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Novel Approach for Air quality Monitoring

Shakunthala B S
Dept. of ISE
KIT
TIPTUR, INDIA
shakukit@gmail.com

Ullas H S
Dept of E & C
SSIT
TUMKUR, INDIA
ullaspatelhs@gmail.com

Suresh M
Dept of E & C
SSIT
Tumkur, INDIA
sureshm@ssit.edu.com

Veeraswamy Ammisetty
Dept. of CSE,
KLEF, Andrapradesh
ammisetty.veeraswamy@gmail.com

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***Abstract*— Air is essential for human life and contains harmful gases. India faces severe health hazards due to air quality issues. The AQI in 2014 monitors pollution on 10 scales, with the present paper developing an IoT-based mobile air quality monitoring system. The Raspberry Pi, a low-cost computer, connects to a monitor or TV using HDMI and a standard keyboard and mouse.**

Keywords*— MQ2 Gas Sensor, ADS1115, MQ9 Gas Sensor,Raspberry Pi, SVM.

I. Introduction

Air pollution [1] impacts human health, with hazardous elements like LPG gas, smoke, CO, and methane present. Raspberry Pi microcontroller's wireless adaptor enables remote monitoring, aiming to identify and address polluting components. India is developing IoT-based indoor air quality monitoring systems to address health hazards from air pollution. The system integrates Smart-Air sensor devices and web servers, enabling remote monitoring of aerosol concentrations, VOC, CO, and temperature humidity.

Lungs in humans can cause illnesses like asthma and coughing due to air pollution, which contains hazardous elements like LPG gas, smoke, CO, and methane. Contaminated air can be poisonous, and a Raspberry Pi microcontroller with a wireless adaptor allows remote monitoring of air quality. The rise of motorization and robotization has led to a global increase in mechanical insurgency, impacting the living necessities of the average person. Industrial IoT[2] (IIoT) has gained significant attention, focusing on productivity and efficiency. The rapid growth of vehicles and machines has negatively impacted environmental factors, causing air and water pollution, causing health issues like hypersensitivity, eye problems, heart problems, hypersensitivity, and bronchitis. The need for smart toxins GPS beacons and air pollution monitoring is growing, with traditional methods often being confounded by rapid advancements. The proposed method offers a promising solution, reducing the incentive to one/10.

The rise of motorization and robotization[3] has led to a global mechanical insurgency, impacting the living necessities of the average person. Industrial IoT (IIoT) has gained significant attention, focusing on productivity and efficiency. The rapid growth of vehicles and machines has negatively impacted environmental factors, including air and water pollution, which negatively affects human presence. This has led to the need for smart GPS[4] beacons for air quality monitoring and health monitoring.

A. Existing System

IoT-based wireless sensor network monitors air quality using a central server and gas sensors. Urban air pollution predictions face challenges due to large ecological monitoring data and complex atmospheric changes. To improve environmental management resolution, effective estimating methods are needed to improve prediction accuracy and avoid severe contamination episodes. A new method using deep neural networks is developed to estimate contaminants' levels, using a Neural Network Model as the bottom layer and a long-term memory network as the output layer Experimental results show significant improvement compared to basic models. Traditional forecast techniques, such as mathematical assessment and AI, have some disadvantages, such as relying on knowledge.

B. Proposed System

Air pollution is caused by harmful gases like smoke, carbon monoxide, LPG gas, and methane, which are extremely hazardous. Advancements in study enable human observers to determine airborne component content and monitor pollution levels remotely using Raspberry Pi modules and Wi-Fi adaptors.

The proposed paper examines the industry, analyzing methods and identifying gas spillage risks. Additionally, fuel spillage can be addressed using potential targets and comparing sensors. The data can be sent to Google Cloud, enabling real-time monitoring and implementing preventive measures. The goal is to enhance productivity, worker wellbeing, and natural obligation. The machine sends sensors to specific locations on the business floor, detecting gas outflow, fuel spillage, and heater temperature.

C. Problem Statement

Modern air quality is highly polluted due to heavy car emissions, industrial chemicals, and smoke, causing severe health issues like asthma, coughing, and lung ailments.

