AIR QUALITY MONITORING AND IMPROVEMENT SYSTEM

A PROJECT REPORT

Submitted to

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CERTIFICATE

Certified that the Project Work titled '**Air Quality Monitoring And Improvement System'** is carried out by **Mr. Ganesh Shridhar Hegde**, USN: **4SU19IS009, Mr. Laxminarayana S Bhat Alekha**, USN: **4SU19IS011, Mr. Prajwal L**, USN: **4SU19IS016, Mr. Rohit Narayan Nayak**, USN: **4SU19IS022,** bonafide students of SDM Institute of Technology, Ujire, in partial fulfillment for the award of the degree of **Bachelor of Engineering** in Information Science and Engineering of Visvesvaraya Technological University, Belagavi during the year 2022-2023. It is certified that all the corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said Degree.

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Abstract

This project aims to improve indoor air quality by implementing an air purification system using an Arduino Uno microcontroller and an MQ135 sensor. The MQ135 sensor can detect various gases in the air, including VOC and CO_2. An Arduino Uno is used to control a microalgae-based air purification system that uses spirulina to remove pollutants from the air. The air purification system grows spirulina in a controlled environment using CO_2 and nutrients in the air. The cleaned air is then returned to the environment. The system was tested in a controlled environment and showed significant improvement in air quality as measured by the MQ135 sensor. This project offers a sustainable and cost-effective solution for cleaning indoor air. Using microalgae as a cleaning mechanism is an ecological approach to solving the problem of poor air quality. Arduino Uno microcontroller implementation provides a flexible way to control the system. Overall, this project demonstrates the potential of using an Arduino Uno microcontroller and a microalgae-based air purification system to improve indoor air quality.

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Chapter 1

Introduction

In recent years, air pollution has become one of the most important public health concerns due to its negative impact on human health and the environment. Outdoor air pollution has been a major problem for decades, but indoor air quality has also become a concern. Poor indoor air quality can lead to various health problems such as respiratory diseases, headaches and allergies. This has led to increased interest in developing effective indoor air quality solutions. One of these solutions is the use of air purification systems that can remove pollutants from the air inside the house. The need for air filters can be traced back to the 1800s, when John Tyndall first identified the presence of airborne particles in the air. Studies in the 1900s linked exposure to indoor air pollution to respiratory diseases and other health problems.

Today, air purification systems are used in various environments, including residential, commercial and industrial environments. These systems work by removing pollutants and contaminants from the air, improving indoor air quality and promoting better health. The development of air filtration technology is carried out due to the need to create a cleaner and healthier indoor environment and makes the use of sustainable and environmentally friendly methods an important point in this field. In this context, the above project aims to develop an air quality monitoring and improvement system to optimize indoor air quality using Arduino Uno microcontroller and MQ135 sensor. Using microalgae-based air purification is a green and sustainable approach to air purification, and spirulina is a very effective microalgae in removing air pollutants. This system involves growing spirulina in a controlled environment using ambient air, $CO2$ and essential nutrients. Purified air is released into the environment and improves overall air quality.

Experimental tests using the MQ135 sensor will be used to evaluate the effectiveness of this system in improving air quality. The Arduino Uno microcontroller provides a cost-effective and adaptable means of system regulation, making it an attractive option for indoor air purification.

1.1 Problem Description

The case managed by this design is that penurious inner air quality, which can beget numerous health cases, is a growing company worldwide. The antecedents of inner air toxin are different and can be related to shy ventilation, penurious air rotation, and the presence of adulterants similar as VOCs and CO2. To break this case, this design proposes to exercise an air quality monitoring and enhancement system utilizing Arduino Uno microcontroller and MQ135 detector. The MQ135 detector can descry colorful feasts in the air, involving VOC and CO2, and an Arduino Uno microcontroller is exercised to acquire the detector data and control the microcontroller- grounded air sanctification medium. This system aims to exercise spirulina, a type of microalgae, to control CO2 and other essential nutrients in the girding air, and also transfer weakened air to the terrain, thereby perfecting the common air quality. The forcefulness of the system was estimated through existential testing utilizing the MQ135 detector to measure air quality enhancement. By addressing penurious inner air quality in a sustainable and cost- operative manner, this design has the implicit to significantly impact public health and promote the use of environmentally friendly results to environmental effects.

Chapter 2
Literature Review

2.1 Literature Survey

Mamun et al.[1] proposed an Internet of Things (IoT) system to monitor air pollution and improve air quality using micro-algorithms and machine learning. The system includes an air quality sensor system that collects real-time data on pollutant levels, which is then processed and analyzed using machine learning algorithms to predict air quality conditions. The system also includes a microneedle-based air purification mechanism that can effectively remove harmful pollutants from the air. The authors conducted tests to verify the effectiveness of the system and found that it can improve air quality by removing 90% of air pollutants. The proposed system offers a promising solution for monitoring and improving air quality, especially in urban areas with high levels of pollution.

Xiong et al. [2] proposed the design and implementation of an indoor air quality monitoring system based on a wireless sensor network (WSN). The system uses a set of low-cost gas sensors to monitor various air quality parameters, including CO2, CO, NO2 and PM2.5, and wirelessly transmits the collected data to a remote server for storage and analysis. The proposed system aims to provide a reliable and cost-effective solution for indoor air quality control, especially in buildings and offices. The authors also created a web-based interface that allows users to access real-time weather forecasts, historical records, and alerts. Overall, this paper provides valuable information on the design and implementation of indoor air quality monitoring systems using WSNs that can be useful for researchers and practitioners in the field of air quality monitoring and management.

