A
Mini-Project Report
On

Wireless Sensor Network Node to measure Air Pollution

SUBMITTED BY

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PROJECT GUIDE
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D.Y.PATIL COLLEGE OF ENGINEERING
AKURDI, PUNE – 411044

2022-2023

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DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION

CERTIFICATE

This is to certify that **Aditya Jayvant Korade– T190083092** of T.E. E&TC has completed the mini-project on

'Wireless Sensor Network Node to measure Air Pollution'

satisfactorily under my supervision and guidance and submitted the project report in complete fulfillment of requirement for the award of TE (E&TC) Degree of Engineering course under the Savitribai Phule Pune University, Pune during the academic year 2022-2023.

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DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION

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This is to certify that following students of T.E. Electronics & Telecommunication have completed the mini-project on **‘Wireless Sensor Network Node to measure Air Pollution’** satisfactorily under my supervision and guidance and submitted the project report in complete fulfillment of requirement for the award of Bachelors Degree of Engineering course under the Savitribai Phule Pune University, Pune during the academic year 2022-2023.

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CHAPTER -1
INTRODUCTION

The issue of pollution has become a global concern in recent times, with a significant impact on the environment and human health. To address this issue, it is necessary to have accurate and timely data on the level of pollutants in different regions. Traditional methods of collecting pollution data are often limited by factors such as cost, time, and accuracy. However, with advances in technology, data acquisition systems using multi-node have emerged as a viable solution for collecting pollution data from various areas.

The data acquisition system using multi-node is a network of sensors that are distributed in different locations to monitor the level of pollutants. These nodes are equipped with sensors for measuring various types of pollutants, including air quality, water quality, and noise pollution. The data collected by these nodes are transmitted to a central server, where it is analyzed and stored. The system provides real-time data, which can be used for environmental monitoring and pollution control.

This project report aims to describe the development and implementation of a data acquisition system using multi-node for collecting pollution data from various areas. The report includes details about the system architecture, hardware and software components, communication protocols, and data analysis techniques. The effectiveness of the system is demonstrated through experimental results obtained from field tests conducted in different regions. The report concludes by discussing the system's advantages, limitations, and potential applications in environmental monitoring and pollution control.

CHAPTER -2
Literature survey

Ref No	Year and Publication	Objective	Methodology	Conclusion
1	2019(IEEE)	A low cost, open source Supervisory Control and Data Acquisition (SCADA) system for solar photovoltaic (PV) system monitoring and remote control	Utilizes Internet of Things (IoT) SCADA Architecture which incorporates web services for data analysis. Arduino Uno micro-controller serves as a Remote Terminal Unit to receive the acquired sensor data, Raspberry Pi with a Node-RED programming tool.	Developed Dashboards and Charts showing the acquired data on Emmons's server where an operator can monitor the data in the cloud using both a computer with internet access, and Emmons's mobile app are presented in the paper.
2	2018(IEEE)	This paper proposes a novel data collection technique using Unmanned Aerial Vehicles (UAVs) in dense wireless sensor networks (WSNs) using projection-based Compressive Data Gathering (CDG) as a solution methodology.	Developed device gathers data from heads to a remote sink to enhance efficiency by avoiding long range transmissions from heads to the sink.	Decomposed the problem into separate parts and propose a heuristic to solve each sub problem for large-scale network scenarios.
3	2022(IEEE)	Wireless Sensor Networks should be self-automated and there must be a continuous power supply for the proper functioning of sensor networks.	Sensor nodes are established, and when data from the environment is meant to be collected and relayed to a base station.	This paper analyses the use of energy harvesting in sensor nodes which is powered by batteries, dramatically lowering the cost of battery replacement.
4	2023(IEEE)	Focuses on the problem of data collection in WSNs with the minimum mobile nodes.	Minimizing the number of mobile nodes, we formally prove that the problem of minimizing the number of mobile nodes required by periodical data collection in WSNs is NP hard. We propose a path planning	Our simulation results show that our approach can notably reduce the number of required mobile nodes as much as 55.6%

			algorithm to minimize the number of mobile nodes.	
5	2022(IEEE)	Study is addresses to the ones that carry out their activity in the university environment, implementation of acquisition systems of audio signals.	Data acquisition systems are implemented using either the Arduino UNO development board or the Raspberry Pi 3B, board in both the graphical programming environment LabVIEW and Simulink.	Obtained Correct implementation of the two acquisition systems allows obtaining similar virtual results in the analysis of audio signals.
6	2022(IEEE)	Sensed and collected data from sensor is communicated to the end user via the sink node using multi-hop transmission.	Wireless sensor network has been deployed with thousands of sensor node which are operated with energy Constrained battery. All the activities such as sensing environment parameters, processing, coding, transmission, reception etc., involves energy consumption in WSN	This paper summarizes the energy consumed in a WSN and provides an insight for further research in WSN.
7	2022(IEEE)	Digitizing the solar generation pattern serves various purposes, collected data being used for further research, forecasting of solar generation in future, identifying faults by analyzing the real time solar generation data	Raspberry Pi with Internet of things (IOT) and the second method uses Arduino Uno without IOT. Direct voltage (DC), direct current (DC), temperature and light intensity are the parameters measured.	In this system we developed a data acquisition system to analyze solar generating data.
8	2019(IEEE)	Introduce an alternative solution to the many existing IoT data acquisition and storage systems.	Present a self-designed and developed prototype electronic circuit extension for Raspberry Pi development board used for collecting sensor data. There is also presented a Pi4Java API based Java application used for sensor data collection and storage	Presented system is a full IoT data acquisition, storage and visualization solution
9	2020(IEEE)	Aiming at the defects of traditional networks, this paper proposes a	Dynamic clustering algorithm is used to cluster the randomly arranged	This paper clusters and randomly arranges sensor nodes, and then manually

		scheme for collaborative data collection using multiple mobile nodes (MN) as sink nodes	sensor nodes, and then a sensor node with higher energy is manually arranged at the virtual cluster center generated by the clustering algorithm.	arranges cluster head nodes on the generated virtual cluster center, and then divides the monitoring network into fan-shaped regions

CHAPTER -3
Problem Statement with Objectives

Problem Statement:

1. Air pollution is a major concern in urban areas, and there is a lack of real-time monitoring systems to accurately measure and analyze pollutant levels. This hinders the implementation of effective pollution control measures and poses a risk to public health and the environment.
2. Existing air pollution monitoring systems are often expensive, require complex infrastructure, and are not easily scalable. This restricts their deployment in various locations and limits the ability to gather comprehensive data on air pollution levels, especially in remote or underserved areas.
3. Air pollution is not limited to outdoor environments; indoor air quality also plays a significant role in human health. However, there is a lack of cost-effective and reliable wireless sensor network nodes that can monitor and provide real-time data on indoor air pollutants, making it challenging to identify and address indoor air quality issues effectively.

Objectives:

1. The aim of this wireless sensor network node project is to develop a low-cost, scalable, and reliable system for measuring and monitoring air pollution levels in urban areas.
2. The objective of this project is to design and implement a wireless sensor network node that can be easily deployed in different locations, including remote and underserved areas.
3. The goal of this project is to develop a wireless sensor network node specifically designed for monitoring indoor air pollution as well as suitable for outdoor conditions. The node should be compact, portable, and capable of detecting pollutants commonly found indoors.

