AIR QUALITY AND ACOUSTIC POLLUTION MONITORING WITH ESP32 AND SENSOR ARRAY

A MINI PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **"AIR QUALITY AND ACOUSTIC POLLUTION MONITORING WITH ESP32 AND SENSOR ARRAY"** is the bona-fide work of **"RESHMA R (210701212), SOWMIYA S (210701255)"** who carried out the project work under my supervision.

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ABSTRACT

In infrastructure and industrial plants the rapid growth creating environmental issues like pollution (Air, Water, Noise), climate change and malfunctioning has greatly consequence for the requirement of an, operationally adaptable, efficient, cheap and smart monitoring systems. The technology like Internet of Things (IOT) is included in the form of solution which is outcome of merged field of computer science and electronics. For monitoring the fluctuation of parameters like noise and air pollution and also humidity and temperature levels from their normal levels in this case the sensing devices are connected to the embedded computing system. The increasing air and sound pollution is one of the significant issue now days. As the pollution increasing it is giving rise number of diseases so, it has become essential to control the pollution for better future and healthy life. Here we propose an air quality as well as sound pollution monitoring system that allows us to monitor and check live air quality as well as sound pollution monitoring in particular areas through IOT. System uses air sensor to detect or sense presence of harmful gases, compounds in the air and constantly transmit data to microcontroller. The system also keeps measure sound level and report it to the online server named Blynk IOT.

ACKNOWLEDGMENT

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CHAPTER - 1
INTRODUCTION

1.1 INTRODUCTION

Our world is experiencing a surge of technological advancements aimed at improving efficiency and meeting human needs. Present innovations in technology are increasingly focused on efficient monitoring and control of various activities to meet human needs. A key driver of this progress is the emergence of the Internet of Things (IoT). IoT allows objects to connect and share data, fostering the creation of "smart environments" capable of self-monitoring and control. As a human we need fresh air to survive. Air is the most important factor in human life The "IoT Air and Noise Monitoring System" aims to tackle the pressing issues of air and noise pollution in urban and industrial environments, which pose significant threats to public health and overall quality of life. Traditional methods of monitoring these pollutants are often inadequate due to their manual nature, lack of real-time data, and limited accuracy.

1.2 SCOPE OF THE WORK

The scope of the IoT Air and Noise Monitoring System project encompasses the development and deployment of a comprehensive solution for real-time environmental monitoring in urban and industrial settings. This includes the selection and integration of air quality and noise sensors, utilizing wireless communication technologies to ensure reliable data transmission to a central processing platform. The project involves creating a cloud-based or edge computing system for data processing, real-time analysis, and anomaly detection. Additionally, it includes developing user-friendly interfaces and dashboards for various stakeholders, including city planners, regulatory bodies, industries, and the public, along with alert systems for critical pollution levels. Strategic placement and maintenance of sensor units are planned to ensure accurate and

continuous monitoring. The system aims to meet regulatory standards, support compliance, and increase public awareness about environmental issues. Designed for scalability, the project will allow future expansion and integration with other monitoring systems, ultimately contributing to improved public health, better environmental management, and informed decision-making.

1.3 PROBLEM STATEMENT

Urbanization and industrialization have led to significant increases in air and noise pollution, posing severe risks to public health, safety, and overall quality of life. Traditional methods of monitoring these pollutants are often manual, infrequent, and lack real-time accuracy, making it difficult to promptly address and manage environmental concerns. Poor air quality can cause respiratory and cardiovascular diseases, while excessive noise pollution can lead to hearing loss, stress, and sleep disturbances. There is a critical need for a scalable, cost-effective, and accurate solution to monitor and manage air and noise pollution continuously. An IoT-based air and noise monitoring system can provide real-time data, enhance public awareness, support regulatory compliance, and enable data-driven decision-making to mitigate the adverse effects of pollution and improve environmental health and safety.

