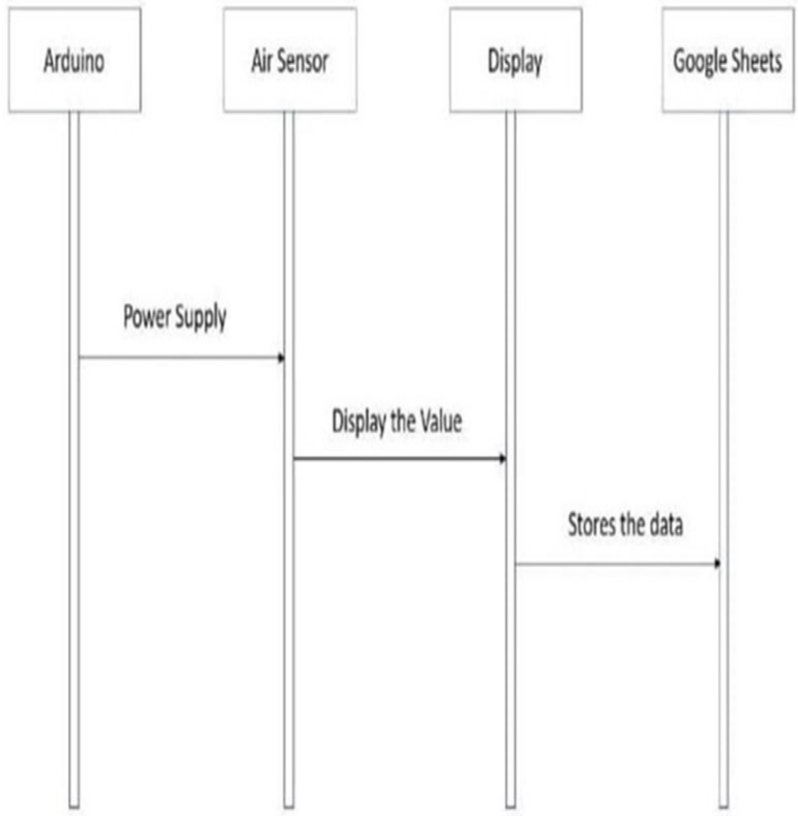


Figure 4.5: **Sequence Diagram**

The Figure 4.5 shows a set of objects and the messages sent and received by the instance of the objects. A sequence diagram is a kind of interaction diagram. It describes the time ordering of the messages between objects in a specific requirement. In this use a sequence diagram to illustrate the dynamic view of a system. This sequence diagram provides a high-level overview of how data flows through the system, from the sensing nodes to the user interface, with processing and analysis steps in between.

4.2.5 Activity Diagram

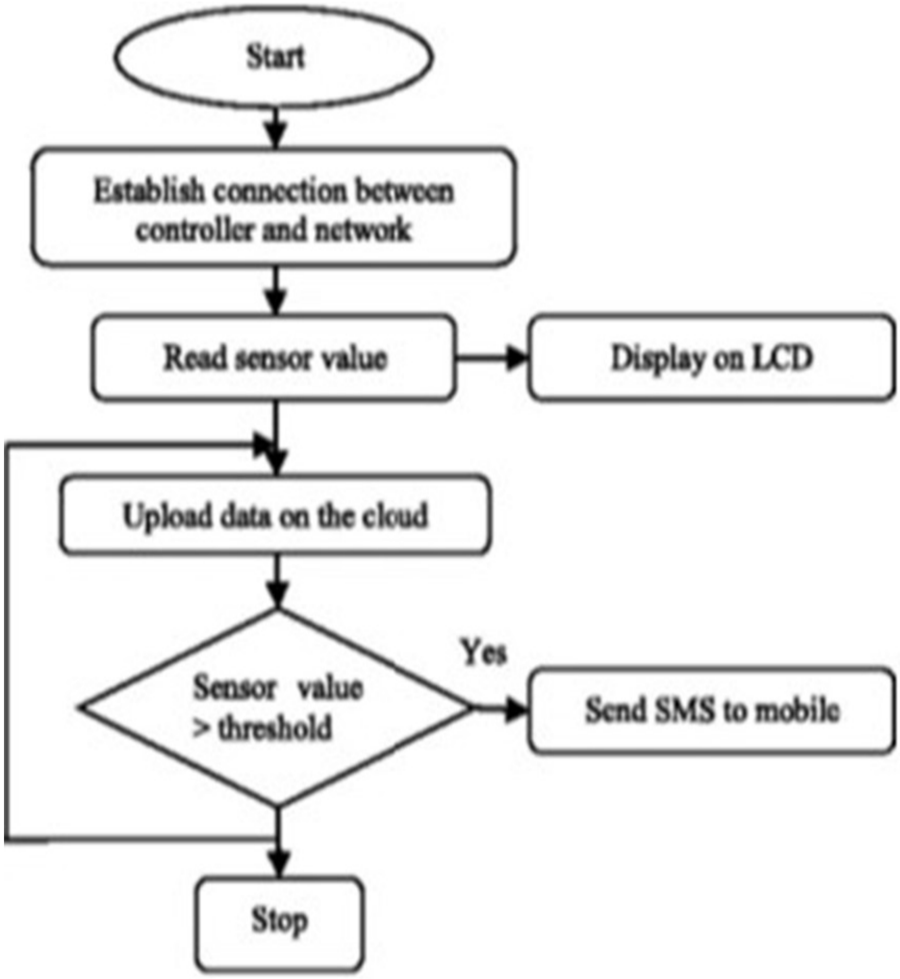


Figure 4.6: **Activity Diagram**

The Figure 4.6 outlines the basic steps involved in an IOT based air quality sensing network. Each step represents a discrete action or process within the system, from initialization and data collection to data processing, notification generation, and visualization/reporting. This activity diagram outlines the sequential steps involved in processing air quality data in the IoT-based sensing network, from data transmission to analysis and user notification.