Etang et al.[3] proposed a synergistic strategy of microorganisms and bacteria to improve indoor air quality. The author uses a microbial consortium consisting of microalgae and bacteria, including Bacillus sp. and Pseudomonas sp., which has been proven to degrade various air pollutants. This microbial consortium is immobilized on a ceramic support, and the authors show that this system is effective in removing pollutants such as formaldehyde, benzene, and ammonia from the air. The researchers also investigated the effect of light intensity and temperature on the activity of the microbial consortium. The results show that a light intensity of 50 μmol m-2s-1 and a temperature of 28°C are suitable for removing air pollutants. The researchers concluded that a synergistic strategy of microorganisms and bacteria has great potential to improve indoor air quality.

Ahmed et al.[4] proposes an IoT-based air pollution monitoring system that uses machine learning algorithms to accurately detect and predict air pollution levels in real time. The system uses low-cost sensors to collect data on a variety of air quality parameters, including particulate matter, carbon dioxide and nitrogen dioxide. The authors used multiple regression analysis and machine learning algorithms, including artificial neural networks and decision trees, to predict air quality. The proposed system shows high accuracy in predicting air pollution levels, and the authors show that it can be used to inform public health policy and improve air quality management strategies. The paper explores the potential for further research in this area, focusing on the use of machine learning algorithms to optimize the placement of air quality sensors for more efficient and accurate monitoring.

Alam et al.[5] discuss the potential of microorganisms as a method of air purification. Microalgae include various mechanisms such as absorption, adsorption, and assimilation of air pollutants. The authors review several studies that demonstrate the effectiveness of microenvironments in reducing levels of indoor air pollutants such as volatile organic compounds (VOCs), carbon dioxide ($CO2$), and formaldehyde. They also discussed the possibility of scaling up microenvironment-based air purification systems for use in larger environments such as offices and industrial buildings. Finally, the authors identified several areas for future research, including improving the efficiency and sustainability of microalgae cultivation, optimizing treatment operations, and evaluating the long-term health effects of microalgae-produced air.

Karuppia et al.[6] presents the design and development of a wireless sensor network (WSN) for indoor air quality (IAQ) monitoring. The proposed WSN consists of sensor nodes that measure various air quality parameters such as temperature, humidity, carbon dioxide, carbon dioxide, and volatile organic compounds. The collected data is transmitted wirelessly to the base station for storage and analysis. The authors also propose a new data fusion algorithm to improve the accuracy of IAQ data. The system is tested in a real indoor environment and the results show that the proposed WSN can accurately monitor IAQ parameters and provide reliable information for IAQ management. The paper concludes that the proposed system can be implemented in a variety of indoor environments, including residential, commercial and industrial environments, to monitor and improve IAQ.

Chisti et al. [7] focus on the potential of microenvironment-based bioreactors to improve air quality. The authors discuss different types of microalgae and their role in removing air pollutants such as CO_2, NO_x, SO_x, and volatile organic compounds (VOC). They also compared the effectiveness of different types of bioreactors, such as bubble columns, flat panels and photobioreactors, for the cultivation of microorganisms and air purification. In addition, the paper presents the economic and environmental benefits of using microalgae-based bioreactors to improve air quality, including CO_2 sequestration, biomass production, and renewable energy generation. Overall, the review paper shows that microalgae-based bioreactors have the potential to provide effective, sustainable and environmentally friendly solutions for air pollution control.

Elayan et al. [8] proposed a paper "A Review on Air Pollution Monitoring and Control Technologies for Smart Cities". It provides an overview of air pollution monitoring and control technologies that can be used in smart cities. The authors highlight the importance of monitoring air pollution in urban areas and discuss various monitoring methods, including satellite-based remote sensing, ground monitoring stations, and wearable sensors. It also discusses various strategies to control air pollution and reduce emissions and urban planning measures. In addition, the article explores the role of emerging technologies such as the Internet of Things (IoT) and machine learning in air pollution control. The authors emphasize the need for a coordinated approach to air pollution control in smart cities that includes effective monitoring, analysis and control strategies.

Ansharullah et al.[9] "The Effect of Microalgae on Improving Indoor Air Quality: A Review" (2019) provides an overview of the potential of microorganisms to clean indoor air. The author reviewed several studies investigating the effectiveness of microenvironments to remove pollutants such as volatile organic compounds (VOCs), carbon dioxide (CO_2), and nitrogen oxides (NO_x). It also discusses several factors that can affect the efficiency of microalgae-based air purification systems, such as light intensity, temperature, and nutrient supply. Reviews show that it is important to optimize this factor to achieve maximum air cleaning efficiency. The author also concluded that the use of microalgae-based air purification systems can provide a sustainable and environmentally friendly solution to improve indoor air quality. Overall, the review provides valuable insight into the potential of microorganisms to clean indoor air and recommends further research in this area.