CHAPTER -4
Specifications of Project

Hardware Components:

- Arduino Uno: Microcontroller board used for data collection and processing.
- Arduino Nano: Microcontroller board used as a receiver for the data transmitted by the Arduino Uno.
- NRF24L01 Wireless Module: Used for wireless communication between the Arduino Nano and Arduino Uno.
- MQ7 Sensor: Carbon monoxide (CO) gas sensor used to measure CO levels in the air.
- MQ135 Sensor: Air quality sensor used to measure the presence of various harmful gases, including ammonia, nitrogen oxides, benzene, and more.
- A total area coverage of 100m.

Data Collection:

- Arduino Uno will be connected to the MQ7 and MQ135 sensors for data acquisition.
- The sensors will provide analog output, which will be read by the Arduino Uno’s analog input pins.
- The Arduino Uno will convert the analog data into digital values and process it.

Wireless Communication:

- The Arduino Uno will utilize the NRF24L01 wireless module to transmit the collected data wirelessly.
- The Arduino Nano, equipped with another NRF24L01 module, will act as the receiver, capturing the transmitted data.

Data Storage:

- The data can be stored in a structured format, such as CSV, for easy retrieval and analysis on the data.

Live Data Plotting:

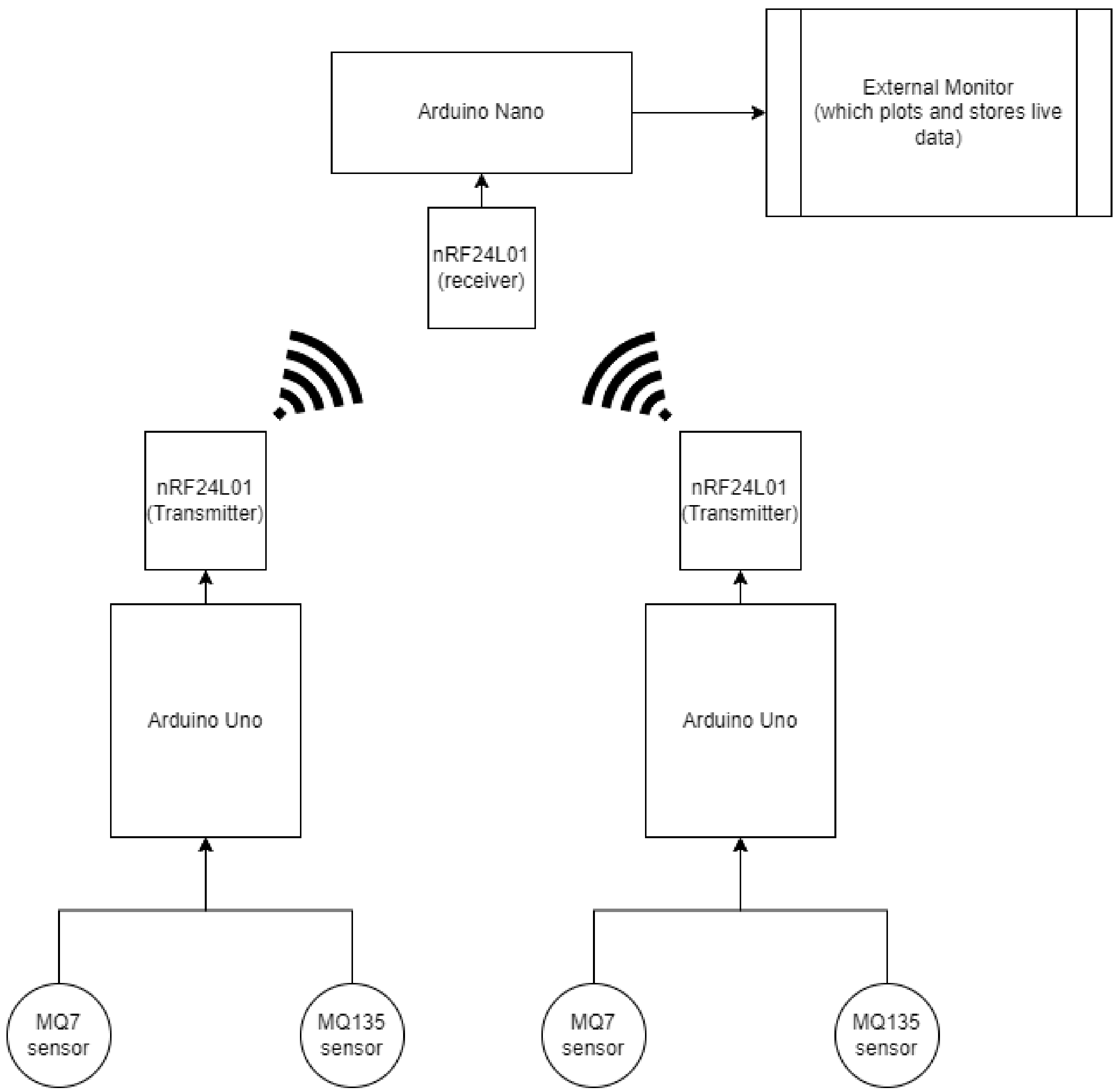
- Software, such as **Excel** and **Tera Term** are being used to receive the data from the Arduino Uno and plot it in real-time.
- The plotted data can be displayed as graphs, charts, or any other visual representation to provide a clear understanding of the air quality measurements.

Power Supply:

- Both Arduino Nano and Arduino Uno can be powered using USB or an external power supply.

CHAPTER -5
Block Diagram

This system serves as a comprehensive solution for capturing, processing, and interpreting the relevant data. Sensors play a crucial role in capturing the raw data, which is then conditioned and converted into digital form by signal conditioning and analog-to-digital conversion modules, respectively. The processed digital data is then passed to a data processing unit, where it undergoes analysis, trend detection, and other computations to identify the downward trend. The acquired data is stored for future reference, and analysis and visualization tools are utilized to present meaningful insights to users. Ultimately, the output of the system provides valuable information for informed decision-making based on the observed downward trend.



[Fig. 5.1 Wireless Sensor Network Node to measure Air Pollution]

Explanation:

In the above figure Fig.. 5.1 two Arduino Uno boards and one Arduino Nano are used, in all 3 microcontrollers. Both the Arduino Uno is connected to two sensors, the MQ135 and MQ7. The MQ135 and MQ7 sensors measure specific air quality parameters. The Arduino Uno is also equipped with an NRF24L01 module, which acts as a transmitter to wirelessly send the sensor data. The Arduino Nano is equipped with another NRF24L01 module, which acts as a receiver to receive the transmitted data.

