AIR QUALITY MONITORING

PHASE 5

INDEX:

INTRODUCTION

- In this phase we are going to include the working process of air quality monitoring system with the help of source code as python program that is able to display the concepts of the air quality in the atmosphere and tell about the levels of air and can be determined whether it is in good condition or else bad or worst.
- According to the quality of air we can further proceed for the other steps to minimise the harmful gases in atmosphere and try to increase the useful gases like oxygen content in the atmosphere by planting a trees or plants as a responsible person to our environment.
- The monitoring system measures all major ambient parameters such as PM1, PM2. 5, PM10, PM100, Carbon Monoxide (CO), Carbon Dioxide (CO2), Sulphur Dioxide (SO2), Nitrogen Dioxide (NO2), Ozone (O3), Hydrogen Sulphide (H2S), Ambient Noise, Light, UV, Temperature, and Humidity.
- An IOT based air pollution monitoring system consists of several hardware and software components that work together to collect and process data.
- The hardware components include sensors, microcontrollers, and communication modules.
- The software components consist of a cloud platform, a mobile application, and a web-based dashboard.
- The system can also alert the users if the air quality reaches a dangerous level, allowing them to take precautions to protect themselves.

Abstract

- In this phase, an IoT-based air quality monitoring platform, consisting of an air
  quality-sensing device called “Smart-Air” and a web server, is demonstrated.

- This platform relies on an IoT and a cloud computing technology to monitor air

quality in anywhere and anytime.

- Smart-Air has been developed based on the IoT technology to efficiently monitor
the air quality and transmit the data to a web server via LTE in real time.

- The device is composed of a microcontroller, pollutant detection sensors, and
LTE modem. In the research, the device was designed to measure a concentration of aerosol, VOC, CO, CO 2 , and temperature-humidity to monitor
the air quality.

- An application was developed to help in monitoring the air quality. Thus, approved personnel can monitor the air quality at any time and from anywhere,
via either the web server or the application. The web server stores all data in the
cloud to provide resources for further analysis of air quality.

Problem definition

Air pollution is one of environmental issues that cannot be ignored. Inhaling

Pollutants for a long time causes damages in human health. Traditional air quality monitoring methods such as building air quality monitoring stations, are typically expensive . This project is suitable for air quality monitoring in real time.

Design a tool which will sense quality of air and display it in the form of percentage, Sense how much carbon mono-oxide(CO) is present in air and display in the form of percentage, Sense the temperature and display it in degree Celsius and humidity .

Once pollutants are emitted into the air, they are influenced by weather conditions. Weather all around the world is extremely variable. Only studying air pollution is not adequate to estimate air quality. Also, air pollution is very complicated in terms of pollutants and their effects on buildings and roads.

This is where air quality monitoring comes into the picture. We can utilize air emissions monitoring to measure the types and concentrations of pollutants, enabling us to further analyze and interpret the data. We can use this information to take actions based on trends.

It can also help us to determine which areas in the country are more pollutants, which type of pollutants are increasing relating to industrial pollution and traffic.

Design Thinking

- Collecting air samples from the site
- Battery operated instruments for real-time measurements of Temperature, Humidity, Wind direction, Wind speed, PM2.5, PM10, CO, CO2, NOx, etc.
- Monitoring human exposure to harmful pollutants
- Detection & measurement of harmful gases in air from the collected sample
- Provide solutions to further improve Air quality in Companies.

Project objectives

- In the future work, we can modify the system to notify a user about the air quality
  when it reaches beyond when it reaches beyond a permissible level through SMS
  or APP.
- Notification,further more, the sensors in the system can be calibrated more
  so that we can get more accurate and get data for more harmful gases such as
  Ammonia, oxides of nitrogen, etc.
- Our work can demonstrate vast opportunities to work on the device, on the app and also on the field using the device that we have worked with.
- The device can be used any time efficiently in different locations of a city and then research with the achieved data for that particular area in that city.
- The device can be updated with additional sensors that can sense data from the existence of other gases such as O2 and H2.
- These gases will provide the condition of the atmosphere and authority can take into further decisions
  accordingly.
- The sensors that we have been worked with can also be reset according to most recent time update.
- The android app which we have developed for turning on and off the device can be updated with newer features by implementing necessary codes.