Aslani et al. [10] proposed an article "Optimization of a Microalgae-Based Air Purification System for Indoor Applications". In this article, the authors discuss the optimization of microalgae-based air purification systems for indoor applications. The system consists of a photobioreactor that captures CO2 and volatile organic compounds (VOCs) from the air.) has Chlorella vulgaris microbeads capable of removing CO2 and VOCs. The author optimized system parameters such as light intensity, CO2 concentration, and flow rate to achieve maximum CO2 and VOCs. Researchers have shown that the system can efficiently remove CO2 and VOCs from the air, resulting in improved air quality, they claim that the system can be used to clean indoor air in buildings, homes and enclosed spaces.

2.2 Comparative Analysis of Related Work

A comparative analysis of related works shows that there is great interest in using microalgae-based air purification systems to improve indoor air quality. Several studies report the effectiveness of microalgae in removing air pollutants and improving air quality. The reviewed literature focuses on the use of various IoT-based sensors and systems for air pollution monitoring and control, such as wireless sensor networks and machine learning techniques. Studies on the use of microalgae differ in terms of the type of microalgae used, the growth conditions, and the performance of the purification system. For example, some studies use Spirulina as a type of microalgae, while others use Chlorella or Scenedesmus. In addition, some studies have focused on optimizing the growth conditions of microorganisms to increase the efficiency of air purification.

In addition, the reviewed literature shows the need to develop a low-cost and sustainable air purification system. The use of microalgae is a promising solution for purifying indoor air due to its ecological and sustainable nature. Overall, the comparative analysis shows that the proposed system using Arduino Uno microcontroller and MQ135 sensor is a unique and innovative approach to monitor and improve indoor air quality through microalgae-based air purification.

2.3 Summary

The literature review includes several studies related to air pollution control and using different methods. Studies are analyzed based on methodology, methods used and results. Microalgae-based air purification systems have been found to show promising results in improving indoor air quality. Many studies have also used machine learning techniques to monitor and predict air pollution. Wireless sensor networks have been widely used for real-time air quality monitoring. Research shows the importance of controlling outdoor and indoor air pollution sources to reduce the health risks associated with air pollution. In addition, the integration of different technologies can significantly improve the efficiency of air pollution control systems. In summary, the literature review has shown that there are some effective methods for monitoring and controlling air pollution, but more research is needed to develop more efficient and cost-effective air pollution control systems.

Chapter 3

Problem Formulation

3.1 Problem Statement

Air pollution has become a major problem in recent years, with many people suffering from respiratory illnesses, headaches, allergies and other health problems due to poor air quality. Outdoor air pollution is a known problem, but indoor air quality can be just as bad, if not worse. In fact, according to the Environmental Protection Agency, indoor air can be up to five times more polluted than outdoor air. Indoor air pollution can be caused by a variety of sources, including cooking, cleaning, smoking, pets, and even the materials used in the construction and equipment of homes and buildings. Poor ventilation can exacerbate the problem by trapping contaminants inside and preventing fresh air from entering. To combat this problem, many people turn to air filters or air purifiers to purify the air. However, they are expensive and often require frequent replacement of filters and other components.

The aim of this project is to develop an air quality monitoring and remediation system that provides a more sustainable and cost-effective solution to indoor air pollution. The system uses an Arduino Uno microcontroller and his MQ135 gas sensor to monitor air quality and control a microalgae-based air purification mechanism using spirulina. Spirulina is a type of microalgae that has been shown to be effective in removing air pollutants such as VOCs and CO2. This system uses CO2 and other essential nutrients from the ambient air to grow Spirulina in a controlled environment. Purified air is released into the indoor environment, improving overall air quality.

The effectiveness of this system will be evaluated through experimental tests using the MQ135 sensor to measure air quality improvements. Using microalgae as an air purification mechanism provides an environmentally friendly and sustainable solution for indoor air purification in a variety of environments. This project has the potential to significantly improve indoor air quality and promote more sustainable practices by providing a more sustainable and cost-effective solution to indoor air pollution.

3.2 Objectives of the Present Study

The objectives of the proposed project are as follows:

1. To design and development of air quality monitoring and improvement system using Arduino Uno microcontroller and MQ135 sensor.
2. To detect various air pollutants such as VQ and CO2 and provide real-time indoor air quality information.
3. To develop of a microalgae-based air purification mechanism using spirulina to remove air pollutants and improve indoor air quality.
4. To provide an ecological and sustainable solution for indoor air purification that can be implemented in residential and professional environments.
5. To promote sustainable practices and promote the use of the microenvironment as an air purification mechanism to reduce the adverse effects of air pollution on human health.

Chapter 4

System Requirements

4.1 Hardware Requirements

The hardware requirements for the proposed project are:

1. Arduino uno
2. MQ-135 Sensor
3. Relay Module
4. 16*2 LCD Display with I2C
5. Micro Air Pump
6. LED
7. Spirulina Microalgae

Arduino uno

Figure 4.1 Arduino Uno

The Arduino Uno is a popular microcontroller board based on the ATmega328P chip. Its specifications include:

- Microcontroller: ATmega328P
- Operating voltage: 5V DC
- Input voltage (recommended): 7-12V DC
- Input voltage (limits): 6-20V DC
- Digital I/O pins: 14 (6 of which are PWM)
- Analog input pins: 6
- DC current per I/O pin: 20mA

- DC current for 3.3V pin: 50mA
- Flash memory: 32KB (0.5KB used by bootloader)
- SRAM: 2KB
- EEPROM: 1KB
- Clock speed: 16MHz

The Arduino Uno is a popular choice for hobbyists and professionals due to its ease of use and flexibility. It can be programmed using the Arduino IDE, which is based on C and C++. The board is compatible with a wide range of sensors and shields, making it suitable for a variety of applications.