4.3 Module Description

4.3.1 Data Processing

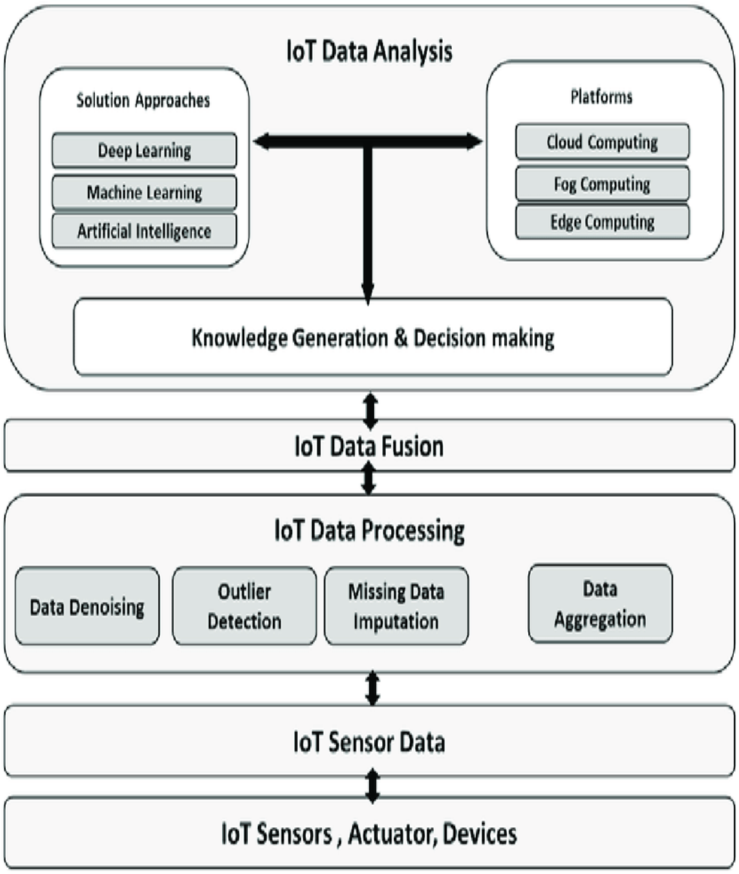


Figure 4.7: **Processing of Data**

The Fig 4.7 represents the processing od data in Air Pollutant Level It indicates the early phase of the project. An IOT based air pollution detection kit is developed.
Step 1: It deals with the collection of data from gas sensors connected to Raspberry Pi and the information is sent to the cloud platform that stores it.
Step 2: After receiving the data, the server employs data analytics techniques to perform various tasks, including data validation, quality control, and visualization.
Step 3: The data contains air quality details. When it enter into the ESP32 the it detects the air quality by calculating it in ppm.