CHAPTER - 2
LITERATURE SURVEY

[1] As of now, the total population is relied upon to be around 7.9B. A review from the recent study has shown that 18% of the populace on the planet possesses somewhere around one vehicle. Lately, the air and clamour have become one of the significant foundations for worry all over the planet. The degree of contamination is expanding quickly because of the variables, for example, enterprises, urbanization, expanding populace, vehicle utilize that are influencing human wellbeing. The continuous information of the air and commotion quality is gotten to through the brilliant gadgets and broke down to gauge the effect on city individuals. The shrewd gadgets are fit for estimating the Temperature, Humidity, Carbon Monoxide, LPG, Smoke, sound and other risky particulate matters like PM2.5 and PM10 levels in the climate. This paper discusses a novel methodology of monitoring the noise and air pollution on a joint basis using IoT elements

[2] With the exponential development of MEMS (Micro-Electromechanical Systems) in the last decade, emphasis has been placed on the construction of IoT devices in conjunction with an appropriate information system to assist citizens in various fields (transportation, trade, etc.). More specifically, in the health sector, there are specific IoT devices which can monitor a patient's health condition or provide environmental data for the area, information which affects health quality conditions. In densely populated areas and especially in large cities, in terms of environmental pollution, as well as the known issue of air pollution, citizens are also exposed to solar radiation (ultraviolet UVA UVB radiation), as well as to noise pollution in areas where people live and work. In this article, a low-cost solar radiation and noise pollution monitoring station is presented. The parts that compose the station and its implementation are a microcontroller (TTGO-OLED32) with an integrated LoRa device, an ultraviolet radiation sensor

and sound sensors. In addition, a mini ups device is used in case of power failure and a GPS device is utilized for the location point. In conclusion, the data obtained from such IoT devices help in the study of cities to optimize factors in people's lives.

[3] Monitoring Indoor Environmental Quality (IEQ) is of growing interest for health and wellbeing. New building standards, climate targets and adoption of homeworking strategies are creating needs for scalable, monitoring solutions with onward Cloud connectivity. Here, we present insights into the development of a MEMS-based Internet of things (IoT) enabled multimodal device for IEQ monitoring. A study was conducted to establish the inter-device variability and validity to reference standard sensors/devices. For the multimodal, IEQ monitor, intraclass correlations and Bland-Altman analyses indicated good inter-sensor reliability and good-to-excellent agreement for most sensors. All low-cost sensors were found to respond to environmental changes. Many sensors reported low accuracy but high precision meaning they could be calibrated against reference sensors to increase accuracy.

[4] Rapid advancements in affordable, miniaturized air pollution sensor technologies offer the potential to capture the high variability of personal exposure to air pollution during daily life with unprecedented spatial and temporal resolution. The aim of this work is the development of a common architecture of three types of highly-reliable, portable air quality devices using low-cost sensors. The devices monitor particulate matter, differential pressure and outdoor emissions (CO, CO2, O3 and VOCs) with high reliability and at a high temporal and spatial resolution while communicating measurements to the cloud in real time. The methodological approach followed in this paper is to develop at a high TRL level a flexible, modular hardware platform, delay and fault-tolerant middleware components and data-centric cloud services that together ensure

reliability in all three places: at the sensor level, the device/edge level and at the cloud.

[5] The main aim of this work is to establish a sensor MESH network using an ESP-MESH networking protocol with the ESP32 MCU (a Wi-Fi-enabled microcontroller) for indoor and outdoor air quality monitoring in real time. Each sensor node is deployed at a different location on the college campus and includes sensor arrays (CO2, CO, and air quality) interfaced with the ESP32. The ESP-MESH networking protocol is a low-cost, easy-to-implement, medium-range, and low-power option. The data of different air quality parameters is taken (every 2 min) from the indoor and outdoor nodes and continuously monitored for 72 min. The performance of the MESH network is estimated in terms of the package loss rate (PLR), package fault rate (PFR), and rate of packet delivery (RPD). The value of the RPD is more than 97%, and the value of the PMR and PER for each active node is less than 1.8%, which is under the limit. The results show that the ESP-MESH network protocol offers a considerably good quality of service, mainly for medium-area networks.