Device design

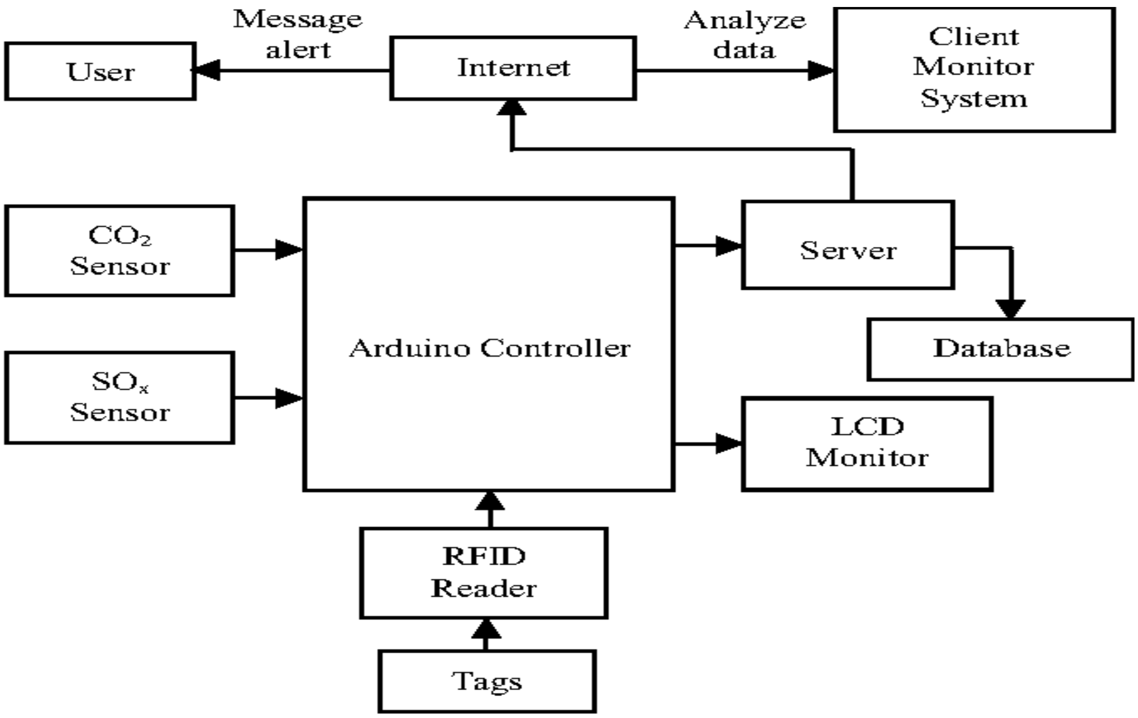
