

## **INTEGRATED AIR AND NOISE POLLUTION MONITORING SYSTEM**

*<sup>1</sup>Dr K Ramesh Babu,<sup>2</sup>M Srikanth,<sup>3</sup>M Sailaja,<sup>4</sup>Palakeerthi Raja*

*<sup>1</sup>Professor,<sup>2,3</sup>Assistant Professor,<sup>4</sup>Student*

*Department of ECE*

*G V R & S College of Engineering & Technology, Guntur, AP*

### **ABSTRACT**

In recent day scenario, the non-stop increase in air and sound pollution prove to be an big alarming problem. It has become mandatory to control and appropriately monitor the situation so that the required steps to control the situation can be undertaken. In this project, an IOT-based method using Raspberry Pi is used to monitor and check live the Air Quality Index and the sound pollution of a region, have been proposed. The recommended technology comprises of two modules namely, the Air Quality Index Monitoring Module, the Sound Intensity Detection Module.

Firstly, the Air Quality Index is measured considering the presence of the air pollutants. Then the sound intensity is detected using respective sensor. System uses air sensors to sense presence of harmful gases/compounds in the air and constantly transmit this data to microcontroller. Also system keeps measuring sound level and reports it to the online server over IOT. The sensors interact with microcontroller which processes this data and transmits it over internet.

This allows authorities to monitor air pollution in different areas and take action against it. Also authorities can keep a watch on the noise pollution near schools, hospitals and no honking areas, and if system detects air quality and noise issues it alerts authorities so they can take measures to control the issue.

### **I. INTRODUCTION**

#### **PROJECT OVERVIEW:**

The Raspberry Pi Air and Noise Pollution Monitoring System is an IoT-based project that aims to monitor and analyse air quality and noise pollution levels in real-time. The project utilizes a Raspberry Pi Pico microcontroller along with various sensors, including a dust sensor, gas sensor, and sound sensor. Wireless connectivity is established to enable data transmission, and an LCD display is used to provide visual feedback. The system continuously collects data from the sensors, which are strategically placed in the target environment. The dust sensor measures the concentration of particulate matter (PM) in the air, indicating air quality. The gas sensor detects the presence of specific gases such as carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), or ozone (O<sub>3</sub>). The sound sensor captures noise levels and intensity.

The Raspberry Pi Pico, acting as the main control unit, interfaces with these sensors, retrieves the sensor readings, and stores the data in variables or data structures. The system then utilizes wireless connectivity, such as Wi-Fi or Bluetooth, to transmit the collected data to a remote server or an online platform for further analysis and visualization. An LCD display module is integrated into the system to provide real-time feedback by displaying the pollution data and other relevant information. The display can show the current air quality index, noise levels, and alerts when pollution levels exceed specific thresholds.

The project offers numerous advantages, including real-time monitoring, data-driven decision-making, remote access, and customization. It can be applied in various scenarios, such as environmental monitoring, indoor air quality assessment, smart cities, personal health monitoring, research, and education. With future developments, the system can be enhanced by integrating AI and machine learning algorithms for advanced analytics and prediction, integrating with smart home ecosystems for automated actions, and expanding the network of monitoring stations for broader data sharing and collaboration.

#### **MOTIVATION OF PROJECT:**

The motivation behind the Raspberry Pi Air and Noise Pollution Monitoring System project stems from the increasing concern and awareness regarding environmental pollution and its impact on human health and well-being. Air pollution, in the form of harmful gases and particulate matter, has been linked to respiratory issues, cardiovascular diseases, and other health problems. Similarly, excessive noise pollution can lead to stress, sleep disturbances, and cognitive impairments. The project aims to address these issues by providing a cost-effective and accessible solution for monitoring air and noise pollution levels.

The Raspberry Pi platform, with its compact size, low cost, and versatility, makes it an ideal choice for creating an IoT-based monitoring system. By building the pollution monitoring system,

individuals and communities can gain real-time insights into the air quality and noise levels in their surroundings. This empowers them to make informed decisions about their daily activities, such as avoiding areas with high pollution levels or taking precautionary measures when pollution exceeds acceptable thresholds.