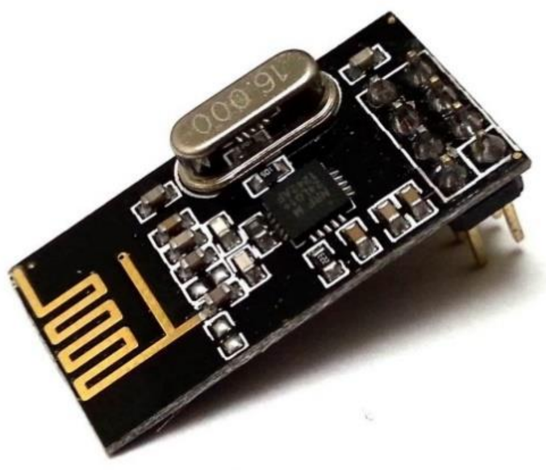
The Arduino Nano board serves as an intermediary for data processing and control. The Arduino Nano board is further connected to a PC, which is responsible for data plotting and storage.

The PC runs appropriate software (i.e. Excel and Tera Term) that receives the data from the Arduino Nano, processes it, and plots the live data in graphical form. The PC also has storage capabilities to store the collected data for further analysis or historical reference. This block diagram represents a setup where two Arduino Uno boards, with the help of NRF24L01 modules, enable wireless communication between sensors and a receiving Arduino Nano. The Nano then interfaces with a PC for real-time data plotting and storage. This setup allows for monitoring and analysis of air quality data from the MQ135 and MQ7 sensors in a convenient and accessible manner.

CHAPTER -6
Selection of components

NRF24L01

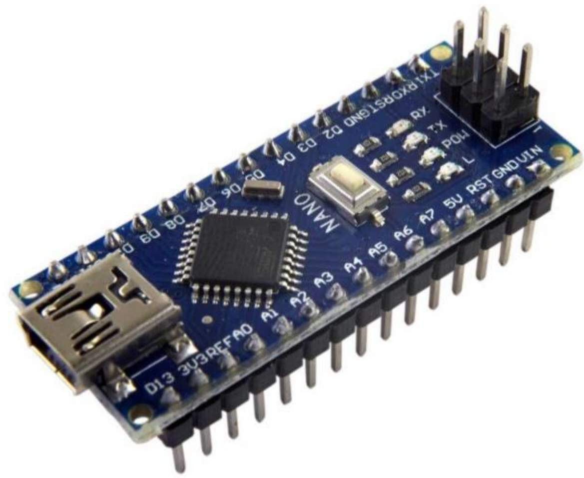
The selection of the NRF24L01 wireless module that is present in the market was driven by the project's requirement for a reliable and efficient wireless communication system between the data collection module and the receiver. The NRF24L01 module stood out as an ideal choice due to its low-cost nature, extensive range, and robust data transmission capabilities. Its ability to operate on the 2.4GHz frequency band ensures reliable and interference-free communication, making it well-suited for transmitting air quality data in real-time.



[Fig. 6.1 NRF24L01]

Arduino Nano

The Arduino Nano was chosen as the main microcontroller board for data collection due to its compact size, low power consumption, and sufficient number of analog input pins. These features make it suitable for integrating with the MQ7 and MQ135 sensors, which provide analog output. The Arduino Nano's compatibility with the NRF24L01 module further solidifies its selection, ensuring seamless integration into the wireless communication setup.



[Fig. 6.2 Arduino Nano]

MQ7 sensor

The MQ7 sensor, specializing in carbon monoxide (CO) detection, was selected based on the critical importance of monitoring this harmful gas for assessing air quality. By accurately measuring CO levels, the sensor provides valuable insights into potential health risks and helps identify pollution sources.

[Fig. 6.3 MQ7 sensor]

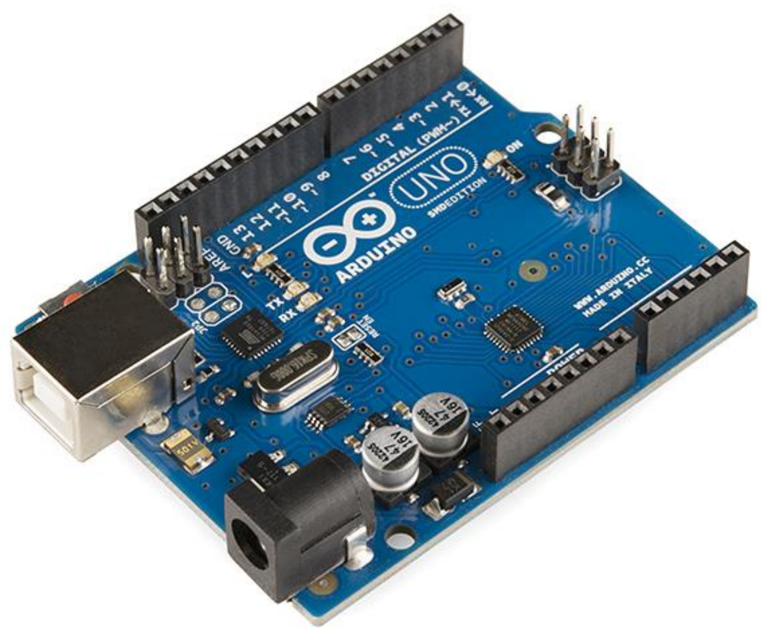
MQ135 sensor

The MQ135 sensor was chosen for its ability to detect a wide range of gases, including ammonia, nitrogen oxides, benzene, and more. This comprehensive gas sensing capability allows for a holistic understanding of the air composition, enabling a more thorough assessment of air quality.

[Fig. 6.4 MQ135 sensor]

Arduino Uno

To transmit data, the Arduino Uno was selected as the transmitter module. Its compatibility with the NRF24L01 module makes it an ideal choice for sensing and wirelessly transmitted air quality data. Additionally, the Arduino Uno offers ample pin (Digital and Analog) going all out with total no of 30 pins which can be used for digital writing, reading and generating PWM, allowing for it to be the most ideal Transmitter.



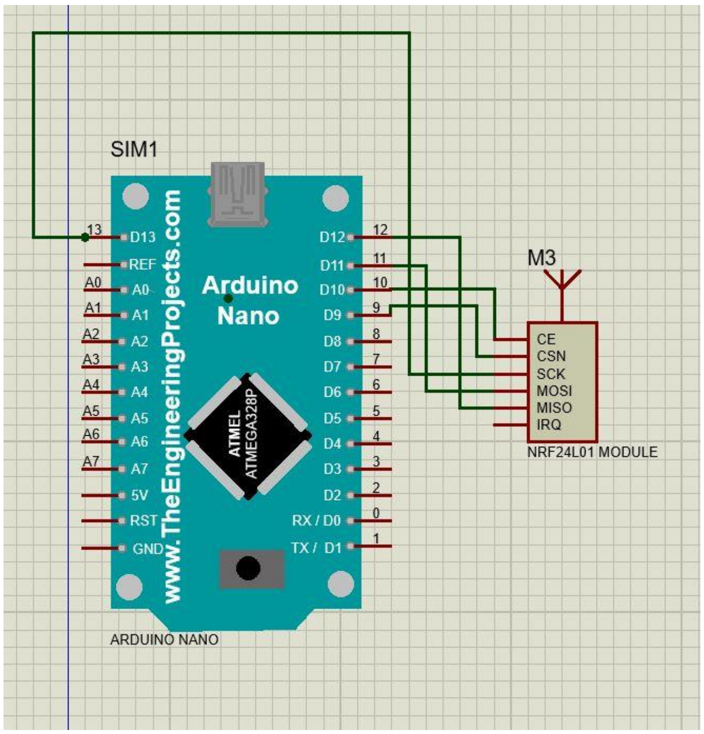
[Fig.6.5 Arduino Uno]

CHAPTER -7
Simulation Results

1. Hardware simulation

In the development of our project, we utilized the Proteus software as a powerful tool for designing and simulating the hardware components. Proteus offered us a virtual environment to create and test the circuitry before implementing it in the physical realm. We leveraged the software's extensive component library, which included popular microcontrollers like the Arduino Uno, Arduino Nano, and NRF24L01 module, as well as the MQ135 and MQ7 sensors. However, to ensure accurate representation and functionality, we downloaded and integrated external libraries specific to these components into the Proteus software. These libraries provided us with accurate models and simulation capabilities, allowing us to validate the hardware design and test its functionality virtually. By using Proteus and integrating the necessary libraries, this implementation could efficiently visualize and troubleshoot the circuit connections, ensuring a reliable and effective hardware setup for our project.