4.3.2 Creating the Interface

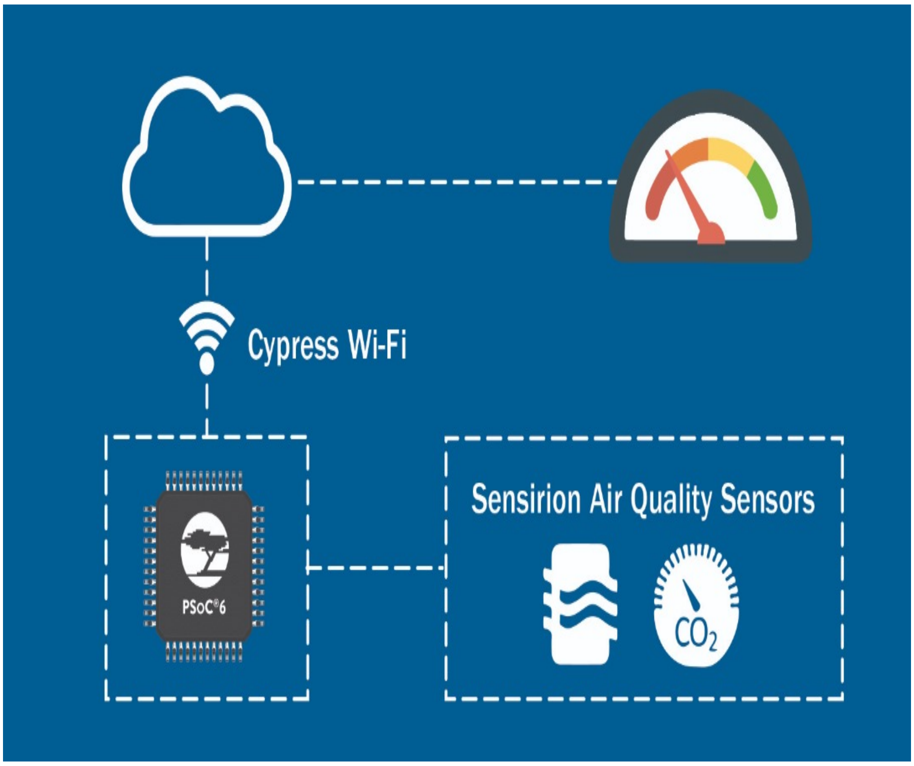


Figure 4.8: **Creating the Interface**

The Fig 4.8 represents the stage involves the clarification of the various components for optional performance.

Step 1: MCP3008 is a 10 bit converter which is calibrated to convert analog data to digital with on-board sample and hold circuitry.

Step 2:The data collected is stored, processed and can be monitored using the mobile application.

Step 3: Users can review the stored data through the application.

Step 4: By execution and testing the various components are interfaced together and the project deliverables are built with the help of different circuit designs.

Step 5: The testing, debugging and troubleshooting of the design is performed to test the performance of the design under various conditions.

4.3.3 Air Quality Sensing

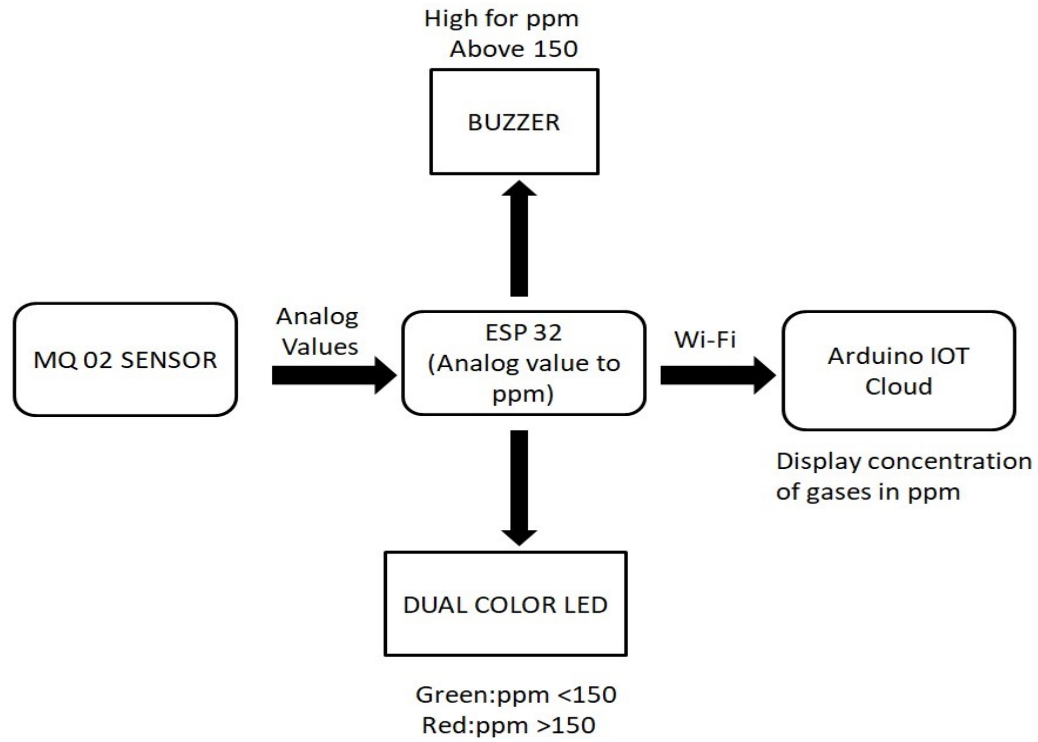


Figure 4.9: **Air Quality Sensing**

The Figure 4.9 outlines the main components and flow of information within an Iot-based air quality sensing network.

Step 1: The nodes consist of air quality sensors like MQ 02 sensor capable of measuring various pollutants such as particulate matter, carbon monoxide, nitrogen dioxide, and others.

Step 2: The sensor continuously collect air quality data, including pollutant concentrations and environmental parameters such as temperature, humidity, and pressure.

Step 3: The MQ02 sensor nodes communicate with a ESP32 device, it acts as a Wi-Fi.

Step 4: The data collected by the sensor nodes is transmitted to a Arduino IOT Cloud platform for storage, analysis, and visualization.

Step 5: The analyzed data is presented in a user-friendly format through visualization tools and dashboards.

Step 6: The air quality sensing network may incorporate alerting mechanisms to notify stakeholders of significant changes in air quality or exceedances of pollutant thresholds.

4.4 Steps To Execute The Project

4.4.1 Framing of project setup with general pin functions:

- LED: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- VIN: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). It can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.
- IOREF: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields that block the one on the board.