[6] Humans can be adversely affected by exposure to air pollutants in ambient air. Hence, health-based standards and objectives for some pollutants in the air are set by each country detection and measurement of contents of the atmosphere are becoming increasingly important. One of the major factors that influence the representativeness of data collected is the location of monitoring stations the planning and setting up of monitoring stations are complex and incurs a huge expenditure. Air pollution affects our day-to-day activities and quality of life. It poses a threat to the ecosystem and the quality of life on the planet. People need to know the extent to which their activities affect air quality. This project proposes an air pollution monitoring system. An IoT-based air pollution monitoring system is proposed to monitor the pollution levels of various pollutants.

[7] This paper deals with measuring Air Quality using MQ135 sensor along with Carbon Monoxide CO using MQ7 sensor. Measuring Air Quality is an important element for bringing lot of awareness in the people to take care of the future generations a healthier life. Based on this, Government of India has already taken certain measures to ban 'Single Stroke' and 'Two Stroke' Engine based motorcycles which are emitting high pollutions comparatively. We are trying to implement the same system using IoT platforms like Cayenne, we can bring awareness to every individual about the harm we are doing to our environment. Already, New Delhi is remarked as the most pollution city in the world recording Air Quality above 300PPM. We have corrected the other papers where they have wrongly calibrated the sensor and wrongly projecting the PPM values. We have also used easiest platform like Things peak and set the dashboard to public such that everyone can come to know the Air Quality at the location where the system is installed.

[8] Today, air pollution is the biggest environmental health problem in the world. Air pollution leads to adverse effects on human health, climate and ecosystems. Air is contaminated by toxic gases released by industry, vehicle emissions and the increased concentration of harmful gases and particulate matter in the atmosphere. Air pollution can cause many serious health problems such as respiratory, cardiovascular and skin diseases in humans. In this study, e-nose, a real-time mobile air quality monitoring system with various air parameters such as CO2, CO, PM10, NO2 temperature and humidity, is proposed. The proposed e-nose is produced with an open source, low cost, easy installation and do-it-yourself approach. The air quality data measured by the GP2Y1010AU, MH-Z14, MICS-4514 and DHT22 sensor array can be monitored via the 32-bit ESP32 Wi-Fi controller and the mobile interface developed by the Blynk IoT platform, and the received data are recorded in a cloud server.

[9] Now a day in metropolitan cities air and noise pollution becomes serious issues, due to high decibels and toxic gases present in the environment which directly effect on human health and thus needs a special attention. Therefore, it has now become necessary to control the pollution (air and noise) to ensure healthy livelihood and better future. In this paper, an effective implementation for Internet of Things is used for monitoring atmospheric conditions of environment like air pollution and sound pollution. This paper presents a conceptual architecture for a versatile, flexible and cost efficient for monitoring the air and sound quality of a particular site. We propose an air quality as well as sound pollution monitoring system that allows us to monitor and check live air quality as well as sound pollution in an area through IOT. System uses air sensors to sense presence of harmful gases /compounds in the air and constantly transmit this data. Also, system keeps measuring sound level and reports it.

[10] The Automatic Air & Sound management system is a step forward to contribute a solution to the biggest threat. The air & sound monitoring system overcomes the problem of the highly-polluted areas which is a major issue. It supports the new technology and effectively supports the healthy life concept. This system has features for the people to monitor the amount of pollution on their mobile phones using the application. So, it becomes very reliable and efficient for the Municipal officials along with the Civilians to monitor environment. Letting civilians also involved in this process adds an extra value to it. As civilians are now equally aware and curious about their environment, this concept of IOT is beneficial for the welfare of the society. And it is implemented using the latest technology

CHAPTER - 3
EXISTING SYSTEM

Current mechanisms for tracking air and noise contamination comprise manual observations, permanent stations, mobile stations, citizen reporting, and space-based monitoring. Manual observation includes time-consuming techniques with irregular measures and occasional stationary stations which although are correct are expensive and provide a small area of surveillance. Mobile units offer more flexibility but also are expensive and labor intensive. Citizen science and public reporting involve individuals using portable sensors but the data obtained is non-real time and can be inconsistent and less reliable. Satellite based monitoring provides a broader coverage but is not detailed enough for monitoring at localized levels and does not provide reliable estimates of noise pollution. Through these systems, some of the issues are data inaccuracy, consequently, high fees, low coverage, no real-time data availability, and reduced public exposure due to the localization of information. These limitations speak to the necessity for an improved answer on a bigger scale and essentially in precise time frames – as an IoT-based air and noise monitoring system that can present the right and whole image of the environmental situation.