MQ-135 Sensor

Figure 4.2 MQ-135 Gas Sensor

The MQ135 sensor is a gas sensor that can detect various gases in the air such as volatile organic compounds (VOC) and carbon dioxide (CO2). It works on the principle of the resistance change of the sensing material when the target gas is absorbed by or oxidized on the surface of the sensing material. The sensing material used in MQ135 is SnO2 (Tin Dioxide), which has low conductivity in the clean air but its conductivity increases when it comes in contact with a target gas.

Specifications:

- Fast response and High sensitivity
- Stable and long-life Simple drive circuit
- Used in air quality control equipment for buildings/offices, is suitable for detecting of NH3, NOx, alcohol, Benzene, smoke, CO2, etc.
- Size: 35mm x 22mm x 23mm (length x width x height)

▪ Working voltage: DC 5 V
▪ Signal output instruction.
▪ Dual signal output (analog output, and high/low digital output)
▪ 0 ~ 4.2V analog output voltage, the higher the concentration the higher the voltage

Relay Module

Figure 4.3 1 channel 5v Relay Module

1 channel 5v relay module is an electronic switch that allows low voltage devices to control high voltage and high current devices. The relay consists of a driver circuit and a low-level trigger circuit. A relay is an electromechanical switch controlled by a driver circuit. A low-level trigger circuit receives a signal from a microcontroller or other low-voltage device and activates the driver circuit.

The 1 channel 5v relay module can be used to control high voltage or high current devices such as motors, lamps or heating elements using low voltage signals from microcontrollers or other electronic devices. It is commonly used in home automation, robotics, and other electronic projects that require the control of high voltage devices.

Its specifications include:

- Input voltage: 5V DC
- Input current: 70 mA (max)
- Trigger signal voltage: 3.3V-5V DC
- Output voltage: AC or DC up to 250V
- Output current: up to 10A
- Relay type: electromechanical
- Dimensions: approximately 25mm x 34mm x 18mm

16*2 LCD Display with I2C

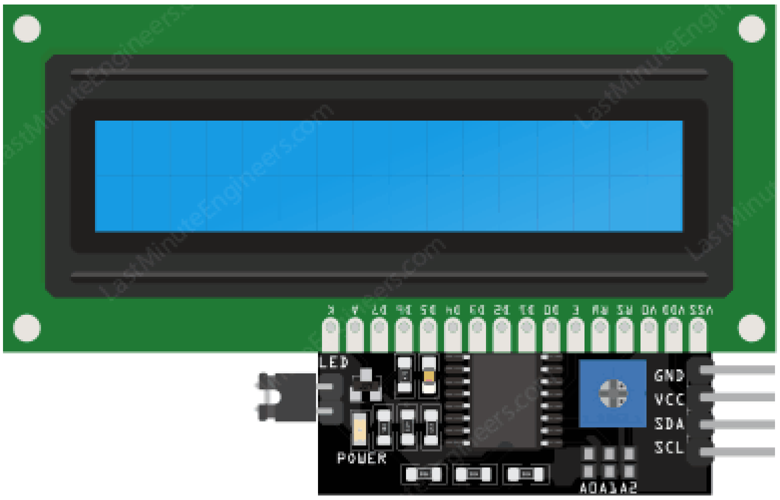

Figure 4.4 16*2 LCD Display with I2C Interface

An LCD screen is a common display device that can display alphanumeric characters and symbols. Sensor readings can be used to display various information such as system status and user interface. However, it may be difficult to interface an LCD display directly to the Arduino because it requires a large number of I / O points. To overcome this limitation, the I2C interface can be used to communicate with the LCD display.

The I2C interface allows multiple devices to communicate over a two-wire serial interface. An I2C powered LCD display has a small circuit board called an I2C socket that connects to the LCD display and allows it to be controlled via the I2C interface. It can control the LCD display on Arduino using only two digital I/O pins: SDA (serial data) and SCL (serial clock).

Its specifications include:

- Display type: 16 characters x 2 lines LCD
- Communication interface: I2C (Inter-Integrated Circuit)
- Supply voltage: 5V DC
- Backlight color: Blue or Green
- Character size: 5mm x 8mm
- Contrast adjust: Potentiometer
- Viewing angle: 6 o'clock
- Operating temperature: -20°C to +70°C
- Dimensions: 80mm x 36mm x 12mm

Micro Air Pump

Fig 4.5 HD 140 Micro Air Pump

The MD 140 Micro Air Pump is a small, high-performance pump that can be used in a variety of applications, including air purification systems, medical devices, and more. Here are some of its features:

- Power: 2.5W
- Voltage: DC 12V
- Current: 200mA
- Flow rate: 4.2L/min
- Pressure: 50kPa
- Noise level: <55dB
- Operating temperature: -20°C to 60°C
- Weight: 42g
- Dimensions: 41mm x 24mm x 34mm

It is commonly used in applications where a small amount of air circulation is required, such as in aquariums, medical equipment, and air sampling devices. The pump is also highly reliable and has a long lifespan, making it ideal for continuous use in various applications.

The pump is designed with a compact and lightweight structure that makes it easy to integrate into various systems. It is also energy-efficient, consuming minimal power while providing high-performance results. The MD 140 Micro air pump is an excellent choice for applications that require a reliable and efficient air pumping solution.