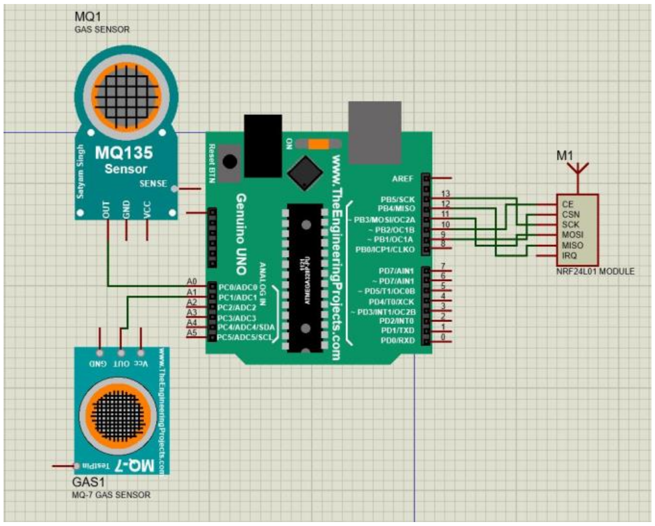
Transmitter:



[Fig.7.1.1 Implementation of Receiver on Arduino Nano]

Figure 7.1.1 showcases the implementation of a receiver on Arduino Nano, simulated on Proteus, utilizing the NRF (Nordic Radio Frequency) module. It delves into the detailed design and simulation of the receiver, exploring the integration of the NRF module with Arduino Nano and examining its performance in terms of signal reception, data processing, and wireless communication capabilities.

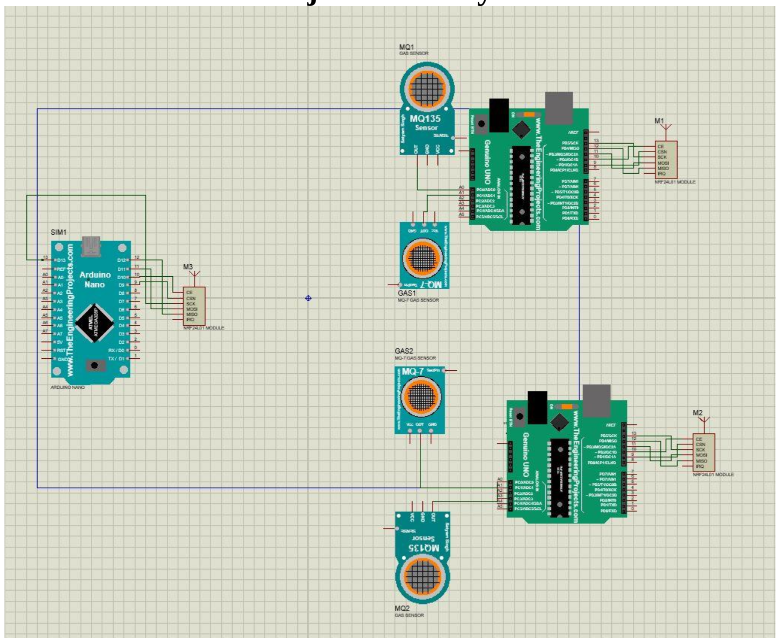
Receiver:



[Fig. 7.1.2 Implementation of Transmitter on Arduino Uno]

Figure 7.1.2 presents a meticulously designed transmitter implemented on Arduino Uno and simulated on Proteus. It showcases the integration of the NRF module, along with two gas sensors, namely MQ7 and MQ135, which contribute to the transmitter's enhanced functionality. It research paper extensively investigates the intricate interconnections between these components, exploring their seamless collaboration in enabling reliable wireless data transmission. Furthermore, it delves into the gas sensing capabilities of the MQ7 and MQ135 sensors, assessing their accuracy and responsiveness within the transmitter system. The comprehensive evaluation of these features sheds light on the overall system functionality and highlights potential applications in areas such as environmental monitoring, industrial automation, and smart sensor networks.

Overall Project Circuitry overview:



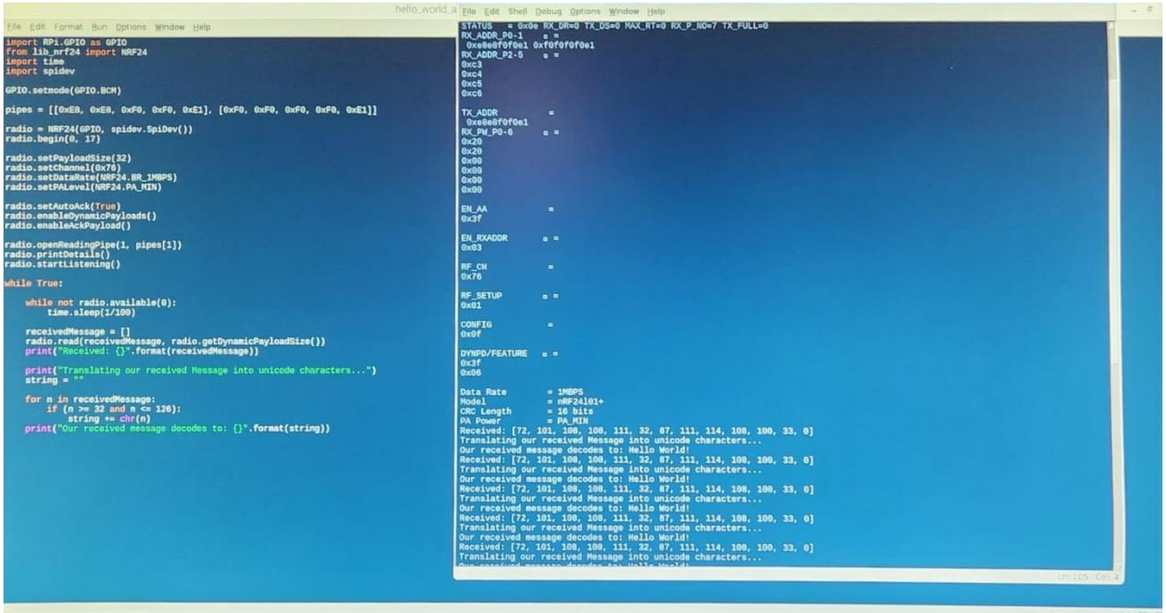
[Fig. 7.1.3 Implementation of complete project]

Figure 7.1.3 depicts the implementation of the complete project, which combines the receiver on Arduino Nano (simulated on Proteus with the NRF module) and the transmitter on Arduino Uno (also simulated on Proteus with the NRF module), along with the integration of two gas sensors, MQ7 and MQ135.

