IOT Based Air Pollution Monitoring Using Machine Learning

[1]Ullas H S and [2]Padmavathi N
[1,2] Dept. of E & C, AIT, Tumkur, Karnataka, India.
[1]ullaspatelhs@gmail.com

Article Info
Jenitta J and Swetha Rani L (eds.), *International Conference on VLSI, Communications and Computer Communication*, Advances in Intelligent Systems and Technologies,
Doi: https://doi.org/10.53759/aist/978-9914-9946-1-2_16

Abstract - The air in the atmosphere has become extremely polluted in recent years. The layers of the atmosphere that are affected by vehicle emissions, including those from buses, vehicles, and heavy chemical pollutants from industry. Because of this, the state of air pollution today is really bad.

Keywords – IoT, Air Pollution, Machine Learning, Chemical.

1. INTRODUCTION

Lungs in humans can be the source of illnesses including asthma and coughing difficulties. Human emotions are unable to sense air pollution. Numerous hazardous elements, including LPG gas, smoke, CO and methane, are present the environment. The compounds in the contaminated air are extremely poisonous. For example., if the CO level is more than 100 ppm, a person may feel groggy and queasy and may pass away within minutes. This kind of investigation organizes the search for the air's polluted components. Because the Raspberry Pi microcontroller has an integrated wireless adaptor (wi-fi), we can remotely check the air quality in this project. This enables regular monitoring of the air pollution situation.

Existing system

IoT-based wireless sensor network that uses a central server and gas sensors to monitor the air quality. Compared to the suggested Monitoring air quality, this project is quite simple.

Proposed system

Some of the most harmful gases such as smoke, carbon monoxide, LPG gas, methane will pollute our environment. The air pollution-related compounds of chemicals are extremely hazardous. For instance, if the CO (carbon monoxide) level is above 100 ppm, it makes people feel drizzy and increases the risk of death by minutes. This advancement in study enables human observers to determine which types of airborne component content are impacted by pollutants. Using the Raspberry Pi module and its built-in (Wi-Fi) adaptor, a researcher may monitor air pollution from a distance. This enables the air pollution level to be periodically checked.

Problem statement

The air quality in the modern world is extremely polluted. Heavy car emissions, Industrial-Chemicals, Smoke, and other pollutants have been found everywhere nowadays. That is the cause of the current high level of air pollution. The effects of pollution in air are very poisonous to human health, especially in areas where our bodies draw to breath air. Some illnesses, such as Asthma, Coughing, lung ailments, etc., which have direct impact on over body.

Objectives

The main aim of controlling the air quality is to collect information that can be used to make informed decisions to best manage and improve the environment conditions. This project helps to develop the air quality monitoring procedure strategically.

II. LITERATURE SURVEY

The Analysis and Design of IoT based Air Quality Monitoring System current quickly aggressive dynamic scientific and technological developments of all these focus on a global impact on environmental issue taking an air quality system into account, reveals the fact that India is facing serious health risks. More than ten Indian cities are recognized as the top cities in

recently published reports. Through data analysis of different air polluting substances like pm 2.5, O3, NO2, SO2, CO, the air quality index (AQI) in India, which was launched in 2014 under the Swachh Bharat Abhiyan, monitors air pollution on 10 scales ranging from low (green) to moderate (yellow) to serious (red).The Internet of Things (IoT) is developed in this study so that air quality monitoring systems can be mobile and analyses ambient data in real-time, including levels of carbon monoxide, smoke, and particulate matter. This system can detect air pollution in a specific location and develop analysis-based ideas from the data, which are then used to inform users via a buzzer device included into the system. This system technology is so user-friendly and eco-friendly that it can be put in homes and small urban areas [1].

The Development of an IoT-based platform for monitoring indoor air quality. This study proposes an Internet of Things (IoT)-based indoor air quality monitoring platform that integrates a "Smart-Air" air quality sensor device and a web server. The current platform uses cloud computing and the Internet of Things to track indoor air quality everywhere, at any time. Based on this IoT technology, smart-air may be created to effectively monitor the air quality and transmit the information in real time through LTE to a web server. A microprocessor, sensors for pollutant detection, and an LTE modem make up the apparatus. In this study, a product system was created to measure an aerosol concentration, VOC, CO, CO2, and temperature-humidity to track the air quality in our. The gadget was then successfully tested for dependability using the recommended process and nomenclature from the Korean Ministry of Environment. A web server has been integrated with the continuing cloud computing concept in order to develop and analyses the data received from the atmosphere to the device and to categories and visualize the indoor air quality condition in accordance with the standards set by the ministry of the Korean government. To accurately track the air quality, a protocol for an application was created. As a result, authorized personnel can check the air quality whenever they want and from any location using a web server or other application. In order to provide resources for additional analyses of indoor air quality, the web server can store all of the data in the cloud. The platform has additionally been successfully implemented in Hanyang University of Korea to demonstrate its feasibility [2].