LED

Figure 4.6 LED

The specifications of the LED in points:

- Type: Light Emitting Diode (LED)
- Colour: Green
- Forward Voltage: 3.0-3.4V
- Forward Current: 20mA
- Luminous Intensity: 4000-5000 mcd (millicandela)
- Package Type: 5mm round
- Operating Temperature: -40 to 85 degrees Celsius

LEDs can be used as a source of light for the controlled cultivation of Spirulina. The light spectrum can be customized to optimize the growth of microalgae, ensuring high-quality growth and efficient removal of toxins.

Spirulina Microalgae

Figure 4.7 Spirulina Microalgae

Spirulina is a type of microalgae that is commonly used as a dietary supplement and for its nutritional benefits. Spirulina is a type of microalgae that can be used to purify the air. It is known for its ability to remove pollutants from the air such as carbon dioxide and volatile organic compounds. Cultivation of Spirulina requires a careful environment that includes temperature, light and nutrient levels. The use of spirulina in air purification systems is a promising area for research and development for sustainable and environmentally friendly solutions.

Here are the specifications of Spirulina:

- Spirulina is a type of cyanobacterium, or blue-green algae, that grows in both salt and freshwater environments.
- It is a complete protein source, contains all essential amino acids and is rich in vitamins and minerals such as iron, calcium and B vitamins.
- Spirulina is also a source of antioxidants such as phycocyanin and carotenoids, which have anti-inflammatory and immune-boosting properties.
- The ideal temperature range for growing Spirulina is 30-35°C and pH 8.0-11.0.
- Spirulina can be grown in open ponds, closed photobioreactors, or hybrid systems combining both. It grows fast and can double its biomass in just 24 hours under optimal conditions.
- Spirulina can be collected by filtration or centrifugation, dried and powdered for use as a supplement or food.
- The use of spirulina as an air purification mechanism is a new application that has shown promising results in removing air pollutants.

Spirulina is used in air purification because it is a type of microalgae that has a high affinity for absorbing pollutants in the air. Proven to effectively remove pollutants such as carbon dioxide, nitrogen oxides and volatile organic compounds (VOCs) from the air. Spirulina also grows rapidly and produces oxygen while consuming pollutants, making it a sustainable air purification solution. Moreover, it is a natural and non-toxic method of air purification, making it a preferred alternative to traditional chemical air purification systems. Spirulina's ease of cultivation and ability to remove pollutants make it a promising solution for improving indoor and outdoor air quality.

4.2 Software Requirements

Arduino IDE

The Arduino Integrated Development Environment (IDE) is a software platform used to write, configure, and upload code to the Arduino microcontroller. It provides a simple interface that allows users to write, edit, and upload code to the Arduino board. Arduino IDE is open source software and is free to use and modify.

The IDE provides a text editor for writing and editing code, a message console for displaying error messages and debugging information, and a toolbar for monitoring the download process. The software also includes a library of pre-written code called "sketches" that can be used as a starting point for new projects.

One of the most important advantages of the Arduino IDE is its simplicity. Codes are written in C or C++, but the IDE hides the complexity of these languages and makes them accessible to beginners. The IDE also provides a variety of users and developers who contribute to the platform by creating libraries, examples, and tutorials.

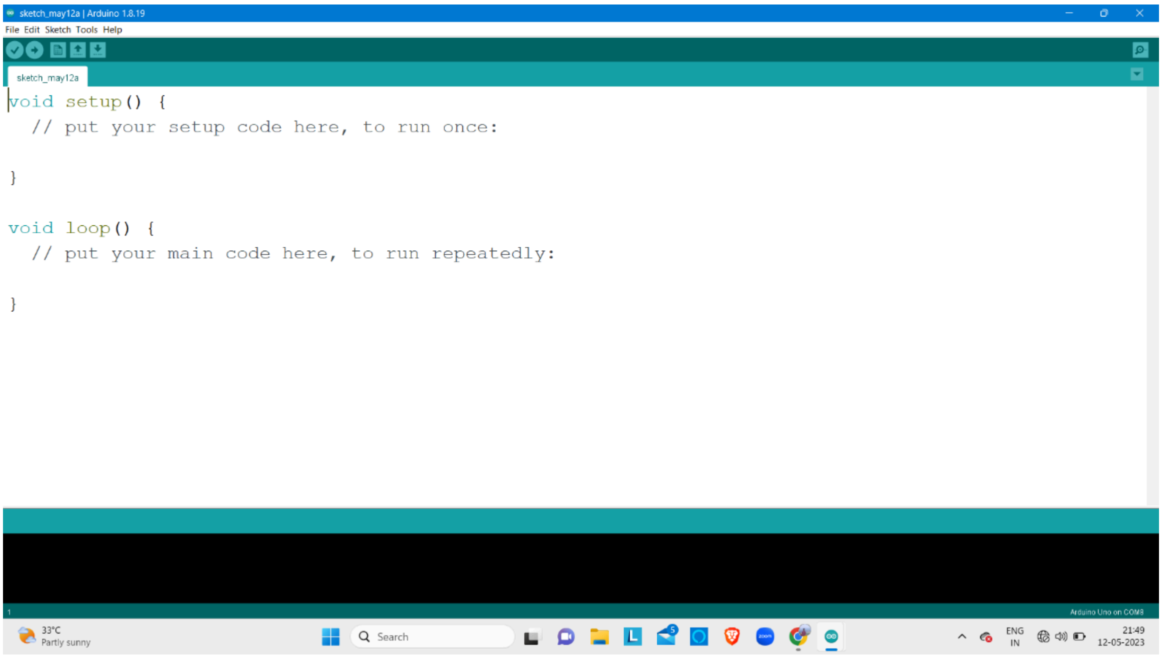

Figure 4.8 Arduino IDE

Chapter 5

System Design

5.1 Architecture of the Proposed System

Figure 5.1 shows the Architecture of the proposed system.