2. **Software simulation**

The process of establishing a connection between two Arduino boards using the NRF24L01 wireless module as both the transmitter and receiver at the same time was a challenging task, but ultimately successful. The NRF24L01 module served as the crucial link, facilitating wireless communication between the two devices.

Initially, configuring the NRF24L01 modules on both Arduino boards required careful attention to the wiring and initialization parameters to ensure compatibility and reliable data transmission. Once the modules were properly connected and initialized, the transmitter Arduino, equipped with one NRF24L01 module, was prepared to send the first message.



[Fig.7.2.1 – Simulation of duplex transmission]

The message chosen for the initial transmission was a simple "Hello, World!" as shown in the above given figure (Fig.7.2.1) to serve as a test signal. The message was encoded using a predefined protocol, consisting of a specific format and set of rules. The transmitter Arduino packaged the message and wirelessly transmitted it using the NRF24L01 module.

On the receiver Arduino, equipped with another NRF24L01 module, the transmitted message was eagerly awaited. The receiver Arduino continuously listened for incoming signals from the transmitter, ready to capture and decode the data. Upon receiving the "Hello, World!" message, the receiver Arduino successfully decoded the encoded message, marking the establishment of a successful connection between the two Arduino boards.

CHAPTER -8
PCB Art work

In our project, creating a Printed Circuit Board (PCB) was an essential step in the hardware implementation. To design the PCB artwork, we followed a commonly used technique called the iron-on method, which allows for easy and cost-effective fabrication of prototype PCBs.

The process began with designing the PCB layout using computer-aided design (CAD) software EasyEda (which is shown in Fig.8.3). This involved placing the components, routing the traces, and defining the copper areas for the circuit connections. Once the PCB layout was finalized, we printed the artwork onto a glossy paper using a laser printer. It's crucial to ensure that the printer settings are adjusted to achieve high-quality prints with precise dimensions.

By utilizing the iron-on method, we were able to create our own custom PCBs quickly and cost-effectively. It provided us with the flexibility to iterate on the design and quickly test and validate our circuitry.

Here are the rules for PCB designing.

Rule 1: Choose the right grid-set and always use the grid spacing that matches the most components.

Rule 2: Keep the path shortest and most direct.

Rule 3: Use the power layer as much as possible to manage the distribution of power lines and ground lines.

Rule 4: Group related components together with the required test points.

Rule 5: Copy the required circuit board on another larger circuit board multiple times for PCB imposition.

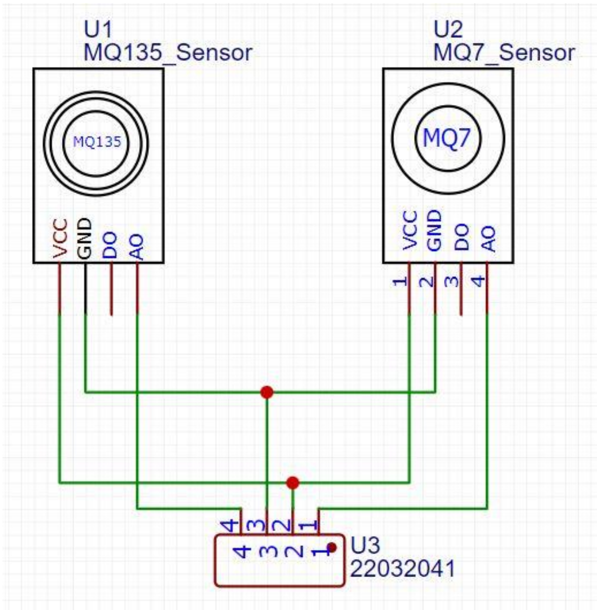
Rule 6: Integrate component values.

Rule 7: Perform design rule checks (DRC) as much as possible.

Rule 8: Use screen printing flexibly.

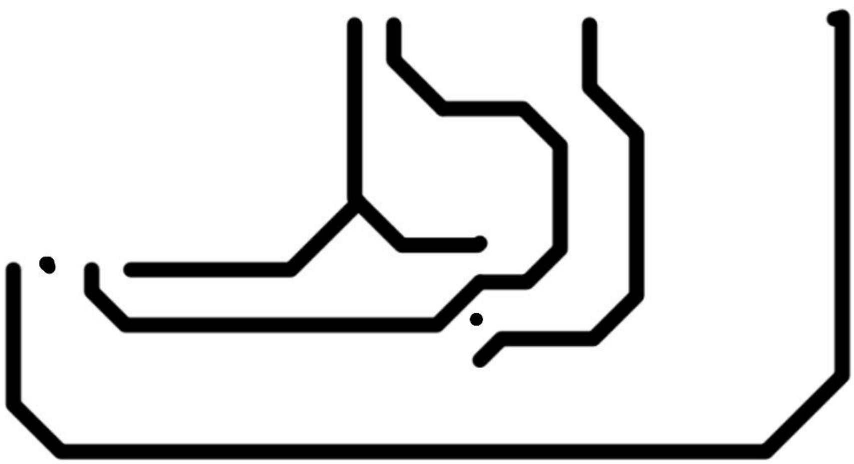
Rule 9: Decoupling capacitors must be selected.

Rule 10: Generate PCB manufacturing parameters and verify them before submitting for production.



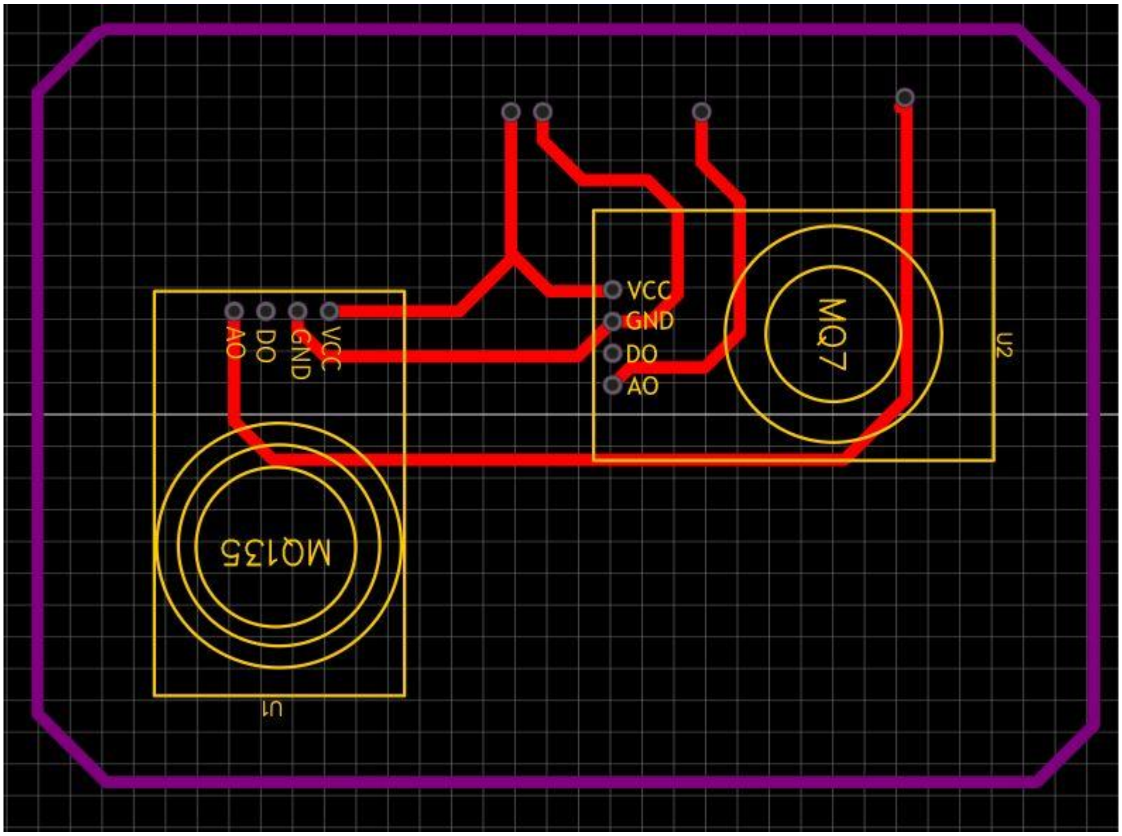
[Fig.8.1 - Schematic PCB layout of transmitter]