D. Objectives

Project aims to develop strategic air quality monitoring procedure for informed decision-making and environmental improvement.

E. Organization of the paper

This project report is organized into seven chapters, including an introduction, literature survey, main block diagram, software and hardware requirements, advantages and disadvantages, results, and conclusion. The structure ensures a clear understanding of the project's scope and methodology.

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II. Related Work

In this paper we introduced IoT technology to tract indoor air quality and to measure air contamination present in atmosphere.The system displays data on temperature, humidity, dust particles, and polluting gases. It sends data to the ThingSpeak Cloud via Wi-Fi for remote monitoring.

A low-cost, portable Internet of Things (IoT) Indoor Air Quality (IAQ) monitoring system[5] with 30 hours of battery life is designed to monitor total VOCs, CO2, PM2.5, PM10, temperature, humidity, and illuminance. The system can be used for real-time measurements and hourly and daily averaging in low power modes. The device calculates a qualitative air quality index from measurements taken in-situ, based on EPA standards. Environmental data is used by the system to provide recommendations, such as increasing ventilation or reducing activity levels, to help users improve their air quality. This system can be used as a node to monitor air quality in large-scale networks for Smart Cities. A prototype Personal Air Quality Monitor[6] based on low-cost sensors and low power communication by IoT devices is introduced, storing data in the cloud. This system demonstrates how real-time monitoring of data can be achieved from any browser-capable device. An alternative, cheap, IoT-based air quality monitor[7] can track air pollution in real time and transmit relevant data rapidly through a low-power wide area network.

A network of IoT-based sensors[8] can generate vast data for real-time analysis of air pollution in cities. These sensors can predict future pollutants based on past and present pollutants, saving data in Excel sheets for further evaluation. Low-cost sensor nodes measure CO and NO2 concentrations and PM levels[9-11], powered by solar-recharged batteries or mains supply. This system uses a reference sensor for accurate monitoring and air quality analysis.

Utilizing the cloud computing paradigm, a web server [12] has been seamlessly integrated to analyze data and present visualizations of indoor air quality conditions in compliance with government standards. This innovative platform has been effectively deployed at Hanyang University in Korea, showcasing its practicality. Given that over 8 million individuals rely on subways daily in South Korea, where harmful gas contamination is prevalent in the air, the study employs an IoT-based air quality monitoring system to gauge PM10 levels [13-15] within subway tunnels. Through real-time experiments, the system has proven its efficiency and success in monitoring particulate matter, contributing to the improvement of air quality within subway tunnels.

III. Proposed Method

The SVM algorithm predicts normal or abnormal values, with a buzzer activated if abnormal conditions occur.

IoT technology detects air quality using less cost-effective gas sensors, such as MQ9 for carbon monoxide, MQ2 for smoke, and PMS7003 for PM2.5, collecting real-time environmental data and sending it to the internet. ThingSpeak is an IoT platform for storing sensor data via HTTP, allowing graphical analysis and visualization as shown Figure 1 and 2.