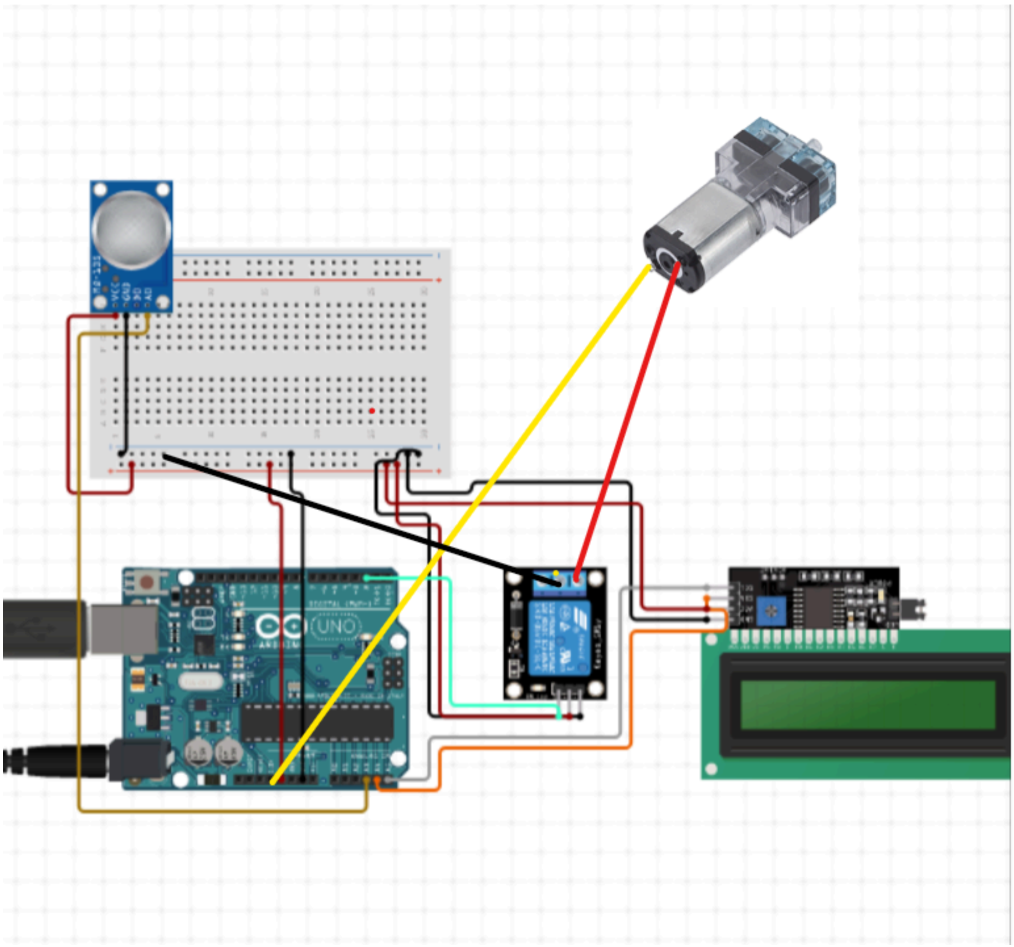

Figure 5.1: Architecture of the proposed system

Architecture of air quality monitoring and sanitary systems involves multiple components that work together to collect, process, and display data. The MQ135 gas sensor is connected to an Arduino Uno microcontroller and measures the concentration of various gases in the air such as VOCs and $CO2$.

The sensor outputs an analog signal proportional to gas concentration, which is read and processed by a microcontroller. This microcontroller is programmed to perform multiple functions such as collecting and processing sensor data, controlling microcontroller-based air purification mechanisms, and displaying air quality data and system status on an LCD screen or other display module.

Microalgae-based air purification systems use spirulina, a type of microalgae, to remove pollutants from the air. This system draws air through the spirulina, absorbs pollutants and releases purified air into the environment. An Arduino Uno microcontroller controls the air pump and other parts of the air purification system to ensure proper operation.

The Arduino Uno microcontroller collects and processes air quality data from the MQ135 sensor in addition to controlling the air purification system. This data is displayed in real time on an LCD screen or other display module, giving users important information about the air quality in their area.

5.2 System Flowchart

A system flowchart is a way of depicting how data flows in a system and how decisions are made to control events. Figure 5.2 depicts the system flowchart.