Figure 8.1 illustrates the schematic PCB layout of the transmitter, providing a detailed visual representation of the circuit design and component placement. It extensively examines the transmitter's PCB layout, focusing on the optimization of signal paths.



[Fig.8.2 - PCB layout of transmitter mount for Arduino Uno]

Figure 8.2 showcases the PCB layout of the transmitter mount specifically designed for Arduino Uno. It thoroughly explores the layout design, considering factors such as component placement, signal routing, and mechanical compatibility with Arduino Uno.



[Fig.8.3 - PCB editing easyeda.com]

Figure 8.3 highlights the PCB editing process using the EASEDA.com platform. It delves into the utilization of EASEDA.com as a powerful tool for designing and editing PCB layouts.

CHAPTER -9
Testing Procedures

To validate the performance and accuracy of the MQ7 and MQ135 sensors, a comprehensive testing procedure was implemented. An incense stick was utilized as a reference source to assess the response of the sensors to a known concentration of pollutants. The incense stick was burned at a controlled distance from the sensors, allowing the emitted smoke and gases to interact with the sensing elements. The sensor outputs were recorded and analyzed to determine the correlation between the measured values and the expected concentration of pollutants.

Furthermore, additional testing involved burning various materials known to release specific gases, such as carbon monoxide, ammonia, and volatile organic compounds (VOCs). For instance, controlled experiments were conducted by burning small amounts of propane gas to evaluate the sensitivity and response time of the MQ7 sensor to carbon monoxide. The sensor outputs were observed and compared with the expected levels of the respective gases, enabling the assessment of the sensors' accuracy and reliability. During the testing procedure, careful attention was given to maintaining a controlled environment and minimizing external influences that could affect the sensor readings. Factors such as temperature, humidity, and airflow were monitored and kept within acceptable ranges to ensure consistent and accurate measurements.

The recorded data from the testing procedure were analyzed and compared against known pollutant concentrations to determine the sensitivity, selectivity, and overall performance of the MQ7 and MQ135 sensors. This analysis helped in calibrating the sensors and establishing appropriate thresholds for detecting and quantifying specific gases in real-world scenarios. By employing the incense stick as a reference source and conducting controlled tests using various materials, the testing procedure provided valuable insights into the responsiveness and accuracy of the MQ7 and MQ135 sensors. The results of these tests contribute to the reliability and credibility of the collected air quality data, enabling users to make informed decisions based on accurate pollutant measurements.

Timestamp	Arduino 1 MQ135	Arduino 1 MQ7	Arduino 2 MQ135	Arduino 2 MQ7
7:33:59 PM	157	160	266	266
7:34:01 PM	157	160	266	266
7:34:03 PM	167	166	265	265
7:34:05 PM	167	166	265	265
7:34:07 PM	179	171	265	265
7:34:09 PM	179	171	265	265
7:34:11 PM	168	166	265	265
7:34:13 PM	168	166	265	265
7:34:15 PM	159	159	264	264
7:34:17 PM	159	159	264	264
7:34:19 PM	156	155	264	264
7:34:21 PM	156	155	264	264
7:34:24 PM	155	178	266	266
7:34:26 PM	155	178	266	266
7:34:28 PM	170	170	266	266
7:34:30 PM	170	170	266	266
7:34:32 PM	157	157	266	266
7:34:34 PM	157	157	266	266
7:34:36 PM	167	169	265	265
7:34:38 PM	167	169	265	265
7:34:40 PM	157	156	265	265

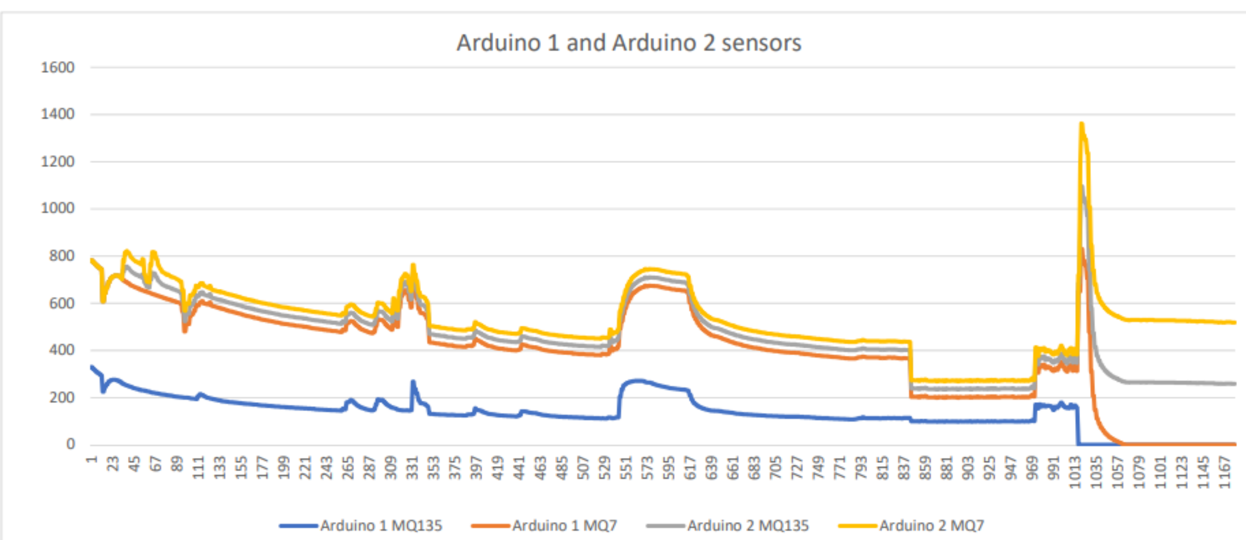
Above given table presents the sample data recorded using Tera Term software from all the sensors received at the receiver end. Specifically, data from four different sensors is captured, providing valuable insights into their respective measurements. It explores the implementation of data acquisition protocols, highlighting the seamless transmission and reception of sensor data through the wireless communication system. The analysis of the recorded data offers a comprehensive understanding of the sensor outputs, enabling in-depth analysis, interpretation, and potential applications in various domains such as environmental monitoring, industrial automation, or scientific research.