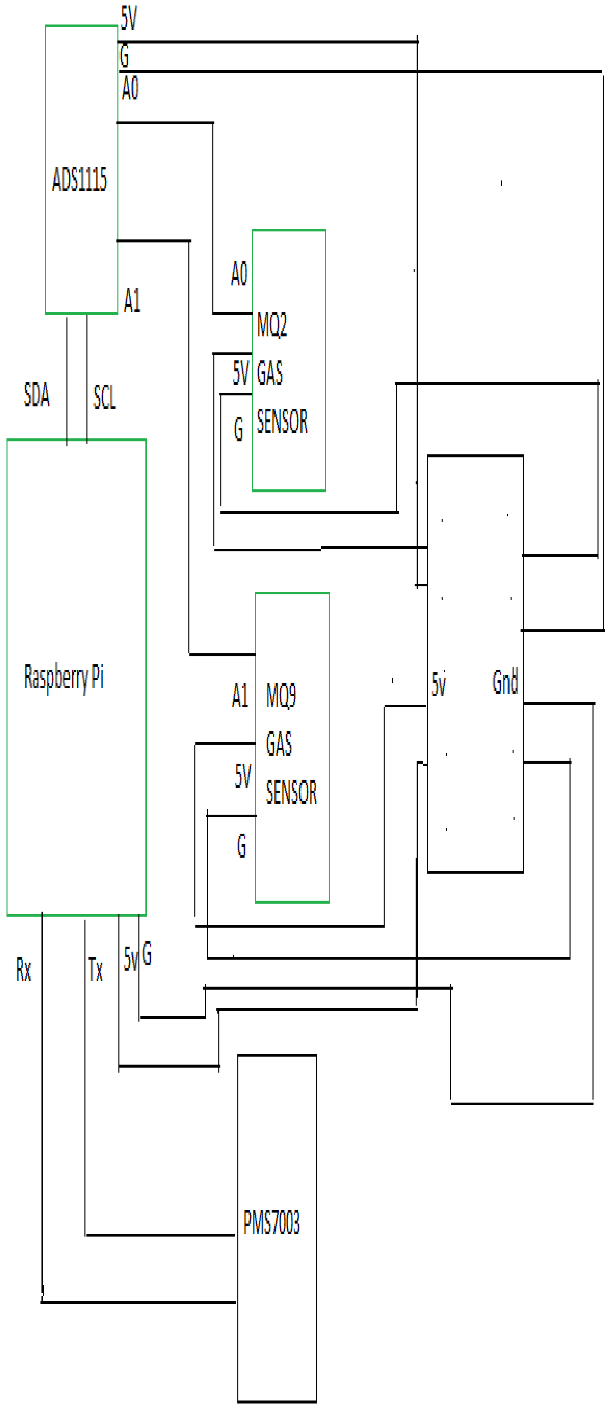

Fig. 1. Circuit diagram and flowchart of proposed system

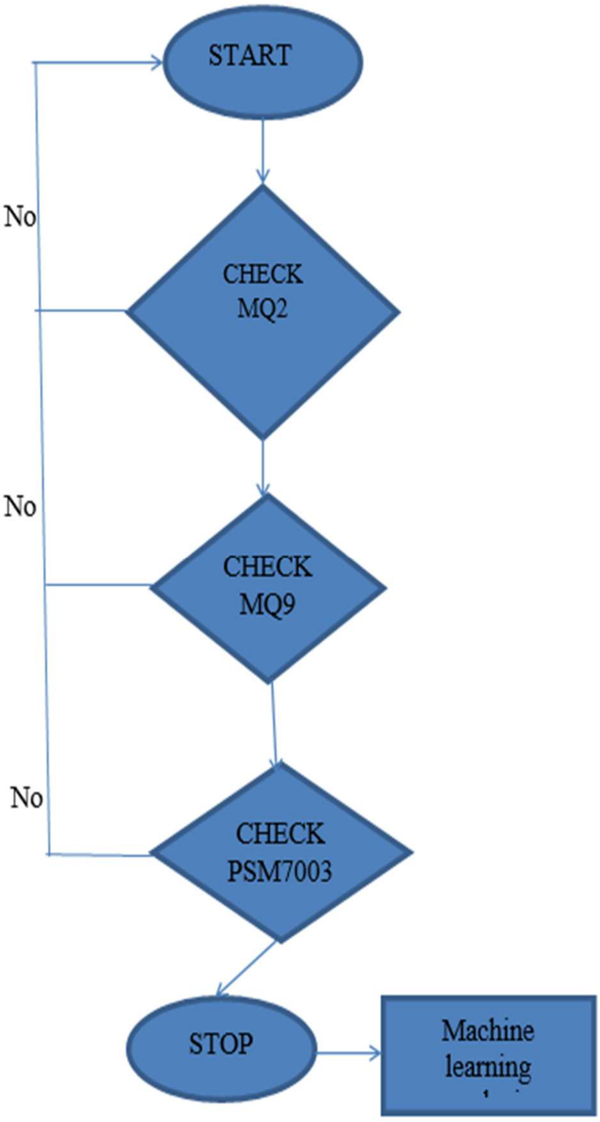

Fig. 2. Flowchart of proposed system

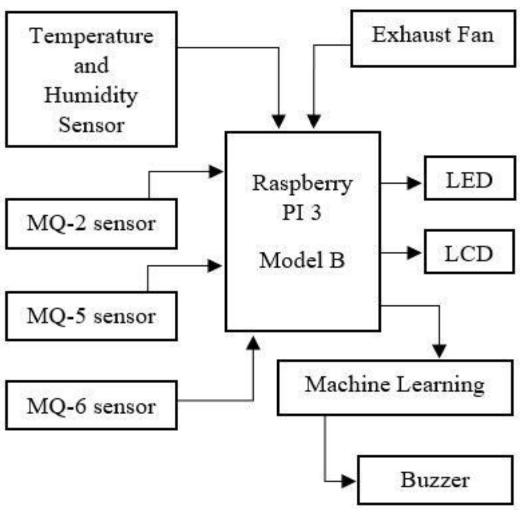

Fig. 3. Block diagram of the Proposed Method

The block diagram of proposed methodology as shown in Figure 3 and it contains so many components as shown in Figure 4,5,6 and 7.

Gas and petrochemical businesses use numerous workers, generating gases like carbon dioxide, methane, and butane that can be lethal when inhaled. To address this issue, smart sensors can be used to detect and address gas and fuel spillage. The proposed paper examines the industry, analyzing methods and identifying potential sources of gas and fuel spillage. The data can be sent to Google Cloud, enabling global monitoring. Preventive measures, such as using alerts, can help maintain the lives of many. The industry's focus should be on increasing productivity, worker wellbeing, and natural obligation. Real-time monitoring using sensors detects gas outflow, fuel spillage, and heater temperature, and sends alerts to the ground manager via Google Cloud.

The proposed framework uses Raspberry Pi for real-time monitoring of mechanical ground, detecting fuel levels and contaminants like smoke, carbon monoxide, LPG, and methane. It uses lightweight sensors to monitor boiler temperature and dampness levels. Consistent data collection is achieved by gathering large data from sensors and integrating it into Google Sheets. Raspberry Pi and IoT shields ensure application-level security, door and part safety, and an API connects Raspberry Pi and workers.

In this paper the method used to identify different hramfull gases present in air like CO2, Propane and CO etc.