CHAPTER - 4
PROPOSED SYSTEM

In the IoT-based air and noise monitoring system that we propose to implement, the Blynk platform for developing IoT solutions is at the heart of the mobile application that would be used by the system's users to interact with the system and receive information about the air and noise quality. The utility of this app is that users receive information immediately, and it is an ideal method to transmit data about air quality and noise pollution. By providing user-friendly controls and personalized options for managing alerts, it is simple to configure thresholds for different types of pollution and be notified immediately when they occur. The Blynk application also offers integrated data representation capabilities to visualize pollution changes in real-time and display general trends over time to make decisions to protect their health. Our system is developed using the Blynk IoT platform to provide the integration between the different parts of the system and to provide a strong and reliable performance for the system as a whole and also to make sure the system follows a user-friendly design that enables an individual to take action and prevent the occurrence of and/or worsening of the effects of air and noise pollution.

CHAPTER - 5

SYSTEM DESIGN

5.1 ARCHITECTURE DIAGRAM

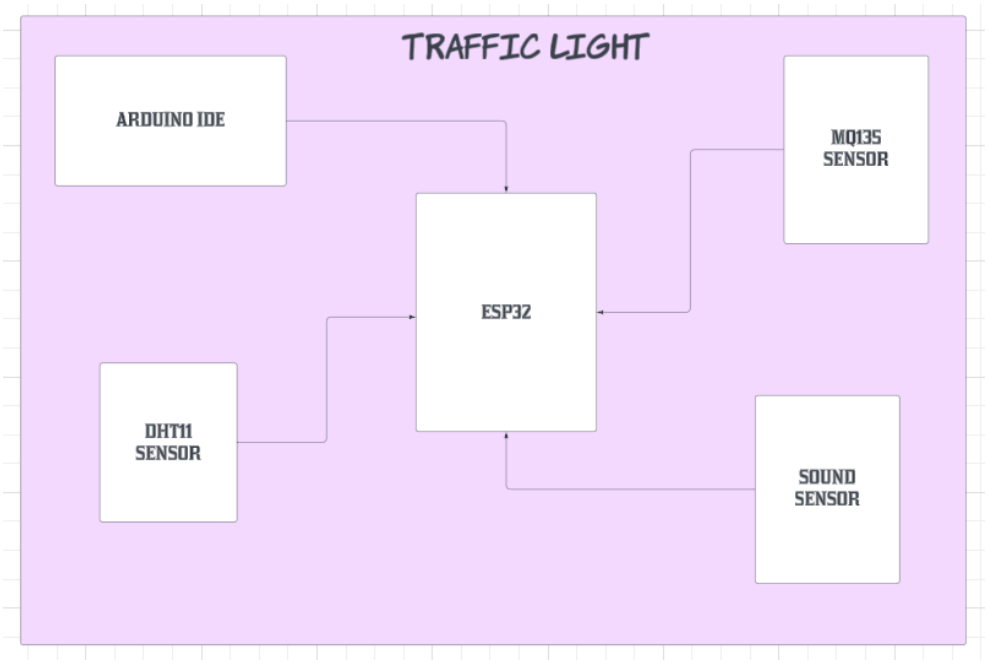


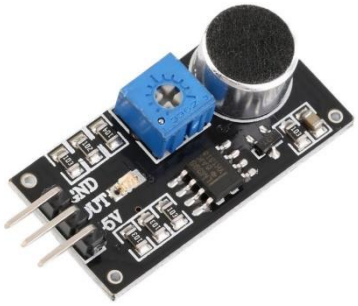
Fig 5.1: Architecture Diagram

5.2 HARDWARE SPECIFICATIONS

1. ESP32

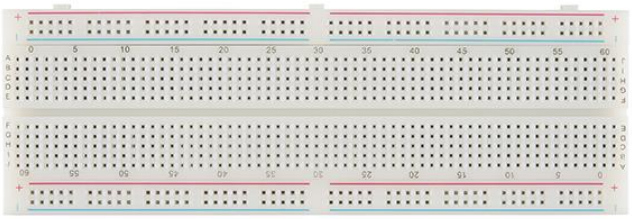
2. DHT11 Sensor

3. Sound Sensor (e.g., KY-038)



4. MQ-135 Sensor

5. Breadboard



6. Jumper Wires

5.3 SOFTWARE SPECIFICATIONS

- Arduino IDE
- Blynk IoT

CHAPTER – 6

OUTPUT

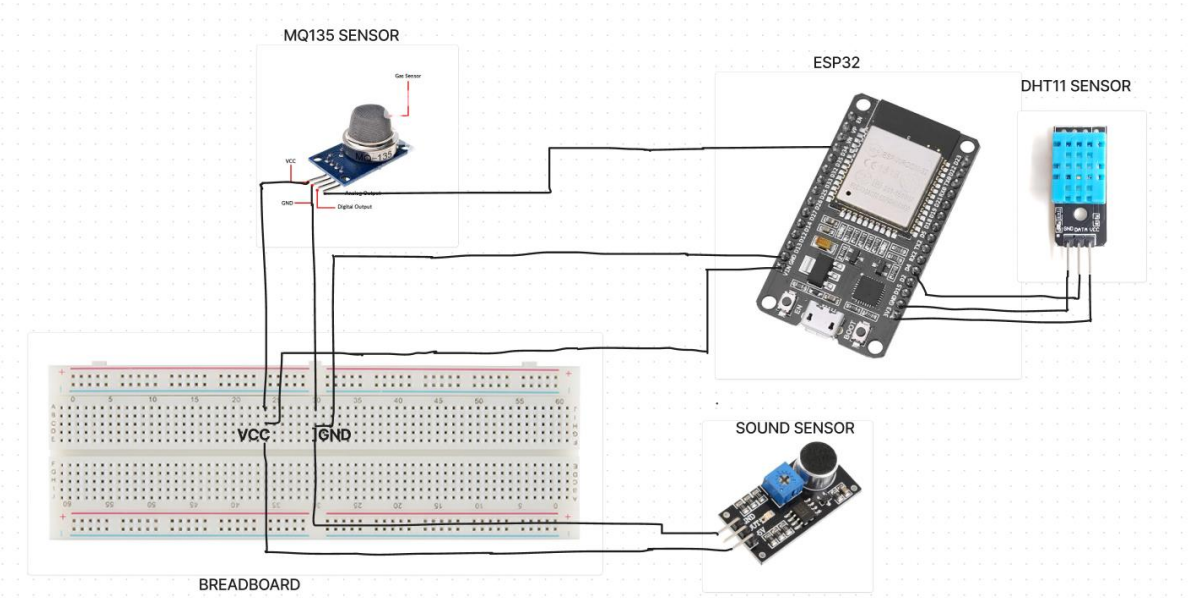


Fig 6.1: Circuit Diagram

The system continuously tracks air quality and noise levels, providing up-to-date information to the user through notifications. These notifications provide them with the clear view of the Pollution statistics.