Implementation of IoT-Based Air Quality Monitoring System for investigating Particulate Matter (PM_{10}) in Subway Tunnels. More than 8 million people use the subway every day in South Korea, which has a higher concentration of particulate matter (PM10) than the atmosphere above ground, making air quality monitoring for subway tunnels a hot topic. The concentration of PM10 in subway tunnels is being monitored in this study using an Internet of Things (IoT)-based air quality monitoring system, which consists of an air quality measurement device named Smart-Air, an IoT gateway, and a cloud computing web server. By fusing IoT and cloud computing technologies, the system aims to effectively monitor air quality at any time and from any location. This method was successfully used to measure PM10 levels in the subway tunnels of Incheon. Between morning and afternoon traffic hours, there was a peak in particulate matter concentration. Additionally, as the depth of the monitoring point grew, the residence time of PM10 lengthened. The South Korean government put in place an air quality management system during the trial phase. Following implementation, an analysis was conducted to see whether the change had helped the situation. The system was efficient and successful at monitoring particulate matter to enhance the air quality in subway tunnels, according to real-time experiments [3].

III. METHODOLOGY

Block Diagram and Description

IoT technology is intended to be used with this device. It is a mobile IoT –based controlling of air quality system that is less cost-effective. There are different kind of Gas sensors - the MQ9 gas sensor for measuring Carbon Monoxide, the MQ2 sensor for measuring Smoke, and the PMS7003 Particle Sensor for measuring PM2.5—collect real-time environmental data and send it to the internet [4].

Thing Speak, an open cloud platform (IoT), is used for storing the data received from the sensor and receive the data through the Hyper-Text Transfer Protocol (HTTP) over the internet. By using Thing Speak platform, the sensor data can be plotted in graphical form and can be used for future analysis shows fig.1 [5].

MQ2 Gas Sensor

The MQ2 sensor is used to detect or measure gases like hydrogen, carbon monoxide, liquid petroleum gas (LPG), alcohol, propane, and even methane with or without a microcontroller [6].

The MQ-2 Gas Sensor measures gases like hydrogen, carbon monoxide, liquid petroleum gas, alcohol, and methane with precision. When you only need to detect one specific gas, having a digital pin on this module version of the sensor allows it to function without the aid of a microcontroller [7]. The analog pin, which is also TTL driven and can be utilized with the majority of common Microcontrollers, must be used to measure the Gas in PPM.

MQ9 Gas Sensor

MQ9 gas sensor module is used to detect CO and methane using MQ9 CO, methane, and LPG gas sensor module. The MQ9 gas sensor's sensitive component is SnO2, whose conductivity is less in clean air.

When there is low temperature, MQ9 use high and low temperatures to detect CO (heated by 1.5V). This leads in increasing sensors conductivity and concentration in gas [8]. It cleans the other gases that have been absorbed under low temperature and identifies flammable gases like methane, propane, etc. when a High-Temperature (heated by 5.0V) is applied.