Here, we used different types of sensors to measure temperature, humidity wind water and forecast and for display we are taken LCD, Raspberry3B+, ADS1114, MQ9 Sensors etc. for cloud computing we are using Thingspeak and some Machine learning algorithm .

HARDWARE COMPONENTS

Mq2 gas sensor

MQ type gas sensor are widely used to detect hazardous gas and monitor air quality in business and offices. These type of sensors will measure different types of gases including H2, CO, LPG, propane etc. It can function without a microcontroller, with a digital pin for specific gas detection, and an analog pin for PPM measurement.

Fig. 4. MQ2 gas sensor.

B. Mq9 gas sensor

This device detects CO, methane using SnO2, cleans absorbed gases, and identifies flammable gases.

Fig. 5. MQ9 gas sensor

This device is sensitive and quick, capable of detecting various gases like hydrogen, LPG, methane, CO2, alcohol, smoke, and Pro-pane.

C.PMS7003

The PMS7003 is a sensor that measures particle presence and suspended particles in the air. It uses the Laser-Scattering method to scatter particles, collect scattered light, and receive modified curves over time. M.I.E Theory is used to determine particle diameters and their varied diameters per unit volume using a microprocessor.

Fig. 6. PMS7003

D.ADS1115

This device used to convert a analog input signal to a digital output. It is a 16 bit converter having a 4 channel configuration for microcontroller project requiring analog to digital conversion and for higher precision. The configuration of ADS1115 can be 4 single ended channels and features a programmable gain amplifier for amplifying weaker signals.