CHAPTER -10
Test Results

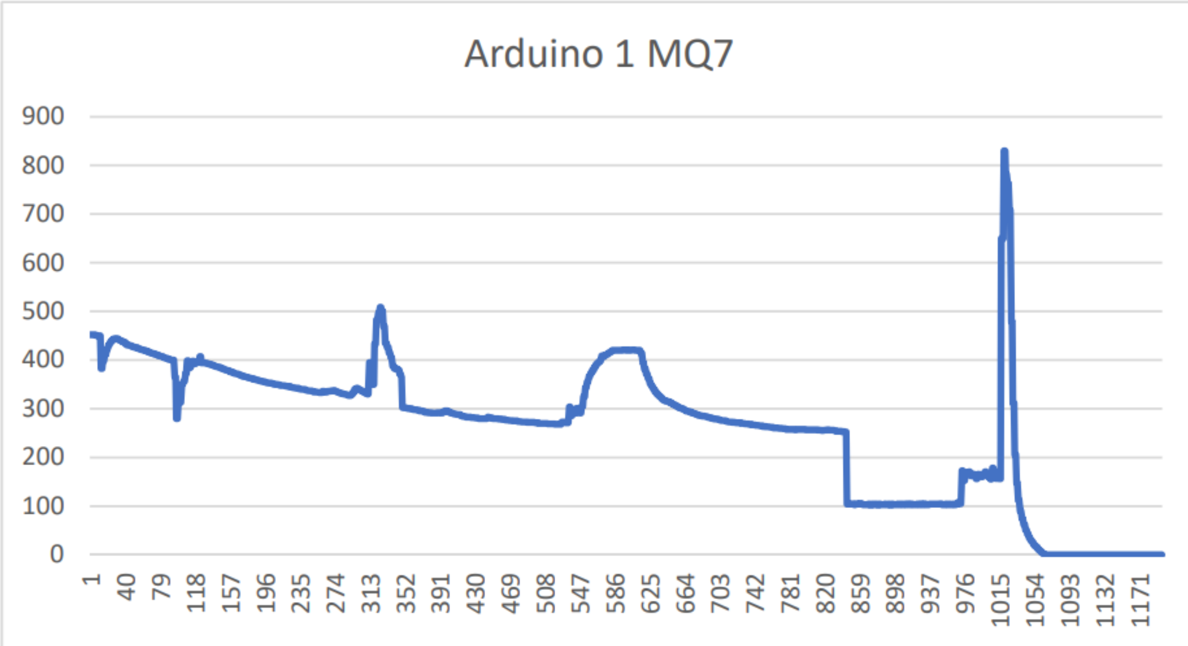
To accurately interpret test results from the project involving the MQ7 and MQ135 sensors, it's important to understand the purpose of these sensors and the significance of the data they collect. The MQ7 sensor is commonly used for detecting carbon monoxide (CO) gas, while the MQ135 sensor is used for measuring air quality, particularly the concentration of harmful gases like ammonia (NH3), carbon dioxide (CO2), and volatile organic compounds (VOCs).

For testing procedure, we used the 2 different rooms for collecting data where we alternatively changed the environment (by burning essence stick). We came across quite good and expected results.

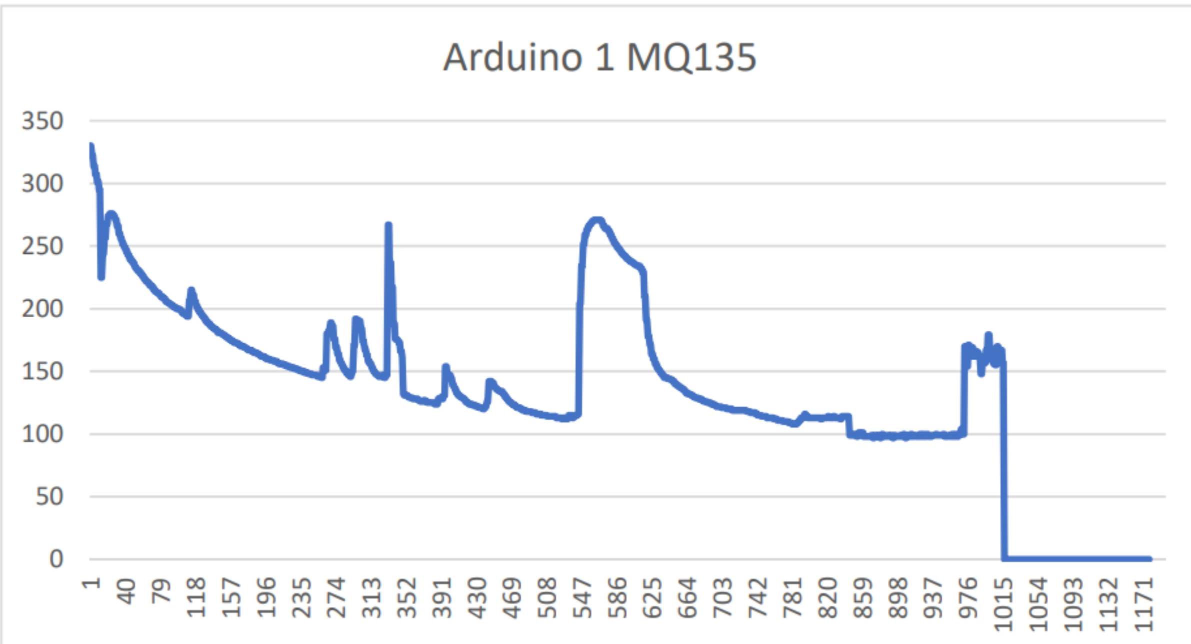
When conducting tests with the MQ7 and MQ135 sensors, you collect data over a certain period to monitor the levels of carbon monoxide and various gases present in the air. This data can be represented in the form of a chart, where the x-axis typically represents time, and the y-axis represents the sensor readings or gas concentrations.