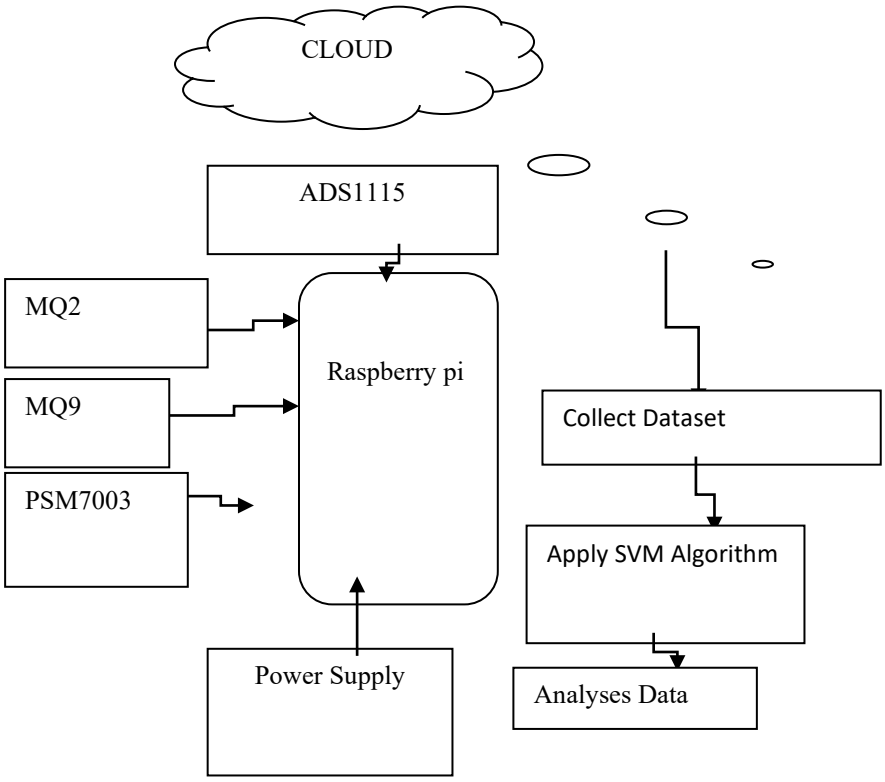

Fig 1. Block Diagram

ADS1115

ADS1115 is a 16-Bit ADC – 4 Channel with Programmable Gain Amplifier which is used for microcontrollers project that requires an analog-to-digital converter or when you want a higher-precision ADC. The chip can be configured as 4 single-end input channels or two differential channels [9]. The Chip can be configured with either two differential channels or four single-ended input channels. To help amplify weaker Single or Differential signals to the entire range, it even comes with a programmable gain amplifier that can be set to a gain of up to 16.

Raspberry pi

The Raspberry Pi is a micro-processor which is Small, cost-effective and inexpensive the size of a credit card that connects to a computer monitor or TV and use the regular keyboard and mouse. By using this competent small gadget, individuals from teenagers to aged people may learn about computing and can learn programming languages like python and scratch. It supports all type of features including browse the Internet, create spreadsheets, High-Definition video, word documents and Play games [10]fig

Apart from this, the Raspberry Pi can connect with the outside world and is used in a variety of digital maker projects, i.e., Music players, weather stations and tweeting birdhouses with infrared camera.

SVM

In this project we are detecting air quality in the environment. By applying accurate algorithms one can detect quality of air that can protect environment from harmful gases. It uses a SVM algorithm to find the air quality. Apart from this, Thing Speak will show the accurate data received from the sensor and can be used for future purpose. We labeled gases as harmful and not harmful. We extracted the related Features, Trained and Tested the data set, built a model and compared results to related work

Thing Speak

Thing Speak isa free, open-source software that lets people converse with internet-connected gadgets. It was created in Ruby. By accessing an api key to both the devices and social network websites, it makes login quickly and data access easily. In order to facilitate IoT applications, Thing Speak was initially introduced by io Bridge in 2010.Thing Speak users can analyse and visualize data using MATLAB without having to purchase a MATLAB license from Math Works.

Working Method of Proposed System

Starting with the connection of raspberry pi giving the power supply of 5V by connecting the Vout and the GND to the MQ2 Gas sensor, MQ9 Gas sensor and the PMS7003 Particle sensor is supplied with 5v using a voltage regulator.MQ2 gas sensor for detecting hydrogen, carbon monoxide, liquid petroleum gas (LPG), alcohol, propane, and even methane in the air, we used MQ2 sensor for smoke situation. MQ9 sensor is suitable for detecting Carbon Monoxide, Methane, and LPG Gas Sensor Module. The utilization is for detecting the Carbon Monoxide (CO). PMS7003 is a sensor used to find the number of suspended particles in the air.

IV. AIR QUALITY PARAMETERS

The different types of gas are listed below:

Carbon Dioxide (CO2): Carbon Dioxide is an inert, odorless gas that is not able to burn easily. Additionally, it falls under the group of asphyxiate gases, which can interfere with the availability of oxygen for tissues. Because it is one of the most vital components in the rapidly growing photosynthesis process, which transforms solar energy into chemical energy, carbon dioxide is a gas that is absolutely necessary for life on the planet. The vast burning of fossil fuels is mostly to blame for the rise in CO2 concentration. Plants grow quickly as a result of this increase. Unwanted plants grow quickly, which increases the need for herbicides to get rid of them.

Nitrogen Dioxide (NO2): Nitrogen Dioxide (NO2) is a brownish colourgas that may be easily identified by its odour. It is also extremely corrosive and highly oxidant. It is a byproduct of the burning of fossil fuels. Usually, chemical mechanisms transform NO2 from NO discharged into the environment. When NO2 levels are excessive, it may cause respiratory issues. Similar to SO2, it causes acid rain.