Furthermore, the project promotes environmental awareness and encourages individuals to actively participate in monitoring and managing pollution. It fosters a sense of responsibility and empowers people to take actions to reduce pollution, such as advocating for cleaner energy sources, promoting sustainable transportation, or implementing sound insulation measures. The project also has educational significance, as it provides a hands-on learning experience for students and enthusiasts interested in environmental science, engineering, and IoT. It allows them to understand the principles of air and noise pollution monitoring, sensor technology, data analysis, and the potential applications of IoT in addressing environmental challenges. Ultimately, the motivation behind the Raspberry Pi Air and Noise Pollution Monitoring System project lies in creating a tool that promotes environmental consciousness, empowers individuals and communities to take actions to mitigate pollution, and contributes to the overall well-being of society.

**OBJECTIVES OF PROJECT:**

The objective of the Raspberry Pi Air and Noise Pollution Monitoring System project is to develop a practical and accessible solution for monitoring and analysing air quality and noise pollution levels. The project aims to achieve the following objectives:

**Real-time Monitoring:** The project intends to provide real-time monitoring of air quality and noise pollution levels. By continuously collecting data from the sensors, the system enables users to have up-to-date information about the pollution levels in their environment.

**Data Analysis and Visualization:** The project aims to analyse the collected data and provide meaningful insights to users. It includes processing the sensor readings, calculating pollution indices, and visualizing the data in a user-friendly format. This allows users to understand the pollution levels and trends over time.

**Alerts and Notifications:** The system aims to provide alerts and notifications when pollution levels exceed certain predefined thresholds. Users can be alerted through visual indicators on an LCD display or via mobile applications, enabling them to take necessary precautions and actions.

**Customization and Expandability:** The system aims to be customizable and expandable, allowing users to add or modify sensors based on their specific requirements. This flexibility enables the system to be adapted for various environmental monitoring

applications.

**Awareness and Sustainable Actions:** The project seeks to raise awareness about air and noise pollution and promote sustainable actions to mitigate pollution. By providing accurate and accessible pollution data, it empowers individuals and communities to make informed decisions and take actions to reduce pollution in their surroundings.

**BLOCK REPRESENTATION:**

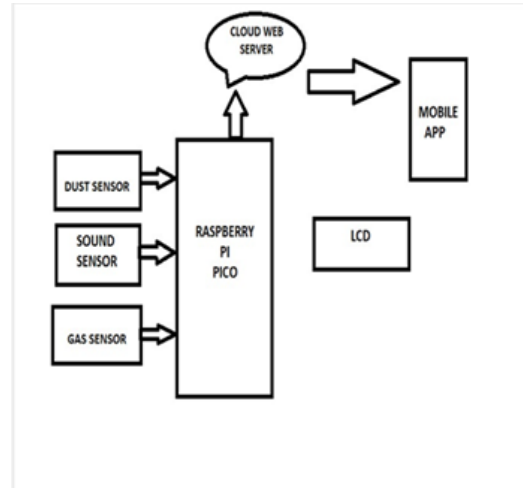


Fig 1.: Block diagram.

**RASPBERRY PI PICO:**



Fig .2: Raspberry pi Pico.

Raspberry pi Pico is a single-board computer that will serve as the brain of your system. Raspberry Pi Pico is an affordable and compact derivative of Raspberry Pi but if you attach Raspberry Pi Pico W with monitor, keyboard, and mouse, it takes up a lot more space. There's no need to connect Raspberry Pi to a display or input devices if you're only trying to program it or using it to operate electronics like lights, motors, and sensors because you can control the system remotely using a VNC or SSH client on your primary computer. This screenless Raspberry Pi system is referred to as a headless setup. It is widely used in many areas, such as for weather monitoring, because of its low cost, modularity, and open design.

**1.4.2 GAS SENSOR:**

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Fig .3: Gas Sensor.

A gas detector is a device that detects the presence of gases in an area, often as part of a safety system. A gas detector can sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave. This type of device is important because there are many gases that can be harmful to organic life, such as humans or Animals. Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion. This type of device is used widely in industry and can be found in locations, such as on oil rigs, to monitor manufacturing processes and emerging technologies such as photovoltaic. They may be used in firefighting.