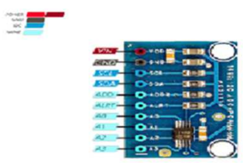

Fig. 7. ADS1115

E. Rasberry pi 3b+

It is a microprocessor which is of small in size, cost effective which contains keyboard and mouse. It supports various features like creating spreadsheet internet browsing video and word document etc. the raperry pi 3b+ is a small inexpensive device designed to solve societal issues. The advantage of this processor is having a Ethernet port. The USB 2.0 port uses external network options, while the Ethernet connects to devices and the web. The chip is designed for image estimation and works with Broadcom video center IV for gaming and video playback.

F. SVM

This project focuses on detecting air quality using SVM algorithms to protect the environment from harmful gases. ThingSpeak displays accurate data from sensors, labeling gases as harmful or non-harmful, and training and testing the model.

G. ThingSpeak

The working of Thingspeak as shown in Figure 8. ThingSpeak is an open-source Ruby-based software for internet-connected gadgets, enabling quick login and easy data access. Initially introduced by ioBridge in 2010, it allows MATLAB analysis and visualization without a license.

ThingSpeak is an open data platform for the Internet of Things (IoT) that allows devices and applications to connect and manage their data. It supports Matlab and offers data analysis and visualization through an online text editor. ThingSpeak has applications ranging from weather data analysis to global light synchronization. With a time-series database, users can save data for free in channels with up to eight data fields per channel. ThingSpeak enables cloud-based data assemblage, visualization, and analysis, allowing easy access to sensor data and enhancing overall IoT analytics.

Thingspeak is an open IoT platform for monitoring and analytics, collecting and storing sensor data in the cloud, and developing IoT applications. It supports REST API and HTTP, enabling online data analysis.

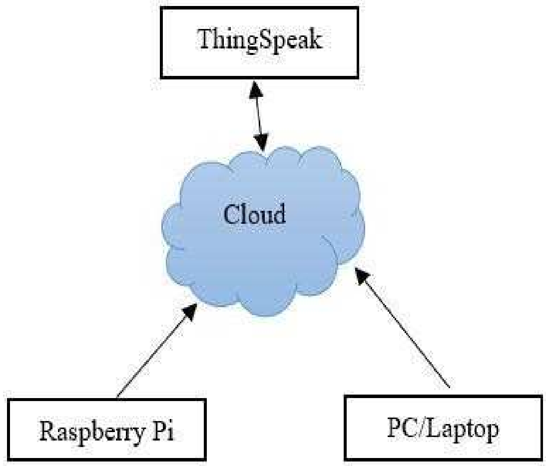

Fig. 8. Working of ThingSpeak

Fig. 9. Cloud server channels

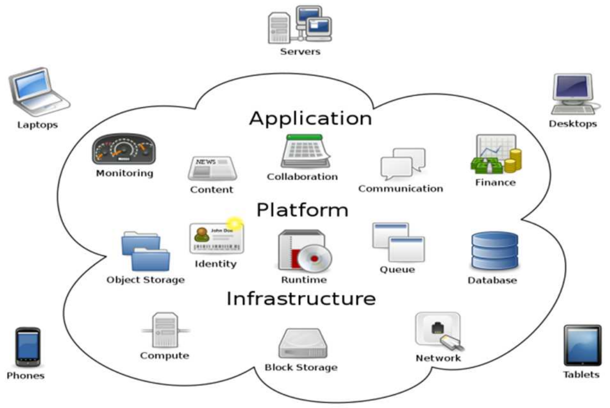

Fig. 10. Cloud

The cloud and cloud server channels as shown in Figure 9 and 10. Cloud computing refers to the availability of computer resources, storage, and processing power without direct user intervention. It involves data centers connecting to multiple users online, with central servers spread across multiple locations. Public and hybrid clouds enable coherence and scale economies by sharing resources. Supporters argue that it reduces upfront IT infrastructure costs and enables IT teams to quickly adjust resources for fluctuating demand. However, "pay-as-you-go" models can lead to unforeseen operating costs. The expansion of cloud computing has led to the availability of large networks, inexpensive computers, and widespread use of virtualization, service-oriented architecture, and autonomous and utility computing.