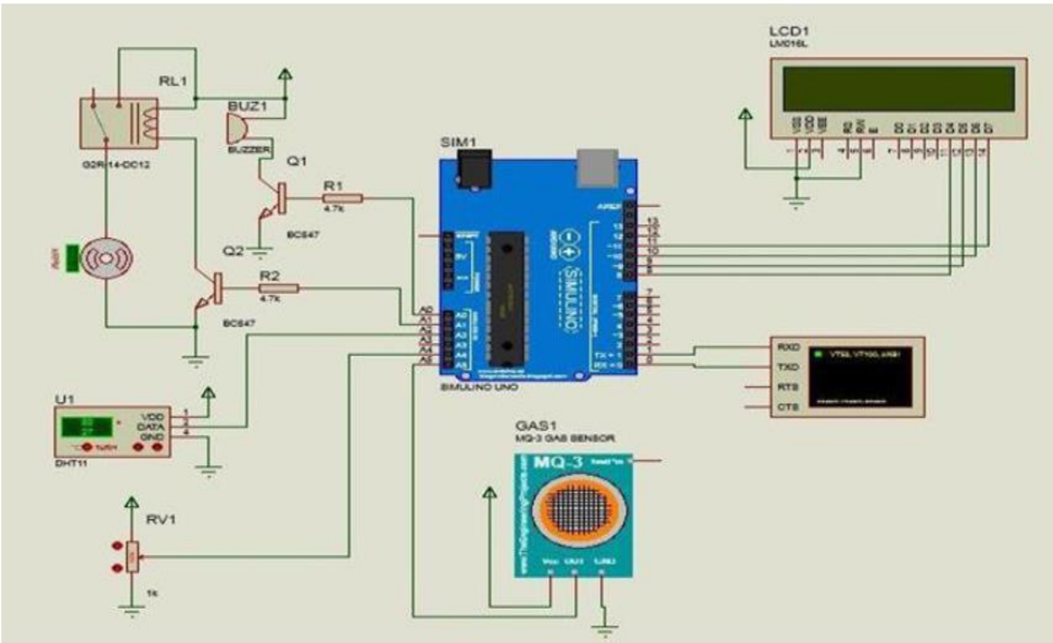
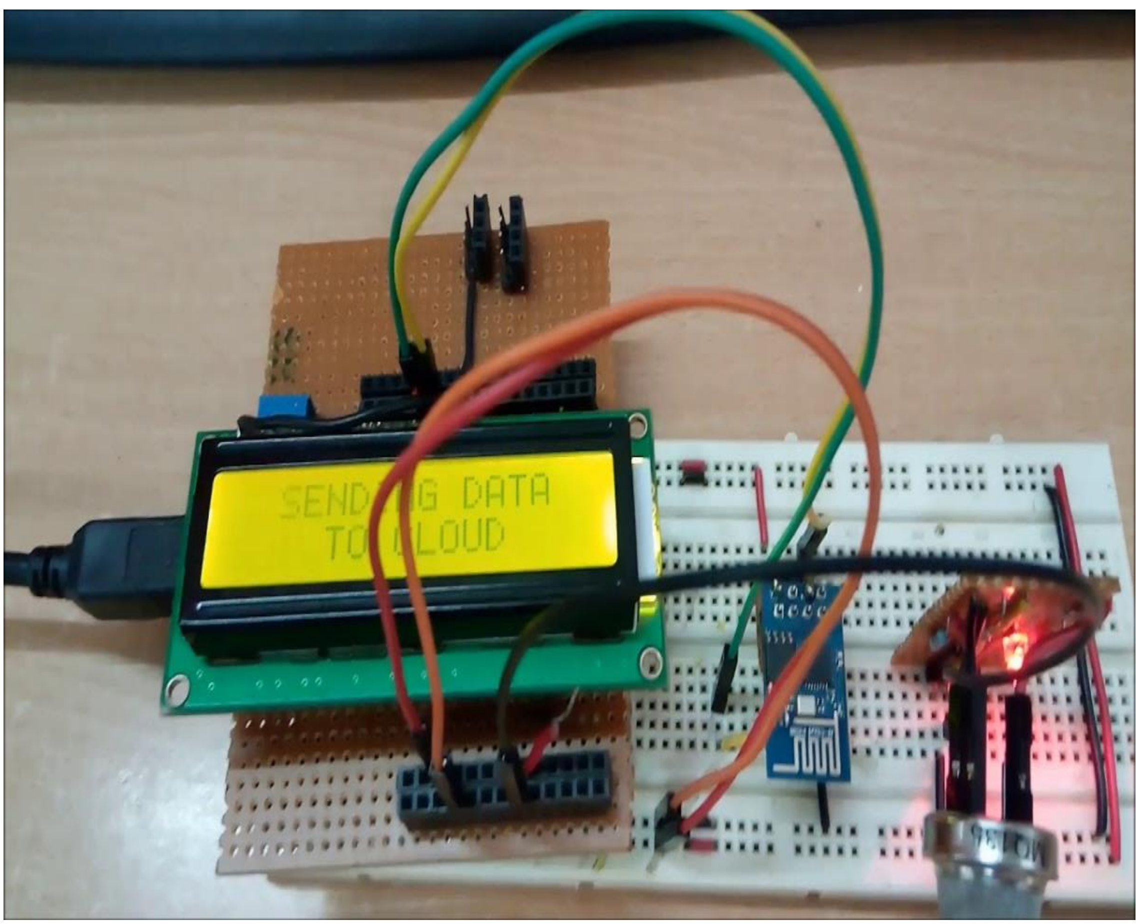