#### 1.4.3 DUST SENSOR:

GP2Y1010AU0F optical dust sensor is used to detect air quality and extremely fine dust particles with an optical sensing system like a light source within the air like smoke, cigarette, etc. This sensor is also called optical air quality sensor and it is normally utilized in air purifier systems. In this sensor, an IR light-emitting diode & a photodiode are arranged diagonally to detect the reflected light of dust within the air. This sensor has extremely low current consumption typically 11mA and 20mA max & it can be powered through up to 7VDC.



Fig .4: Dust Sensor.

#### 1.4.4 SOUND SENSOR:

The sound sensor is one type of module used to notice the sound. Generally, this module is used to detect the intensity of sound. The applications of this module mainly include switch, security, as well as monitoring. The accuracy of this sensor can be changed for the ease of usage. The Sound Sensor is one type of module used to notice the sound. Generally, this module is used to detect the

intensity of sound. The applications of this module mainly include switch, security, as well as monitoring.



Fig.5: Sound Sensor.

## II. LITERATURE SURVEY

The literature survey for the Raspberry Pi Air and Noise Pollution Monitoring System project involved a comprehensive search for existing research papers, articles, and conference proceedings in the field of air and noise pollution monitoring using Raspberry Pi. The primary focus was on understanding the methodologies, sensor technologies, data analysis techniques, and system architectures employed in previous works. Keywords such as "Raspberry Pi air pollution monitoring," "Raspberry Pi noise pollution measurement," and "IoT-based pollution monitoring systems" were used to conduct the search across various academic databases.

The reviewed literature provided valuable insights into the different aspects of air and noise pollution monitoring with Raspberry Pi. Common approaches included the utilization of various sensors, including dust sensors, gas sensors, and sound sensors, for data collection. Researchers emphasized the importance of accurate and reliable sensor measurements for monitoring air quality and noise levels. Data analysis techniques discussed in the literature encompassed data pre-processing, feature extraction, noise filtering, pollutant concentration estimation, and visualization methods. Several studies highlighted the significance of real-time data processing and visualization to enable prompt response and decision-making.

The integration of IoT principles in the monitoring systems was also explored. This involved wireless connectivity options, cloud-based data storage and analysis, remote monitoring capabilities, and real-time data visualization approaches. Researchers emphasized the advantages of IoT-enabled systems in terms of scalability, accessibility, and the ability to capture and analyse large volumes of data.

The literature survey served as a foundation for understanding the current state-of-the-art and identifying gaps and opportunities in the field of air and noise pollution monitoring with Raspberry Pi.

The findings from the survey will inform the design and implementation of the Raspberry Pi Air and Noise Pollution Monitoring System project, ensuring it incorporates best practices and innovative solutions from previous research. It's important to note that the field of air and noise pollution monitoring is evolving, and new research and advancements are continually emerging. Therefore, it is recommended to keep abreast of the latest publications and technologies throughout the project to ensure its relevance and effectiveness.

### **2.1 DESCRIPTION:**

The Raspberry Pi Air and Noise Pollution Monitoring System is a technical solution designed to monitor and analyse air quality and noise levels in real-time using Raspberry Pi and various sensor technologies. This system incorporates the Raspberry Pi single-board computer, which serves as the central processing unit and data collection hub. The system is equipped with different sensors to measure air quality parameters and noise levels. These sensors may include dust sensors to detect particulate matter (PM) concentration in the air, gas sensors to measure the presence of gases such as carbon dioxide (CO<sub>2</sub>), carbon monoxide (CO), and volatile organic compounds (VOCs), and sound sensors to capture ambient noise levels. These sensors are strategically placed in the monitoring area to ensure comprehensive coverage.

The Raspberry Pi acts as the control unit for the system, collecting data from the sensors at regular intervals. It utilizes the GPIO (General Purpose Input/Output) pins of the Raspberry Pi to interface with the sensors and acquire the sensor readings. The data collected by the sensors is processed and stored locally on the Raspberry Pi or transmitted wirelessly to a remote server or cloud storage for further analysis. To enable wireless connectivity, the Raspberry Pi can utilize various communication protocols such as Wi-Fi, Bluetooth, or cellular networks. This allows for remote monitoring and control of the system. The collected data can be transmitted in real-time to a central server or cloud platform for storage, analysis, and visualization.