4.4.2 Specifications of the Components for setting up a model:

ESP32 MODULE:

The below figure 4.10is a ESP32 Development Module. It is a popular, low-cost, low-power system-on-a-chip (SoC) series created by Espressif Systems. It's primarily used for Wi-Fi and Bluetooth-enabled Internet of Things (IoT) applications. The ESP32 is an upgrade over its predecessor, the ESP8266, offering a more powerful CPU, better Wi-Fi, and Bluetooth capabilities, more GPIOs, and other enhanced features.

Figure 4.10: **ESP32 Module**

SPECIFICATIONS:

Processor: Tensilica LX6 Dual-Core
Wi-Fi: 802.11 b/g/n standards.
Input Voltage:2.2 to 3.6
Flash Memory: 4 MB
SRAM: 512 KB
Clock Speed: 240 MHz
Bluetooth v4.2 BR/EDR and BLE (Bluetooth Low Energy) standards.

MQ-02 GAS SENSOR:

The below figure 4.11 is a MQ2 gas sensor. It is an electronic sensor used for sensing the concentration of gases in the air.MQ2 gas sensor is also known as chemiresistor. It contains a sensing material whose resistance changes when it comes in contact with the gas. This change in the value of resistance is used for the detection of gas.

Figure 4.11: **MQ-02 Gas Sensor**

SPECIFICATIONS:

Operating Voltage: Commonly around 5V.
Input Voltage is 5V DC
Range:200 to 1000ppm
Heating Power: 800mW to 1W.

BUZZER:

The below figure 4.12 describes a buzzer. It is a simple audio signaling device that can be used in a wide range of applications. Buzzers are commonly found in alarm devices, timers, confirmation of user input (like in keypads), and other electronic devices where generating sound is required.

Figure 4.12: **Buzzer**

SPECIFICATIONS:

Operation Voltage: 3-24V DC.
Current: ¡ 15mA.

Frequency: 2 kHz to 4 kHz

LED:

The below figure 4.13 describes a Light Emitting Diode (LED). It is a semiconductor light source that emits light when current flows through it. LEDs are used extensively in a wide range of applications due to their efficiency, long life, and the diverse array of colors they can produce.

Figure 4.13: **LED**

4.4.3 Assembling of Different Components[Circuit Diagram]:

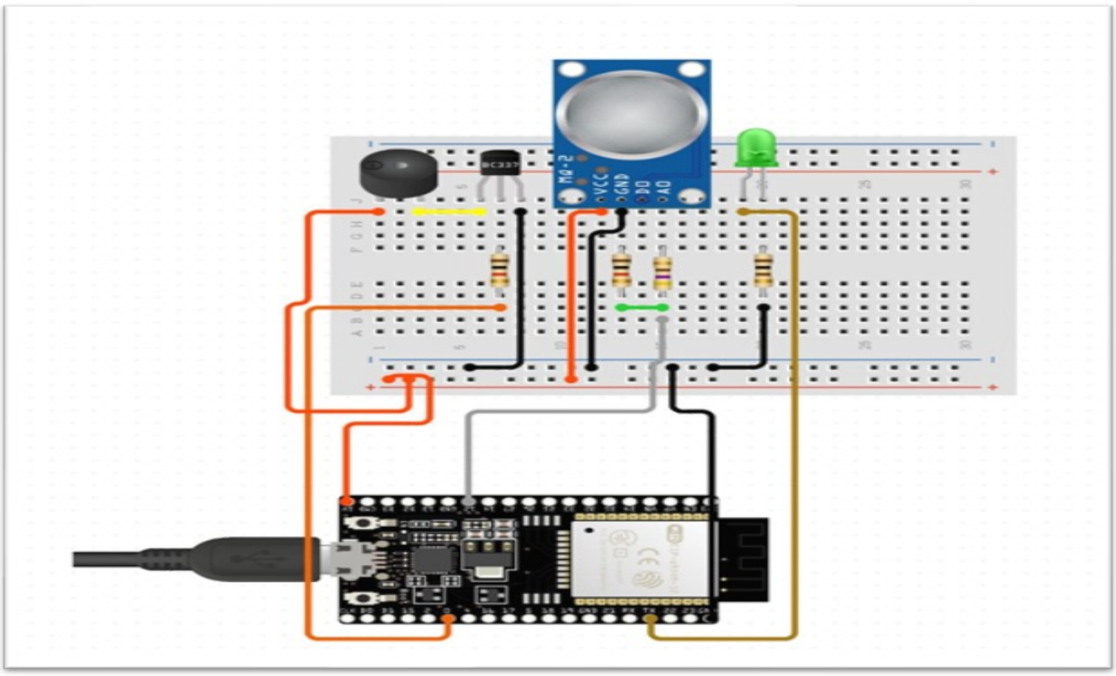


Figure 4.14: **Circuit Diagram**

The above figure 4.14 represents an Iot based air quality sensing network circuit diagram involves various components and might vary based on specific sensors, IOT devices, and microcontrollers used.