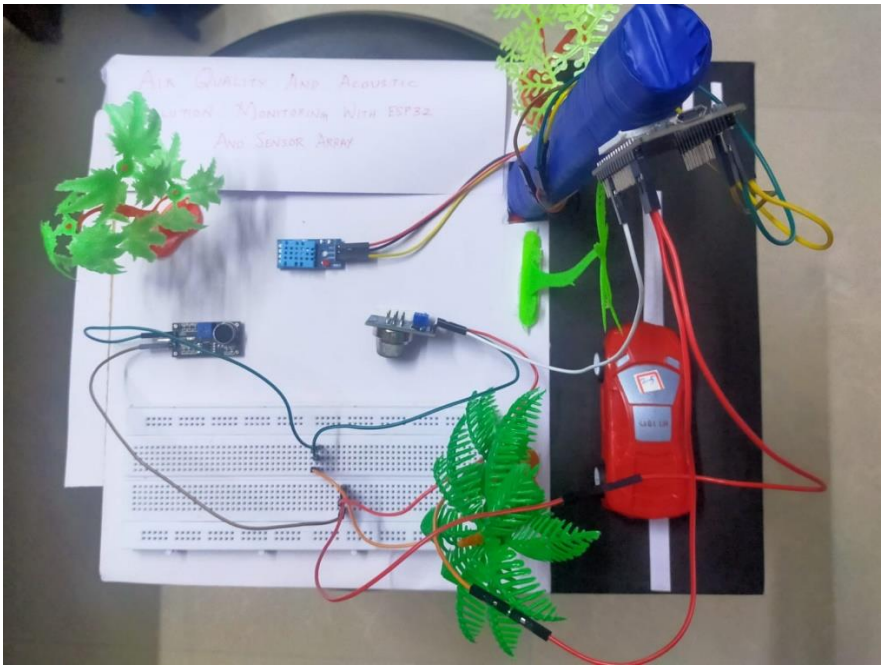


Fig 6.2: Setup Picture

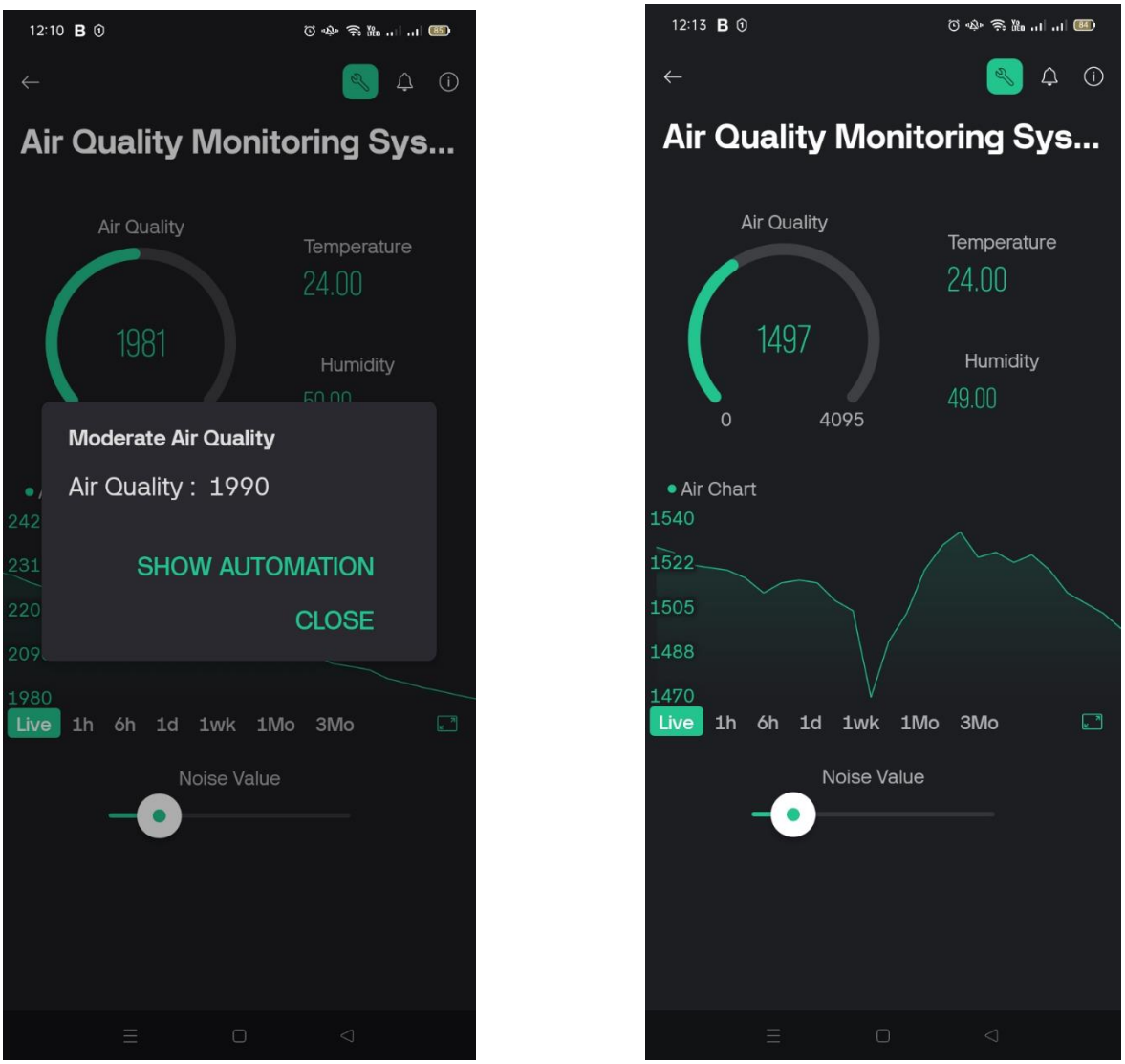


Fig 6.3: Blynk IOT Automation & Display

Automated alerts notify users of critical pollution levels, ensuring timely response to environmental hazards. The alert configuration and notification examples are shown in the screenshots.