Data analysis plays a crucial role in the system. The collected sensor data is processed using appropriate algorithms and techniques to derive meaningful insights. This may include statistical analysis, machine learning algorithms, or other data processing methods. The results can be visualized through a graphical user interface (GUI) or displayed on an LCD screen for easy interpretation and monitoring. The technical description of the Raspberry Pi Air and Noise Pollution Monitoring System demonstrates its ability to continuously monitor and analyse air quality and noise levels. By leveraging the power of Raspberry Pi, wireless connectivity, and various sensors, this system enables efficient and effective environmental

monitoring with potential applications in urban areas, industrial zones, and public spaces.

### **2.2 WORKING**

The Raspberry Pi Air and Noise Pollution Monitoring System works by integrating Raspberry Pi, sensors, wireless connectivity, and data analysis to monitor and analyse air quality and noise levels in real-time. Here's an overview of its working process:

**Sensor Data Collection:** The system incorporates various sensors such as dust sensors, gas sensors, and sound sensors. These sensors are strategically placed in the monitoring area to collect data on air quality parameters and noise levels. The sensors measure specific pollutants or environmental parameters and provide corresponding readings.

**Raspberry Pi Integration:** The Raspberry Pi serves as the central processing unit of the system. It interfaces with the sensors through the GPIO pins, collecting the sensor readings at regular intervals. The Raspberry Pi also provides the necessary computational power and memory to process and store the collected data.

**Data Processing and Analysis:** The collected sensor data is processed and analysed to derive meaningful insights. This may involve data pre-processing, feature extraction, noise filtering, and other data manipulation techniques. Various algorithms, such as statistical analysis or machine learning, can be applied to analyse the data and identify patterns or anomalies.

**Wireless Connectivity:** The system utilizes wireless connectivity options, such as Wi-Fi or Bluetooth, to transmit the collected data. This enables remote monitoring and control of the system. The data can be sent in real-time to a remote server or cloud platform for storage and further analysis.

**Data Visualization and Presentation:** The analysed data can be visualized and presented through a graphical user interface (GUI) or displayed on an LCD screen. This allows users to easily interpret and monitor the air quality and noise levels. The visualization may include real-time graphs, charts, or alerts indicating pollution levels exceeding predefined thresholds.

By integrating Raspberry Pi, sensors, wireless connectivity, and data analysis, the system provides an efficient and effective solution for monitoring and analysing air and noise pollution. Its continuous monitoring capabilities and real-time data insights contribute to improved environmental management and decision-making.

### **2.3 CIRCUIT DIAGRAM:**



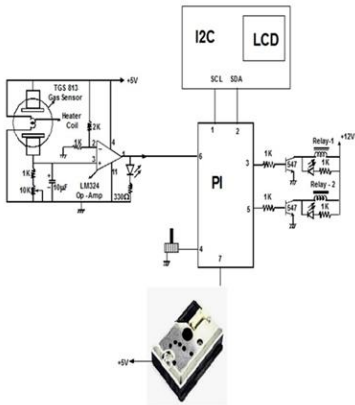


Fig 6: Circuit Diagram.

**III. CIRCUIT CONNECTION AND RESULTS**

**3.1 CIRCUIT DIAGRAM:**

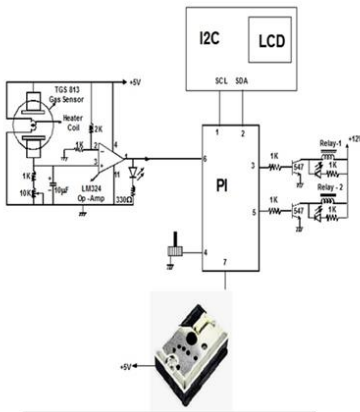


Fig 7: Circuit Diagram.

**IV. RESULTS:**

The project hardware kit is as show in below figure 8, without power supply.

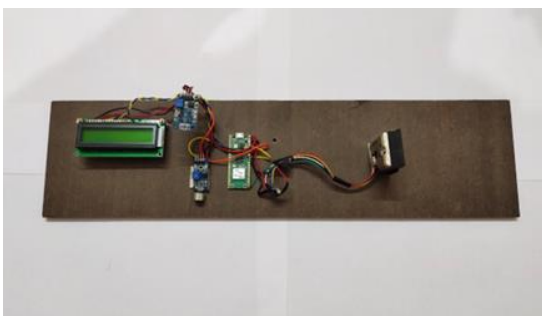


Fig 8: Circuit Without Power Supply.