Chapter 5

IMPLEMENTATION AND TESTING

5.1 Input and Output

5.1.1 Input Design

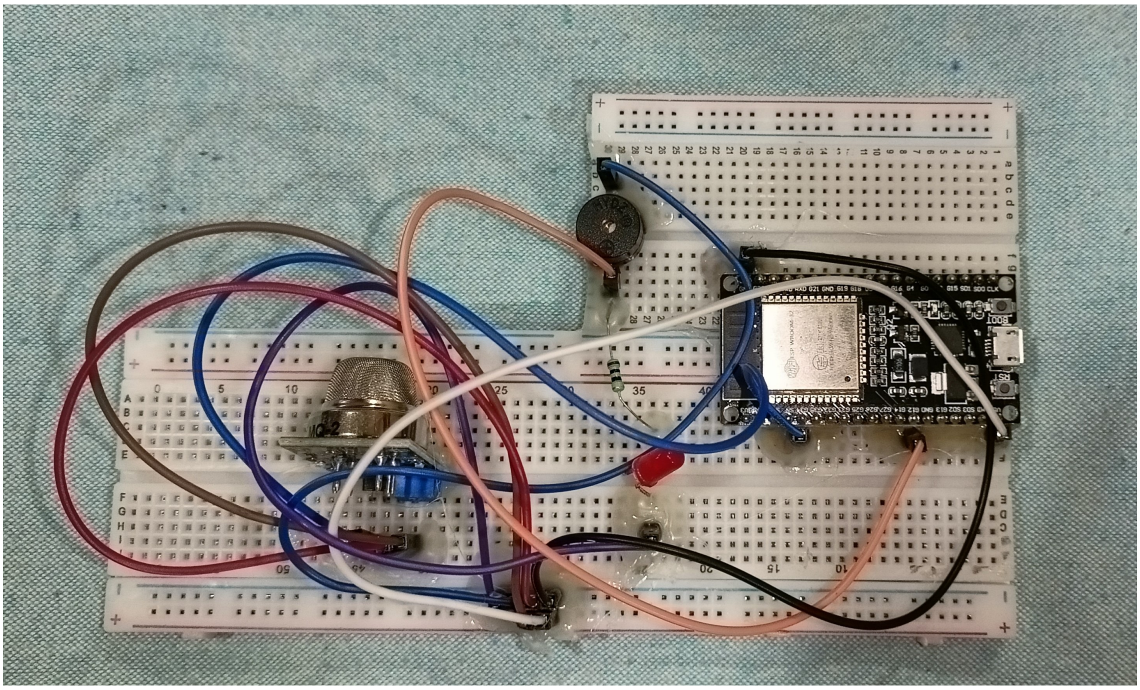


Figure 5.1: **Input Design**

These inputs collectively form the foundation for an IOT-based air quality sensing network. The data collected from these inputs are processed, analyzed, and transmitted to the cloud or central server for further evaluation, visualization, and reporting.

5.1.2 Output Design

In an IOT-based air quality sensing network, various outputs are generated based on the data collected, processed, and analyzed. These outputs serve to inform stakeholders, authorities, and the public about air quality conditions.They enable informed decision-making and proactive measures to address air quality issues.

5.2 Testing

5.2.1 Test Result

Figure 5.2: **Testing of Air Pollution**

The above figure 5.1 shows the test result of air quality sensing network. It shows if there are any bad things in the air, like dust or chemicals, that could harm us. These sensors also look at things like temperature and humidity to see how they affect air quality. By studying these results, we can find out where the air is cleanest and dirtiest in our area. This helps us understand what might be causing pollution in certain places. With this information, we can work on making our air cleaner and healthier for everyone. When air monitor occurs above 150ppm then it is considered as polluted air. when air monitor occurs below 150ppm that it is considered as good air.

Chapter 6

RESULTS AND DISCUSSIONS

6.1 Efficiency of the Proposed System

Identify the pollutants to Determine the type and amount of pollutants that the system is designed to control. Measure the emissions to Conduct an emissions test before and after the installation of the air pollution control system to measure the reduction in emissions. Compare the results of the emissions test before and after the installation of the system to determine the efficiency of the system.
Analyze cost-effectiveness to Evaluate the cost-effectiveness of the system by comparing the costs of installing and operating the system with the economic benefits of reducing pollution. Conduct a health risk assessment to Assess the potential health risks associated with the pollutants that the system is designed to control, and evaluate the effectiveness of the system in reducing these risks. By following these steps, we can evaluate the efficiency of our proposed air pollution control system and determine its effectiveness in reducing pollution.

6.2 Comparison of Existing and Proposed System

Existing system:(Smart Air Pollution control)

In the Existing system, we implemented the library in the Arduino was loaded and a message was sent to the LCD. Air quality data was collected using the MQ 02 gas sensor. The calibrated sensor made the analog output voltage proportional to the concentration of polluting gases in Parts per Million (ppm). The data is first displayed on the LCD screen and then sent to the Wi-Fi module. The Wi-Fi module transfers the measured data valve to the server via internet. The Wi-Fi module is configured to transfer measured data an application on a remote server called “Thing speak”. The online application provides global access to measured data via any device that has internet connection capabilities. Data collected from the sensor was converted into a string and used to update the information sent to the remote server.