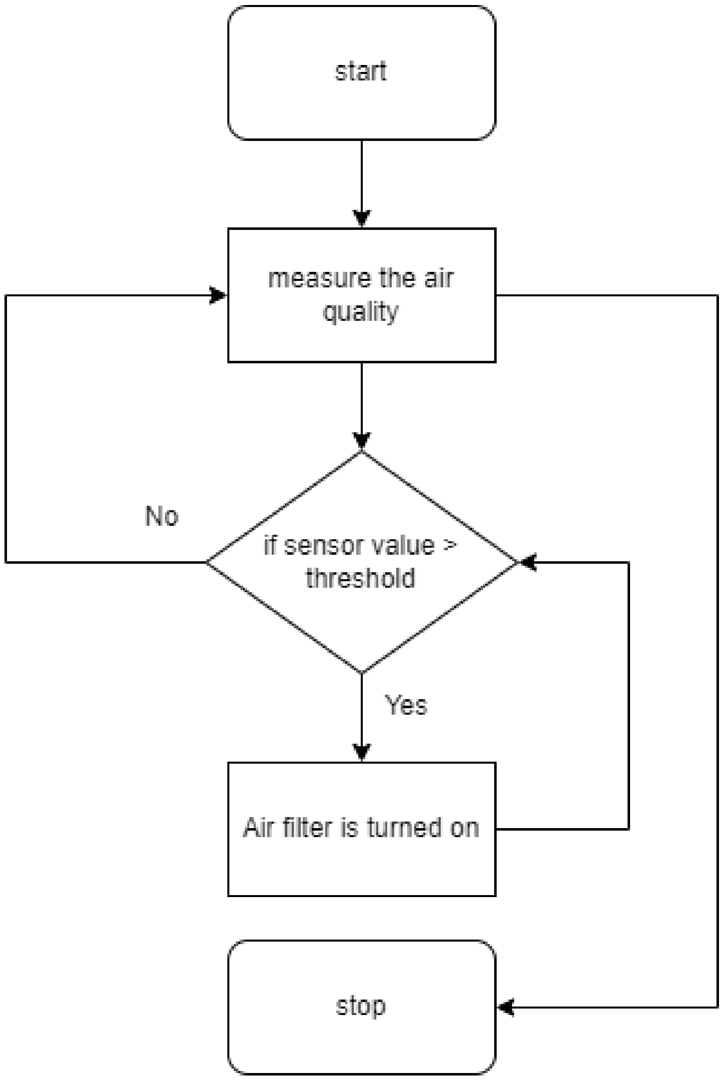

Figure 5.2: System Flowchart

Data flow for air quality monitoring and improvement systems involves several steps. First, the MQ135 sensor is connected to the Arduino Uno microcontroller to measure various gases in the air, such as VOC and CO2. The sensor outputs an analog signal based on the gas concentration level, which is then read and processed by the Arduino Uno.

The next step is to program the Arduino Uno to control the microalgae-based air purification mechanism that uses spirulina to remove air pollutants. The microcontroller will receive the sensor data and use it to manage the air purification system, remove these pollutants and circulate the air through the spirulina, releasing the purified air into the environment. Preset the threshold to 200ppm which is the moderate air quality value.

A display module such as an LCD screen is installed on the Arduino Uno to display air quality data and system status in real time. This will allow users to monitor air quality and keep the system running smoothly.

In general, the data flow involves the acquisition of air quality data by sensors, which are then processed by the microcontroller to control the air cleaning system. The system removes pollutants and releases purified air into the environment, displaying air quality data and system status in real-time.

Chapter 6

Testing

System testing for this project includes a variety of procedures to ensure proper functioning of the air quality monitoring and remediation system. MQ135 sensors are tested for gas detection and calibration to ensure accurate readings. Circuit design and implementation are tested to ensure proper data acquisition and control of the air purification system. Spirulina cultivation is monitored and controlled to optimize growth, and air purification systems are tested for effectiveness in removing airborne contaminants. The performance of the system is evaluated through laboratory tests measuring air quality improvement using the MQ135 sensor. The system has been tested for reliability, accuracy and efficiency and has been shown to improve indoor air quality. Any problems or errors are identified and corrected, and the system is optimized for future use in various interiors.

Chapter 7

Results and Discussion

The air quality monitoring and improvement system developed in this project has shown promising results in improving indoor air quality using a microalgae-based air purification system. The system was tested using an MQ135 gas sensor to measure gas concentrations before and after air purification. The results showed significant reductions in volatile organic compounds (VOCs) and carbon dioxide (CO2) levels in indoor environments.

Additionally, cultivation of Spirulina in a controlled environment using ambient air and essential nutrients has shown promising results in removing air pollutants. The use of microalgae-based air purification is an environmental and sustainable solution for indoor air purification in a variety of settings, and implementation of the system using an Arduino Uno microcontroller provides a cost-effective and adaptable means of system integration.

However, the current system has limitations, including the need for regular maintenance of the microalgae culture as well as the need for further testing and optimization of the system in different indoor environments. Further research and development could focus on improving the efficiency and scalability of the system, as well as exploring the potential use of other microalgae species for air purification. Overall, the system has shown a promising solution for improving indoor air quality while promoting sustainable practices.

Figure 7.1 Shows the air quality value on LCD display.