Temperature and humidity sensors:
Temperature and humidity sensors monitor heat dissipation in industrial objects and systems, ensuring accurate temperature and humidity measurements.

Exhaust fan, LED, LCD and Buzzer:
The exhaust fan removes excess heat, while LEDs check air quality using red and green values. A 16x2 LCD module displays experimental setup values, while a buzzer detects abnormalities with beeps or mini speakers.

H. Working method of proposed system

Air quality is crucial for human health and the environment, and air pollution is increasing due to factors like vehicle emissions, industrial activities, energy production, and natural disasters. Air Quality Monitoring (AQM) systems measure pollutants like ozone, nitrogen oxides, and sulfur dioxide, but infrastructure requirements and ongoing expenses limit their expansion.IoT technology offers a promising solution, allowing remote monitoring of air quality using sensors, Arduino, cloud platforms, and machine learning algorithms. This paper presents a low-cost and user-friendly air pollution monitoring system, real-time data gathering capabilities, Blynk for real-time data visualization, and ThingSpeak for daily pollution visualization. Regular calibration and validation are essential to ensure the accuracy of air quality monitoring systems.

Raspberry Pi provides 5V power to MQ2 Gas sensor, MQ9 Gas sensor, and PMS7003 Particle sensor. MQ2 detects hydrogen, carbon monoxide, LPG, alcohol, propane, and methane, while MQ9 detects CO and PMS7003 measures suspended particles.

Air quality parameters include carbon dioxide (CO_2), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), smoke, temperature, humidity, and LPG. CO_2 is an inert, odorless gas that is essential for life on Earth and is a byproduct of fossil fuel burning. It is corrosive, oxidant, and can cause respiratory issues and acid rain. NO_2 is a brownish color gas and is a byproduct of fossil fuel burning. SO_2 is a colorless gas with a distinct smell and taste, causing respiratory issues in sensitive populations.

Smoke is a significant health hazard, causing 4.9 million deaths annually. Temperature and humidity are crucial for human safety. LPG, a colorless, odorless liquid, is highly flammable and can be a mutagen or carcinogen.

Machine Learning (ML) is an AI variant that allows machines to access and authorize data, learn and explore themselves, and improve performance and predict future instances without explicit programming.

Python is an open-source, high-level programming language with a powerful, easy-to-read syntax derived from C. It can run code on any computer and features more than Python , the interpretation of machine learning as shown in Figure 11.

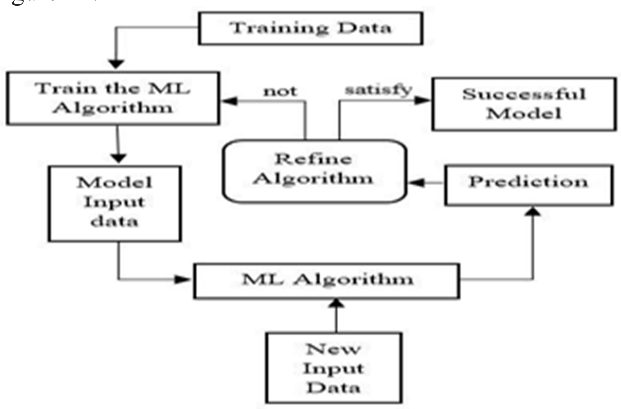

Fig. 11. The interpretation of machine learning

SVM
This algorithm used for classification and regression problems in Supervised Machine Learning. It creates a decision-boundary that splits n dimensions into classes, allowing for easy classification of new data points. The algorithm uses SVM techniques to represent data points in a dimensional space, and then classifies by locating the hyperplane that successfully separates the two classes as shown in Figure 12.

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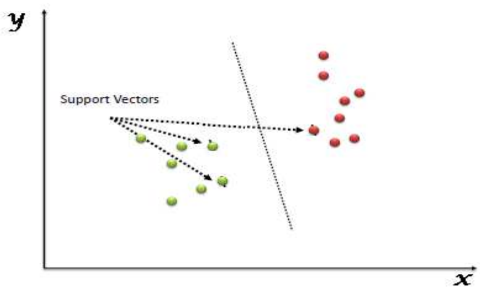

Fig. 12. Support vector co-ordinates

Advantages

IoT platform offers easy access, affordable rates, and enables sharing of applications and visualization of global values.