Proposed system:(Air pollution Monitoring using IOT)

Identify the pollutants to Determine the type and amount of pollutants that the system is designed to control. Measure the emissions to Conduct an emissions test before and after the installation of the air pollution control system to measure the reduction in emissions. Compare the results of the emissions test before and after the installation of the system to determine the efficiency of the system. Analyze costeffectiveness to Evaluate the cost-effectiveness of the system by comparing the costs of installing and operating the system with the economic benefits of reducing pollution. Conduct a health risk assessment to Assess the potential health risks associated with the pollutants that the system is designed to control, and evaluate the effectiveness of the system in reducing these risks. By following these steps, we can evaluate the efficiency of our proposed air pollution control system and determine its effectiveness in reducing pollution. we proposed a ecofrendly and budget free project by use ardino uno and air quality sensor and the values are displayed by the lcd display it show the air quality.

6.3 Sample Code

```
#include <Wire . h>
#include <LiquidCrystal_I2C .h>
LiquidCrystal _I2C  lcd (0 x27 , 16 , 2) ;
const int RunningAverageCount1 = 6 4 ;
float RunningAverageBuffer1 [ RunningAverageCount 1 ] ;
int NextRunningAverage 1 ;
float RunningAverageVolt 1 ;
int i 1 ;
int co2 ;
#include  MQ7 . h
#define A _PIN 2
#define VOLTAGE 5
MQ2 Q7 (A.PIN, VOLTAGE)
int co:
#define DHIP   3 //
Digital pin connected to the DHT sensor
Pin 15 can work hat DHT must be discennested during program upload
DHT dht (DHTPIN, DHITYPE):
int ms0p125 0.
char disp. flag 0:
```

```
void setup()
Serial, hegin(9600);
Icd.begin():
 Turn on the blacklight and print a message. led.backlight();
Icd.setCursor(0, 3); led, print("IOT-AIRPOLLUTION");
Icd.setCursor(0, 1): lcd.print("MONITORING SYS):
//Serial.println("Calibrating MQ7"):
mq7.calibrate();
Serial printin (F(DHT)
dht.begin();
elif();//stop interrupts
TOCR2A 0; // net entire TCCR2A register to 0
TOOR280:// same for TCURIB
TCNT20:
OCRZA 249,1/ (10-100) / (8000+5) I must be <256)
JOCR2A (1 <<< WGM21):
TCCR2B = (1 << CS21)
enable timet compare interrupt
TIMSK2 (1<<<          ):
set();//allow interrupt
led.clear(
ISR(TIMER2.COMPA.vect)
{
++mslp125:
if (ms0p 125 4000) // 500mk
{
disp.flug 1:
ms0p125 0:
void loop()
{
Running Average Buffer | NextRunning Averagel++ analogRead(AU):
if (NextRunning Averagel Running AverageCount) NextRunning Averagel 0
Running Average Volti = 0;
for (il=0: il RunningAverageCounti: ++il) Running Average Volt1 +=Running AverageBuffer) [il]
Running AverageVolti / Running AverageCounil:
if(disp.flag = 11
Atmospherie C Level 4100ppm
Average indour 350-450ppm
Maximum acceptable 1000 ppm
Dangerous co  levnis >2000ppm
mapi(int) Running Average Volti, 0, 1023, 400, 5000):
4001002 400: else if (co2 > 5000) co2 5000
(int imq7, readIpm(); //20-2900pm
ifico < Dico 0:
else if(cu 9999]co
float h dht.readHumidity():
float t =dht read Temperature():
float f =dht read Temperature(true))
if (isnan (h) || lsman (1) || isnan (T))
return:
```

```
float hic
dht.computeHeatIndesit, h, false);
Serial.print(Ft Humidity: 11:
Serial.print(h):
Serial.print():
Serial.print(F("C")):
Serial, print(F):
Serial.print("STemp:");
if(110) Serial.print("")
else ifit < 100) Serial print(" ");
Serial.print(1, 2); Serial.print("degC, Humy:");
ifth < 10) Serial.print("");
else ifth < 100) Serial.print(" "):
Serial.print(h. 0);
Serial.print("SRH. CO2:");
if (co2 < 10) Serial.print("");
else if (co2 < 100) Serial print(""):
else if (co2 < 1000) Serial.print("");
Serial.print(co2): Serial.print("ppm, CD: ");
ifico < 10) Serial.print("
else if (co < 100) Serial, print(" ");
else if (co <1000) Serial.print("");
Serial.print(co);
Serial.println("ppens");
//lcd.setCursor(0, 0); lcd.print("C02:1000 ppm T:21");
//lcd.setCursor(0, 1): lcd print CD:1000 ppm H:99");
Icd setCursor(0, 0);
Icd.print("002);
if (co2 < 10)1cd.print(" ") else if (co2 < 100)led print("");
else if (co2 1000) Icd.print("");
led.print(co2):
led print("ppm T");
if (t< 10) led.print(");
led.print(t0):
lcd.setCursor(0, 1);
Icd.print("00");
if (eo< 10)led.print(":
else ifien < 100) led print(" ");
else if (co1000)
led.print():
led, print(co):
led print (ppm H:");
if (h< 10)led.print("");
lcd.print(h. 0);
disp. flag 0:
}
delay(101:
}
```

Output

Figure 6.1: **Detection of Air Pollution**

The above figure 6.1 represents an IOT based air quality sensing network with a web server, the outputs are typically presented and accessed through a web interface. By utilizing this, the system provides a user-friendly interface accessible via web browsers.