Figure 5: Block diagram of air pollution monitoring system model.





Requirements

- ✓ Sensors
- ✓ Microcontrollers
- ✓ Communication modules
- ✓ Power supply
- ✓ Enclosure
- ✓ Arduino UNO
- ✓ Nephelometers

Sensors:

Sensors are the primary components of IoT-based air pollution monitoring systems. They measure various air quality parameters such as particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides. The sensors can be classified into two categories: physical and chemical sensors. Physical sensors measure parameters such as temperature, humidity, and pressure, while chemical sensors measure air pollutants.

MicroControllers:

The microcontroller is the brain of IoT-based air pollution monitoring systems. It receives data from the sensors, processes it, and sends it to the cloud server. The microcontroller is usually a microprocessor such as Arduino, Raspberry Pi, or similar devices.

Communication Module:

The communication module is responsible for transmitting data from the microcontroller to the cloud server. Communication modules can use various wireless technologies such as Wi-Fi, Bluetooth, or cellular networks.

Nephelometers:

It used to monitor particulate matter such as dusts, smokes, mists, and fumes. They can be used for monitoring the respirable fraction of dust, and are small enough to use for personal exposure monitoring. Results are reported in $\mu g/m^3$ or mg/m^3.

Power Supply:

IoT-based air pollution monitoring systems require a power supply to operate. In case of permanent installations external power supply is provided and batteries are provided for portable devices.

Enclosure:

The enclosure is the outer covering that protects the components from environmental factors such as dust, water, and temperature

Arduino UNO:

Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. This board can be interfaced with other Arduino boards, Arduino shields, Raspberry Pi boards and can control relays, LEDs, servos, and motors as an output.

Source code

Python Source code for air quality monitoring system :

```
import requests

import json

import random

import time

Api_key = "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"

City = "YourCity"

Country = "YourCountry"


APIurl="http://api.openweathermap.org/data/2.5/air_pollution?lat=0&lon=0&appid={api_key}"
```

```
response = requests.get(url)

if response.status_code == 200:
    data = response.json()

    Air_quality = data["list"][0]["main"]

    print(f"Air Quality in {city}, {country}:")
    print(f" - AQI (Air Quality Index): {air_quality['aqi']}")
    print(f" – Particulate Matter (PM2.5): {air_quality['pm2_5']} µg/m³")
    print(f" – Particulate Matter (PM10): {air_quality['pm10']} µg/m³")
    print(f" – Carbon Monoxide (CO): {air_quality['co']} µg/m³")
    print(f" – Nitrogen Dioxide (NO2): {air_quality['no2']} µg/m³")
    print(f" – Ozone (O3): {air_quality['o3']} µg/m³")
    print(f" – Sulfur Dioxide (SO2): {air_quality['so2']} µg/m³")
class AirQualityMonitor:
    def __init__(self, location):
        self.location = location
        self.pm25 = 0
        self.pm10 = 0

    def measure_air_quality(self):
        self.pm25 = random.uniform(0, 100)
        Self.pm10 = random.uniform(0, 150)

    def display_data(self):
        print(f"Location: {self.location}")
        print(f"PM2.5: {self.pm25} µg/m³")
```

```
        print(f"PM10: {self.pm10} µg/m³")
        print("----------------------------")

if __name__ == "__main__":
    outdoor_sensor = AirQualityMonitor("Outdoor Sensor")
    indoor_sensor = AirQualityMonitor("Indoor Sensor")

    while True:
        outdoor_sensor.measure_air_quality()
        indoor_sensor.measure_air_quality()

        outdoor_sensor.display_data()
        indoor_sensor.display_data()

        # Simulate data collection every 5 seconds
        time.sleep(5)
else:
    print("Failed to retrieve air quality data")
def air_quality(aqi):
    if 0 <= aqi <= 50:
        return "Good"
    elif 51 <= aqi <= 100:
        return "Moderate"
    elif 101 <= aqi <= 150:
        return "Unhealthy for Sensitive Groups"
    elif 151 <= aqi <= 200:
        return "Unhealthy"
    else:
```

return "Hazardous"

Aqi_value = 75

Result = air_quality(aqi_value)

print(f"The air quality is {result}")

<u>Sample Output</u>:

Air Quality in YourCity, YourCountry:

- AQI (Air Quality Index): 24
- Particulate Matter (PM2.5): 3 µg/m³
- Particulate Matter (PM10): 5 µg/m³
- Carbon Monoxide (CO): 200 µg/m³
- Nitrogen Dioxide (NO2): 10 µg/m³
- Ozone (O3): 30 µg/m³
- Sulfur Dioxide (SO2): 1 µg/m3

```

Oxygen state: Good

Carbon Dioxide state: Good

Carbon Monoxide state: Bad

Location: Outdoor Sensor

PM2.5: 35.245 µg/m³

PM10: 78.119 µg/m³

---

Location: Indoor Sensor

PM2.5: 12.874 µg/m³

PM10: 93.572 µg/m³

---
```

Using IoT as an Air Quality Monitor:

IoT as an inter connective device acts as a perfect medium to determine the quality of air monitor air quality. The data is transmitted to a centralized platform without any latency that enables the monitoring of AQI of a location from anyplace in a particular facility. High-end devices like sensors and meters embedded in strategic places can be used to ascertain the air quality index (AQI) or identify the presence of a particular harmful gas.