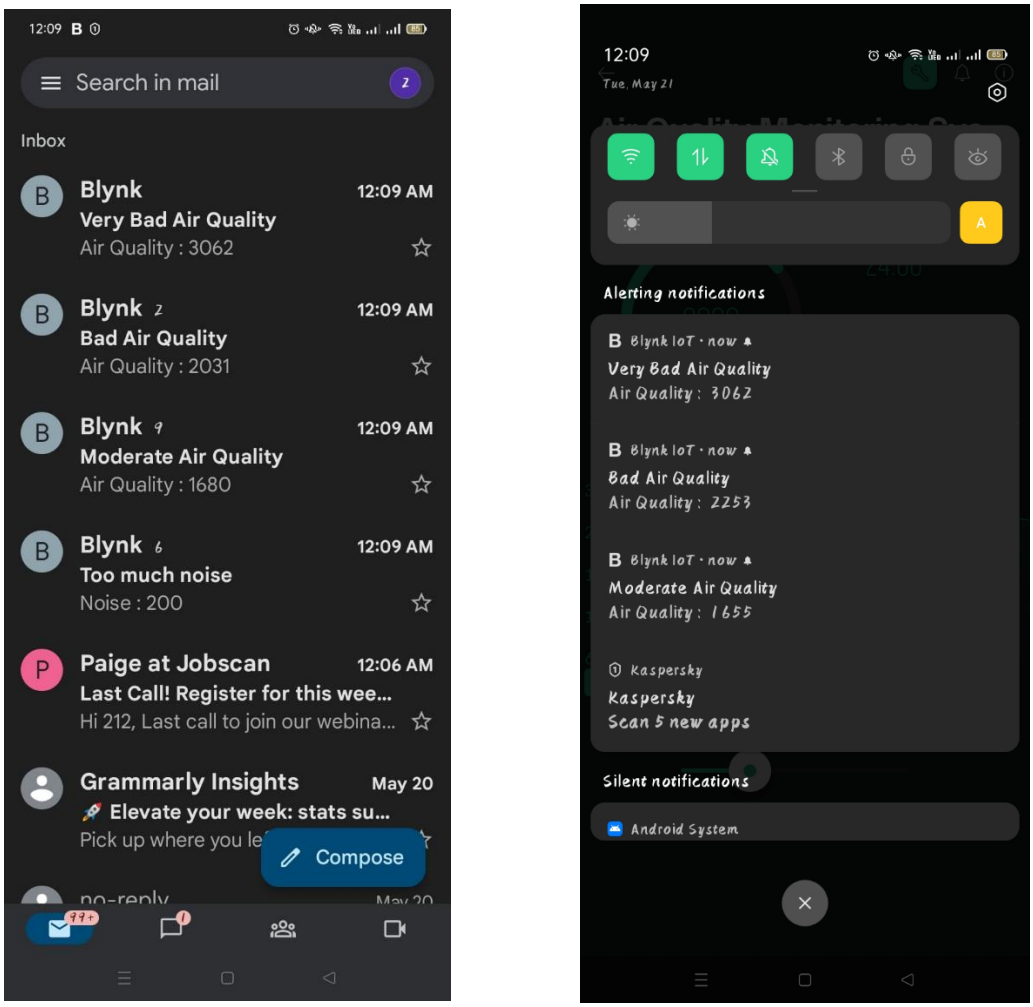


Fig 6.4: Alerting Notifications & Email

These alerts are also sent to the user's account regarding the quality of air and noise present in the atmosphere.

CHAPTER – 7
CONCLUSION AND FUTURE WORK

This system is implemented effectively for the observation of the atmosphere and the surrounding air and sound environment. The proposed system allows for further real-time evaluation of the air quality and sound pollution using the IoT. The use of the Blynk application allows the users to easily supervise the gathered information regarding the pollution of the air and sound. All this works are lively integrated with the Blynk platform, which expands the potential of the user experience, making it easier to read and analyse the environment with the help of familiar interactive interfaces and personalization settings. In conclusion, our method provides an integrated mechanism for addressing pollution challenges in the areas of air and noise in the environment through the use of IoT-based systems and manageable applications for pollution problems.

In future developments, our system may expand by introducing additional component to strengthen the capacity of the system in environmental monitoring. More types of sensors may be incorporated to detect more types of pollutants, including VOCs, O3, and NOx. In addition, machine learning algorithms can be introduced to conduct predictive analysis on historical data and other environmental parameters to predict future incidences of pollution for efficient planning in pollution mitigation. Furthermore, incorporating location-based technologies, such as geospatial maps or GPS trackers, could help visualize the level of pollution within specific geographical boundaries. In