Chapter 7

CONCLUSION AND FUTURE ENHANCEMENTS

7.1 Conclusion

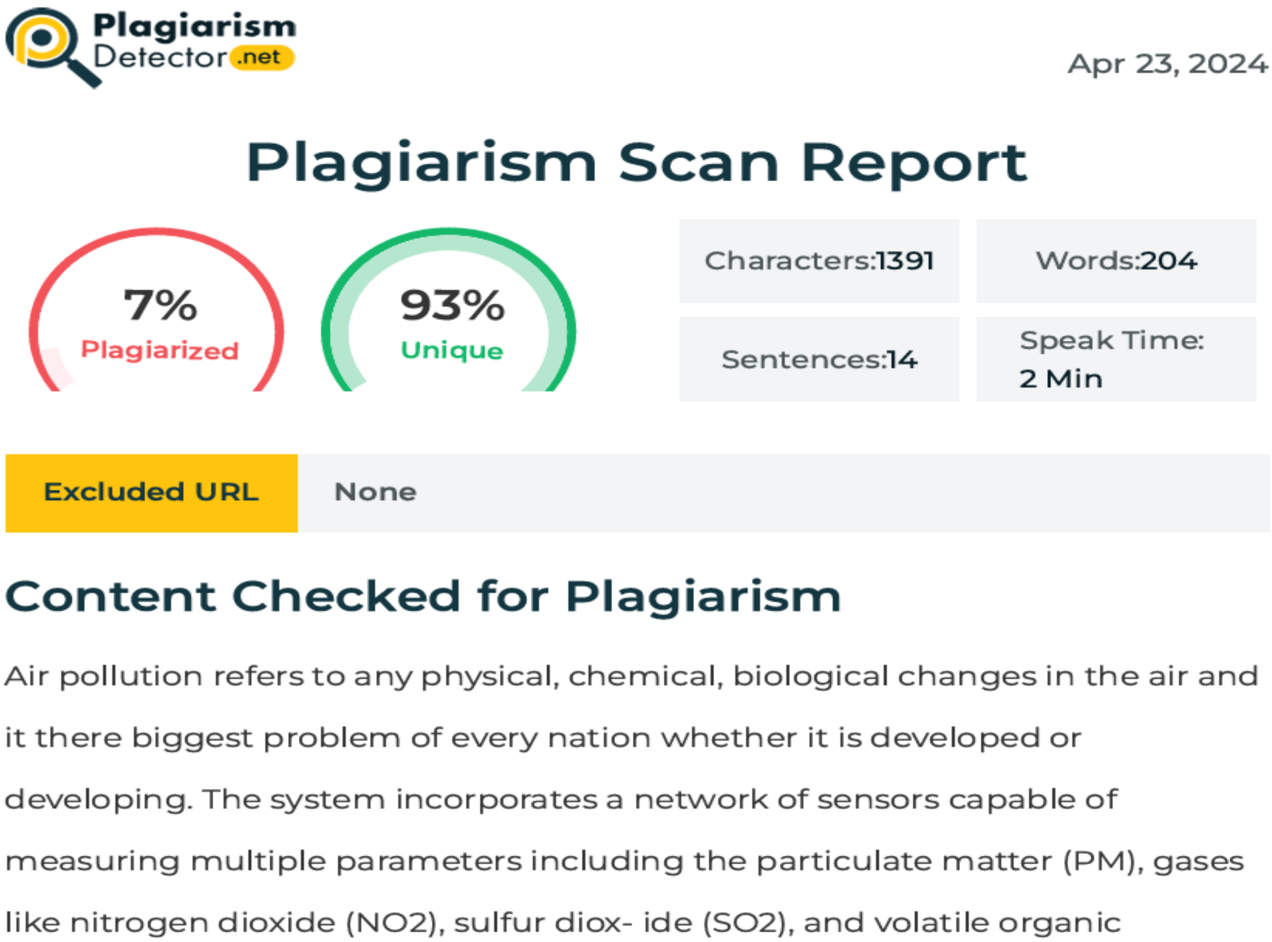
After performing several experiments, it can be easily concluded that the setup is able to measure the air quality in ppm, the temperature in Celsius and humidity in percentage with considerable accuracy. The results obtained from the experiments are verified through Google data. Moreover, the led indicators help us to detect the air quality level around the setup. However, the project experiences a drawback that is it cannot measure the ppm values of the pollutant components separately. This could have been improved by adding gas sensors for different pollutants. But eventually, it would increase the cost of the setup and not be a necessary provision to monitor the air quality. Therefore, it is possible to conclude that the designed prototype can be utilized for air quality, humidity and temperature of the surrounding atmosphere successfully.

7.2 Future Enhancements

The future scope is that device which we are having can be done in an compact way by reducing the size of the device For further implementation or the modifications which can be is that detecting the vehicles amount of pollution which can be determined.Infuture the range can be made increased according to the bandwidth for the high range frequencies. Further research can be made by making the people in the right direction for their welfare. Therefore there is another beneficiary by using this device in an app so the all can be used in an GSM mobile phones for their daily updates by increasing their range.