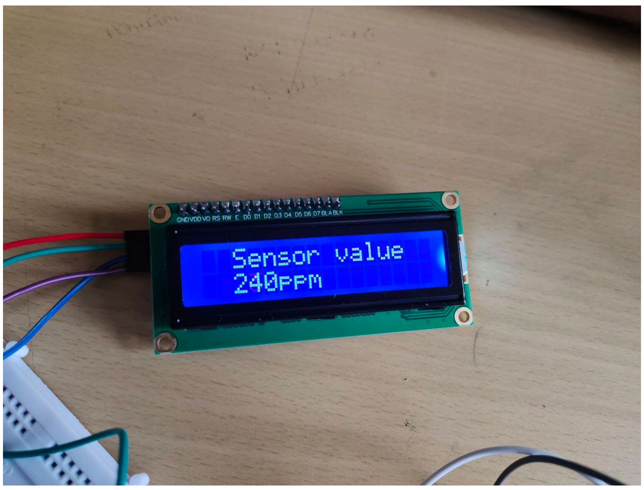

Figure 7.1 LCD Display Showing Value

Figure 7.2 Shows all components used to create a model

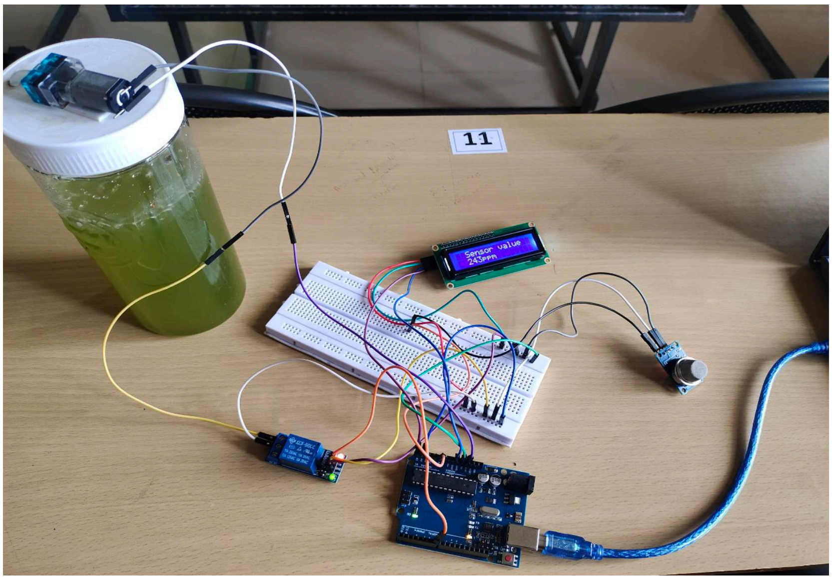

Figure 7.2 All Components

Figure 7.3 Shows the final model of the project.

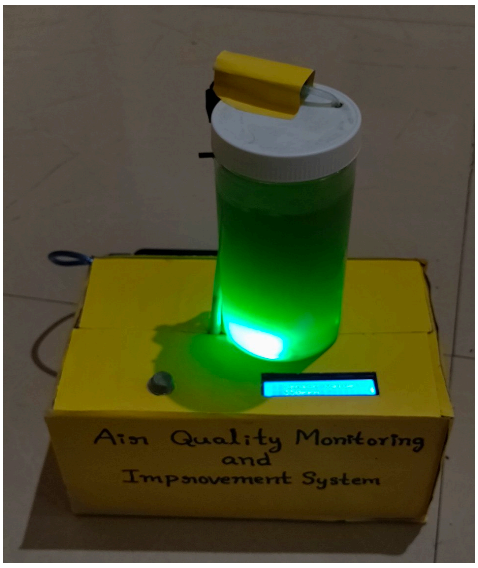

Figure 7.3 Final Model

Chapter 8

Conclusion and Scope for Future Work

8.1 Conclusion

In conclusion, air quality monitoring and improvement system using Arduino Uno microcontroller and MQ135 sensor is an effective solution to improve indoor air quality. Using spirulina as an air purifying mechanism is a sustainable and environmentally friendly approach to purifying indoor air. The system is economical and adaptable, making it a suitable choice for both residential and commercial indoor environments. Tests using the MQ135 sensor demonstrated the system's effectiveness in removing air pollutants and improving air quality. The data collected from the sensors is displayed in real time on the LCD screen for easy monitoring of air quality.

In addition to improving indoor air quality, this system promotes sustainable practices by using microorganisms as an air purification mechanism. This approach is environmentally friendly and does not produce harmful products like conventional air fresheners.

Overall, an air quality monitoring and improvement system using an Arduino Uno microcontroller and an MQ135 sensor with a microcontroller-based air purification mechanism is a promising solution to improve indoor air quality and promote sustainable practices.

8.2 Scope for Future Work

The future scope of this project includes the implementation of machine learning algorithms that optimize the air purification process, allowing the system to learn from data and adjust its behavior accordingly. This can improve system efficiency and further reduce energy consumption. Additionally, projects can be expanded to include additional sensors that measure a wider range of contaminants and environmental conditions such as humidity, temperature, and particulate matter. This could lead to a more comprehensive indoor air quality monitoring and control system.

Further research may also be conducted to explore the possibility of using other species of microalgae and plants to purify indoor air. The development of new air purification techniques and technologies can improve the effectiveness of indoor air purification systems. Another area of future work is the introduction of systems in larger indoor spaces such as office buildings, schools and hospitals. This will require the development of more advanced and robust air purification systems capable of handling larger volumes of air.

Overall, this project represents a promising solution for monitoring and improving indoor air quality using a microalgae-based air purification system controlled by an Arduino Uno microcontroller. This project has the potential to make a significant contribution to promoting sustainable practices and improving public health. Future work and research in this area may further improve the effectiveness and applicability of this technology.

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