Disadvantages

Wireless communication technology offers lower monitoring rates, limited capacity, and improved data sharing through IoT for global value visualization.

Application

Web server and Internet control air quality, detecting high levels of harmful chemicals like smoking, alcohol, NOx, CO_2, , benzene, NH_3, and alerting when air quality drops below specified wavelength.

IV. RESULT ANALYSIS

The overall outcomes, under different conditions, are depicted in Figures 13, 14, 15, 16, and 17 below.

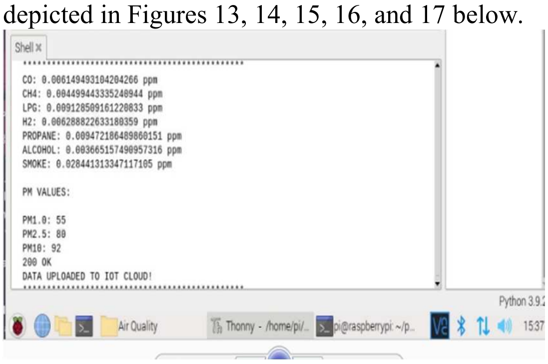

Fig. 13. Illustrates the output window connected to Raspberry Pi

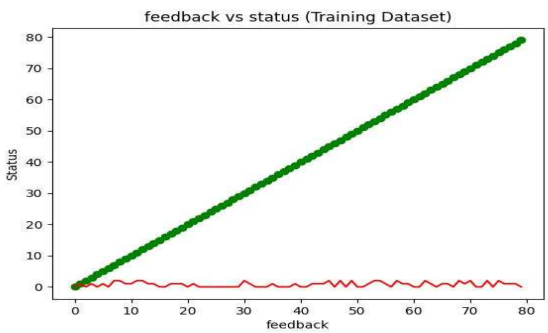

Fig. 14. Illustrate the SVM algorithm output obtained through trained datasheet

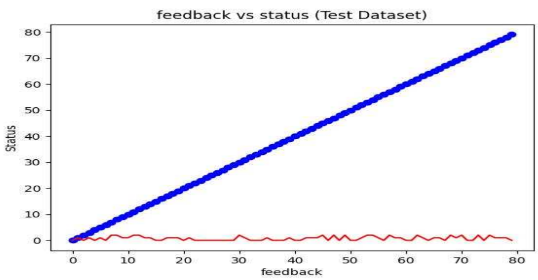

Fig. 15. Illustrate the SVM algorithm output obtained through testing datasheet

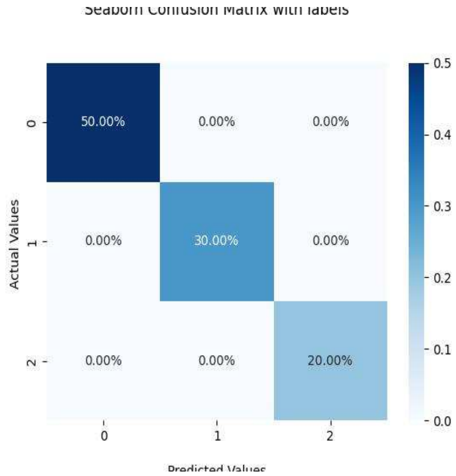

Fig. 16. Illustrates the SVM algorithm output obtained through the Confusion matrix.

Printing Confusion matrix

[10 0 0]
[0 6 0]
[0 0 4]

Fig. 17. The Accuracy through SVM algorithm

V. CONCLUSION

This paper proposes a cloud-driven IoT middleware engineering for air contamination monitoring, focusing on air pollution sensors and climate sensors. The proposed framework expands visibility, quality, and reduces costs compared to traditional sensor network designs. The proposed system will be communicated in the Middleware Layer of IoT design, assisting organizations in limiting contamination impact and providing a second layer expectation method for accurately predicting air pollution.

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