addition, features like individualized health guidance according to air quality levels or collaborative initiatives where people can organize and take action against environmental hazards could be added to the Blynk application to increase its effectiveness in creating champions for environmental health. Taking these future enhancements into consideration can transform our system’s capability to counter air and sound pollution, which is quite important for the environment’s health.

APPENDICES

#IOT_Project.ino

```
#define BLYNK_TEMPLATE_ID "TMPL3YpsOAUTW"
#define BLYNK_TEMPLATE_NAME "Air Quality Monitoring System"
#define BLYNK_AUTH_TOKEN "obNeeHX-mk-iHqaZkj3b1VH2vOSfeLgF"
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include "DHT.h"
DHT dht;
int gas_input = 34;
int dht_pin = 4;
int sound_pin = 35;

char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "Reah";
char pass[] = "12345678";

BlynkTimer timer;

void sendSensor() {
  int analog_data = analogRead(gas_input);
  Serial.print("Air Quality: ");
  Serial.println(analog_data);
  delay(200);
  Blynk.virtualWrite(V0, analog_data);
  double humidity = dht.getHumidity();
```

```
  double temperature = dht.getTemperature();
  // Serial.println(temperature);
  delay(200);
  Blynk.virtualWrite(V1, temperature);
  // Serial.println(humidity);
  delay(200);
  Blynk.virtualWrite(V2, humidity);
  int noise_data = analogRead(sound_pin);
  Serial.print("Noise : ");
  Serial.println(noise_data);
  delay(200);
  Blynk.virtualWrite(V3, noise_data);
  delay(300);

}

void setup() {
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
  dht.setup(dht_pin);
  timer.setInterval(100L, sendSensor);
}

void loop(){
  Blynk.run();
  timer.run();
}
```

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