Powered with features such as real-time monitoring, multi-channel alerts, and advanced analytics; IoT systems are the best tools to.

Html code for air quality monitoring system :

```
<!DOCTYPE html>

<html>

<head>

  <title>Air Quality Monitoring System</title>

</head>

<body>

  <h1>Air Quality Monitoring System</h1>


  <form>

    <label for="pm25">PM2.5 (µg/m³):</label>

    <input type="number" id="pm25" name="pm25" min="0" step="1"
required><br><br>


    <label for="temperature">Temperature (°C):</label>

    <input type="number" id="temperature" name="temperature" step="0.01"
required><br><br>


    <label for="humidity">Humidity (%):</label>
```

```
        <input type="number" id="humidity" name="humidity" min="0" max="100"
step="1" required><br><br>

        <input type="submit" value="Submit">
    </form>

    <h2>Current Air Quality Data</h2>
    <p>PM2.5: <span id="currentPM25">-</span> µg/m³</p>
    <p>Temperature: <span id="currentTemp">-</span> °C</p>
    <p>Humidity: <span id="currentHumidity">-</span> %</p>

    <script>
        document.querySelector('form').addEventListener('submit', function(e) {
            e.preventDefault();
            var pm25 = document.getElementById('pm25').value;
            var temperature = document.getElementById('temperature').value;
            var humidity = document.getElementById('humidity').value;

            document.getElementById('currentPM25').textContent = pm25 + "  ";
            document.getElementById('currentTemp').textContent = temperature +
"  ";
            document.getElementById('currentHumidity').textContent = humidity +
"  ";
        });
    </script>
</body>
</html>
```

Air Quality Monitoring System

PM2.5 ($\mu g/m^3$):

3

Temperature (°C):

36

Humidity (%): 58

Submit

Current Air Quality Data

PM2.5: 3 $\mu g/m^3$

Temperature: 36 °C

Humidity: 58 %

ADVANTAGES

- Sensors are easily available.
- Detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2,Co etc
- Simple, compact & Easy to handle.
- Sensors have long life time & less cost.
- Simple Drive circuit.
- System is Real time.
- Operating voltage: 5 volt,-20°C to +50°C
- Quality of air can be checked indoor as well as outdoor.
- Visual output.
- Continous update of change in percentage of quality.

LIMITATIONS

- Only 3 sensors are used.

- Humidity should be less than 95%.
-
- Accurate measure of contaminating gases cannot be detected in ppm.

APPLICATIONS

- Roadside pollution Monitoring.
- Industrial Perimeter Monitoring.
- Site selection for reference monitoring stations.
- Indoor Air Quality Monitoring.
- To make this data available to the common man.

FUTURE SCOPE

In future the project can be upgraded in more ways than one.

Interface more number of sensors to know detail content of all gases present in air.

→ Design Webpage and upload data on webpage with date and time.

Interface SD Card to store data.

Interface GPS module to monitor the pollution at exact location and upload on the webpage for the natives.

Conclusion:

➢ An IoT-based indoor air quality monitoring platform based on integration of cloud computing and IoT is presented in this research. Also, a device called “Smart-Air” was developed to precisely monitor indoor air quality and efficiently transmit real time data to a cloud computing-based web server using an IoT sensor network.

- The cloud computing based web server introduced in this platform analysis real-time data and adds visual effects to illustrate the conditions of the indoor air quality.
- In addition, the web server was designed to issue alert mobile application users or facility managers of moderate or poor air quality so that responsible parties can take immediate remedial action.
- Real-time monitoring and a rapid alert system produce an efficient platform for improving indoor air quality. Major contributions of the proposed study are as follows:

- ✓ We propose the use of the Smart-Air for the precise monitoring of indoor air quality
- ✓ We propose the utilization of an IoT for efficient monitoring of real-time data
- ✓ We propose the adoption of cloud computing for real-time analysis of indoor air quality
- ✓ We originally developed a mobile application to make the proposed IoT system with features of anytime, anywhere
- ✓ The device has been tested for reliability of the data and the platform has been implemented in a building to test its feasibility.