Chapter 8

PLAGIARISM REPORT


Plagiarism Detector .net

Apr 23, 2024

Plagiarism Scan Report

7% Plagiarized

93% Unique

Characters:1391	Words:204
Sentences:14	Speak Time: 2 Min

Excluded URL	None

Content Checked for Plagiarism

Air pollution refers to any physical, chemical, biological changes in the air and it there biggest problem of every nation whether it is developed or developing. The system incorporates a network of sensors capable of measuring multiple parameters including the particulate matter (PM), gases like nitrogen dioxide (NO2), sulfur diox- ide (SO2), and volatile organic

Figure 8.1: **Plagiarism Report**

Chapter 9

SOURCE CODE & POSTER PRESENTATION

9.1 Source Code

```
include Liquid Crystal.h
include DHT .h
define DHTPIN A0
define DHTTYPE DHT11
DHT dht (DHTPIN, DHTTYPE):

const int rs =8, en = 9, d4 = 10, d5 = 11, d6 = 12, d7 = 13;

Liquid Crystal led(rs, en, d4, d5, d6, d7);
void setup()

dht.begin();
lcd. begin(16, 2);
void loop()
float h = dht.read Humidity ();

float t = dht. read Temperature();
lcd.setCursos (0,0);

lcd.print( HUMIDITY);
lcd.setCursor(0, 1);
lcd.print(h);
delay(2000);

lcd.clear();

lcd.setCursor(0,0);
```

9.2 Poster Presentation

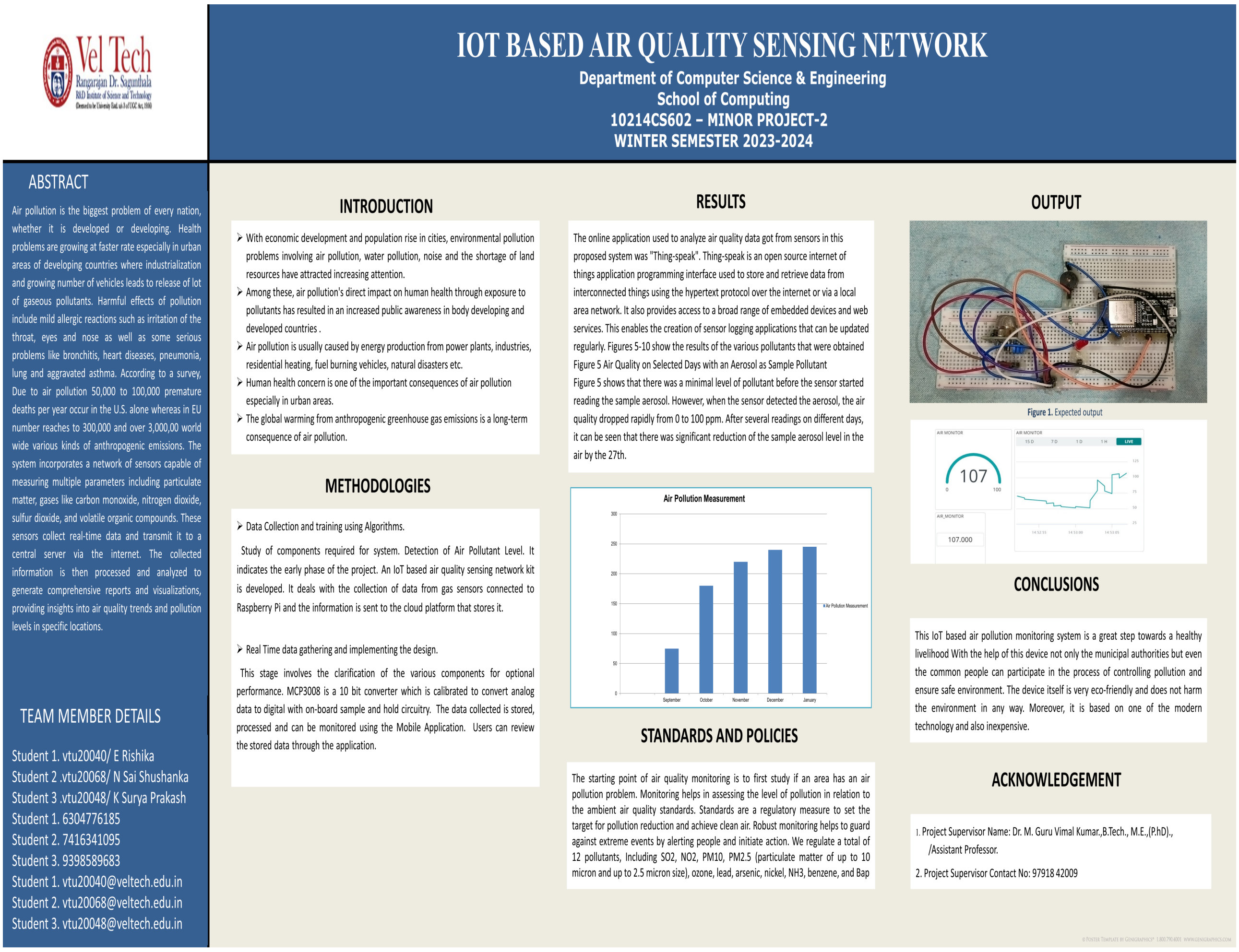


Figure 9.1: **Poster**

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