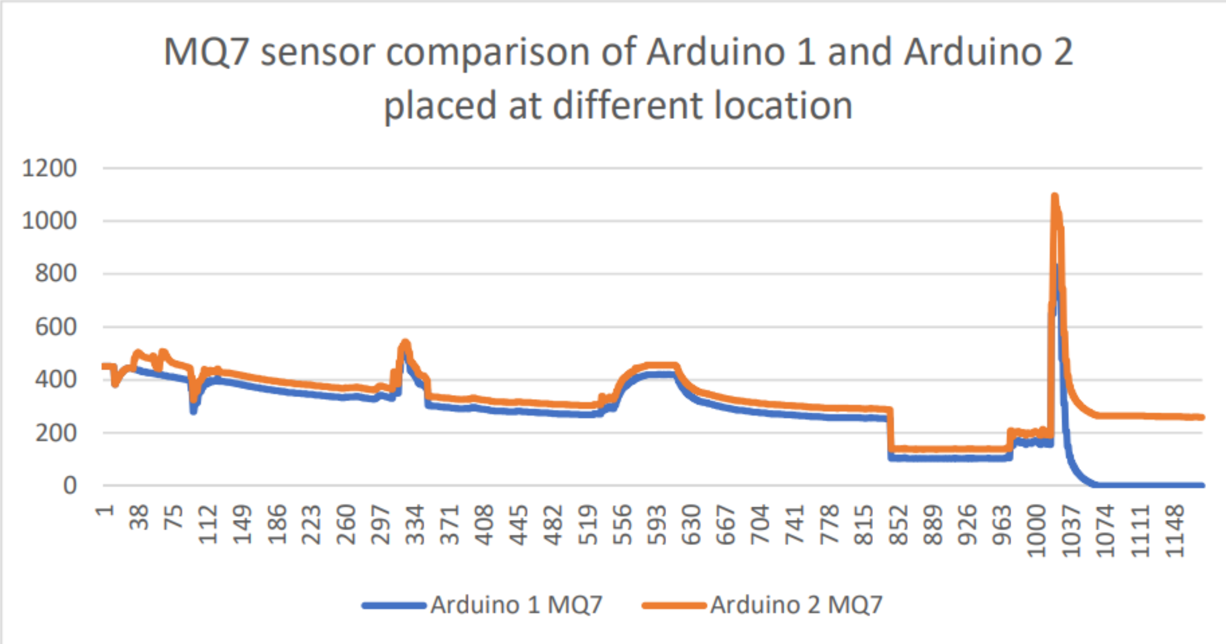
[Fig.11.1 – Graphical representation of all the sensors present in 1 single different at different corners, stating density of CO and CO_2]



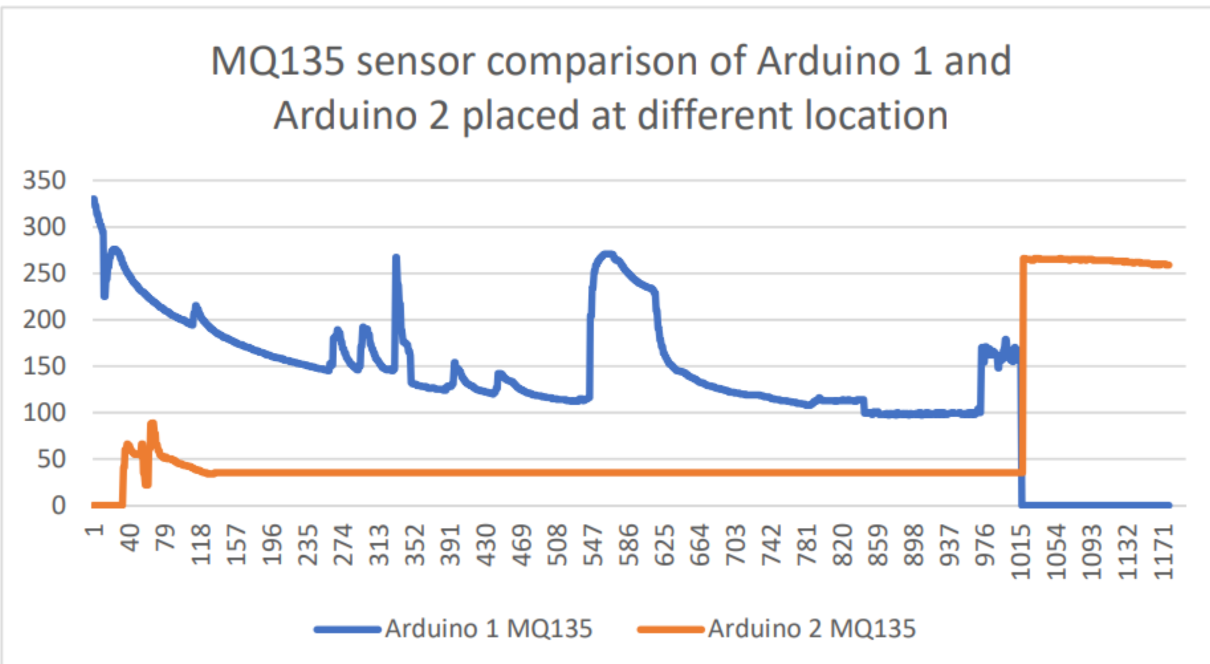
[Fig.11.2 – Data recorded by Arduino 1 MQ7 sensor recording CO levels]



[Fig.11.3 – Data recorded by Arduino 1 MQ135 sensor recording CO_2 levels]



[Fig.11.54 – MQ7 sensor data comparison in same room but at different corner.]



[Fig.11.5 – MQ135 sensor data comparison in different room having polar opposite environment situation.]

NOTE*

Peak/Increasing Trend – *states that the environment had increase level of toxic gasses.*

Declining trend *– States that the it was done by introducing fresh air in the room.*

Steady trend *– States that the room is at normal environmental setting.*

The below given values on the X axis is nothing but time which is given in seconds, which won't be practical for industry, it is just a demonstration of project, the system recorded data for 19 mins.

Within the collected data, you may notice distinct points or peaks that indicate high concentrations of specific gases. These peaks represent the highest recorded values during the testing period. The significance of these peak points can vary based on the specific gas being measured and the context of the test.

For the **MQ7 sensor**, a peak point in the chart would indicate a spike in the carbon monoxide level. Carbon monoxide is a toxic gas produced by incomplete combustion processes, and high levels can pose severe health risks. Identifying peak points in the chart can help determine if there are specific events or situations causing an increase in carbon monoxide, such as the malfunctioning of gas-burning appliances or exposure to high levels of exhaust fumes. In the case of the **MQ135 sensor**, the peak points on the chart may represent elevated concentrations of various gases like ammoni, carbon dioxide, or volatile organic compounds. These gases can be present due to factors such as poor ventilation, industrial emissions, or the use of certain chemicals. Identifying peak points and understanding the corresponding gas can help identify potential sources of pollution or areas with poor air quality.

CHAPTER -11
Conclusion

In conclusion, the wireless sensor network node in short, the data acquisition system using multiple nodes for collecting pollution data from various areas is an innovative project that has the potential to significantly improve air quality monitoring. The use of multiple nodes and sensors allows for a more comprehensive view of air quality, which can help in identifying air pollution hotspots and developing strategies to reduce emissions.

The project utilizes the NRF24L01 radio frequency module, MQ7, and MQ135 sensors, and microcontrollers to collect and transmit data in real-time. The project has many practical applications, including traffic-related air pollution monitoring, indoor air quality monitoring, industrial emissions monitoring, and environmental health monitoring.

The future scope of the project includes the integration of IoT platforms with wider range of communication and machine learning algorithms to provide more comprehensive data analysis and insights. Mobile applications can also be developed to provide users with real-time air quality information. Additionally, the project can be improved by integrating it with other sensors to measure additional air pollutants and by using energy-efficient designs for the sensors and microcontrollers.

Overall, the data acquisition system using multiple nodes for collecting pollution data is a significant step towards better air quality monitoring and has the potential to play an essential role in reducing air pollution levels and protecting public health.

CHAPTER -12
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