The project hardware kit is as show in below figure 9, without power supply.

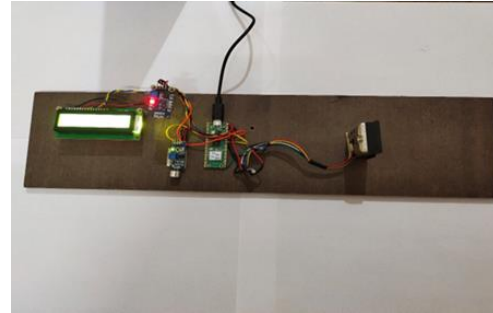


Fig 9: Circuit Diagram With Supply.

When the Power Supply is given to the kit the circuit gets on and the output is displayed in the LCD and also we can see the output through IP address in mobile.

Output in LCD Screen.

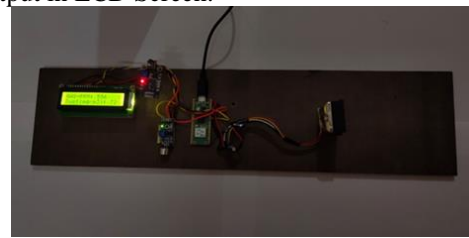


Fig 10: Output in LCD Screen.

Output through IP address in mobile or Laptop.

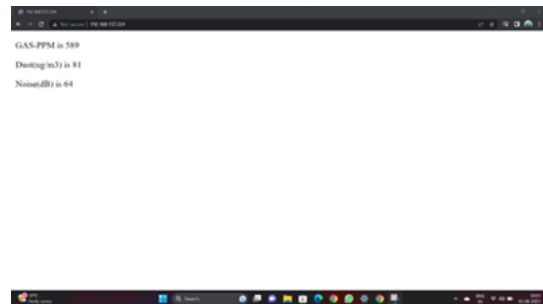


Fig 11: Output in Laptop.

**APPLICATIONS**

- Environmental Monitoring .
- Indoor Air Quality Monitoring
- Smart Cities
- Personal Health Monitoring
- Research and Data Analysis
- Alert and Notification Systems
- Educational Projects

**6ADVANTAGES:**

- Real-time Monitoring
- Data-driven Decisions
- Remote Access
- Cost-effective
- Customizability
- Educational Value.

**DISADVANTAGES:**

- Sensor Accuracy
- Calibration.

**Maintenance:** The system requires periodic maintenance, including sensor cleaning, firmware updates, and troubleshooting.

## V. CONCLUSION AND FUTURE SCOPE

### 5.1 CONCLUSION

Raspberry Pi-based air and noise pollution monitoring system using Raspberry Pi Pico, dust sensor, gas sensor, sound sensor, wireless connectivity, and an LCD display offers numerous advantages. It allows for real-time monitoring, data-driven decision-making, remote access, and customization. The system is cost-effective and provides educational value. However, there are some considerations such as sensor accuracy, calibration, maintenance, power consumption, limited range, and data interpretation that need to be addressed. Overall, this system contributes to environmental monitoring, sustainability, and the development of smart environments. With proper implementation and management, it can help raise awareness about pollution levels and support efforts towards creating healthier and more sustainable living spaces.

#### **FUTURE SCOPE:**

The Raspberry Pi-based air and noise pollution monitoring system, utilizing Raspberry Pi Pico, dust sensor, gas sensor, sound sensor, wireless connectivity, and an LCD display, holds immense potential for future development. One key area of development is the integration of advanced technologies such as Internet of Things (IoT) and advanced sensors. This integration can enable real-time monitoring, seamless connectivity, and more accurate measurements of pollution levels. Additionally, the emergence of mobile and wearable monitoring devices opens up new possibilities for individuals to actively participate in monitoring and make informed decisions about their exposure. Integrating air and noise pollution monitoring systems into smart city infrastructure is another future scope.

By integrating these systems with other city systems such as transportation, energy, and waste management, cities can develop comprehensive environmental management frameworks. The future scope of air and noise pollution monitoring systems lies in the integration of advanced technologies, increased citizen participation, and the utilization of AI and data analytics. These advancements have the potential to revolutionize environmental monitoring, empower individuals and communities, and facilitate effective pollution control and management strategies.

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