Sulphur Dioxide (SO2) - Sulphur Dioxide is a colourless gas that has a recognisable smell and flavour. Similar to CO2, it is mostly caused by the combustion of fossil fuels and industrial operations. Insensitive populations, such as asthmatics, may experience respiratory issues at high concentrations. It helps to cause acid rain.

Smoke-Globally, about 1 million people smoke regularly, with the bulk coming from underdeveloped nations. According to a 2007 estimate, 4.9 million people died annually as a result of smoking. Additionally, secondhand smoke poses a major hazard to the health of people of all ages and is responsible for 41,000 fatalities annually.

Temperature and humidity-Temperature measurement is crucial for human safety and has an impact on our daily lives. Temperature measurements and comparisons of historical and contemporary temperature variations, particularly since the industrial revolution, can be used to monitor the greenhouse effect. A particular sort of gas called humidity shields us from the sun's UV rays and aids in retaining heat on Earth, creating a comfortable environment for habitation. However, as humidity rises, Earth's temperature rises as well, making living miserable. For many storage and food processing facilities, humidity is crucial.

LPG-Liquefied Petroleum Gas (LPG): LPG is a colourless, odourless liquid that rapidly changes to a gas. Usually, an odorant is added to it to detect leakage. It falls under the category of highly flammable gases, and if the butadiene level is higher than 0.1%, it can be categorised as a mutagen and a carcinogen. LPG can leak as a gas or as a liquid. If it escapes as a liquid, it evaporates quickly, eventually forming a big cloud of gas in the air that is substantially heavier than air and falls to the earth. In contrast, LPG vapours travel a great distance along the ground before becoming trapped in basements or drains. Gas ignites or explodes when it comes in contact with a source of ignition.

Advantages and Disadvantages

Advantages

- The IOT platform enables the users with easy access and inexpensive rate.
- Different applications may transfer to or share the proposed monitoring system. We are able to visualize global values thanks to IOT.

Disadvantages

- For the use of wireless communication technology that as less rate, information and limited capacity, this provides a System with Lower monitoring System.
- Suggested monitoring system may transport data to or share data with other applications. Thanks to IOT, we can visualize global values.

Application

- A web server and the Internet are utilized to control the quality of Air for control of Air pollution.
- When the amount of dangerous chemicals including CO2, smoking, alcohol, benzene, NH3, and NOx is high enough, it will beep when the quality of air drops below a specified wavelength.

Results

Based on the various conditions the overall results are shown in the below fig.1, fig.2, fig.3, fig.4, fig.5 and fig.6.

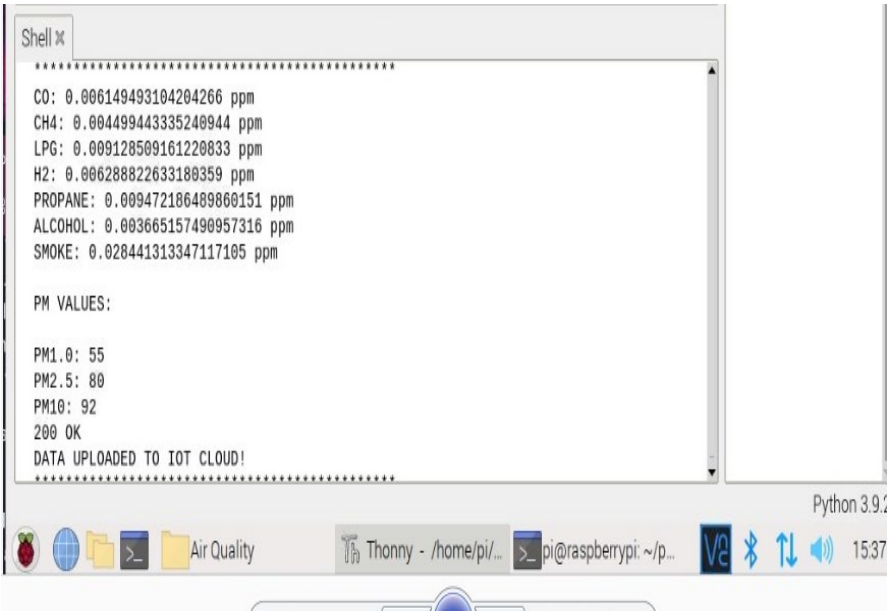

Fig 2. A photo of Output Window Connected to Raspberry Pi

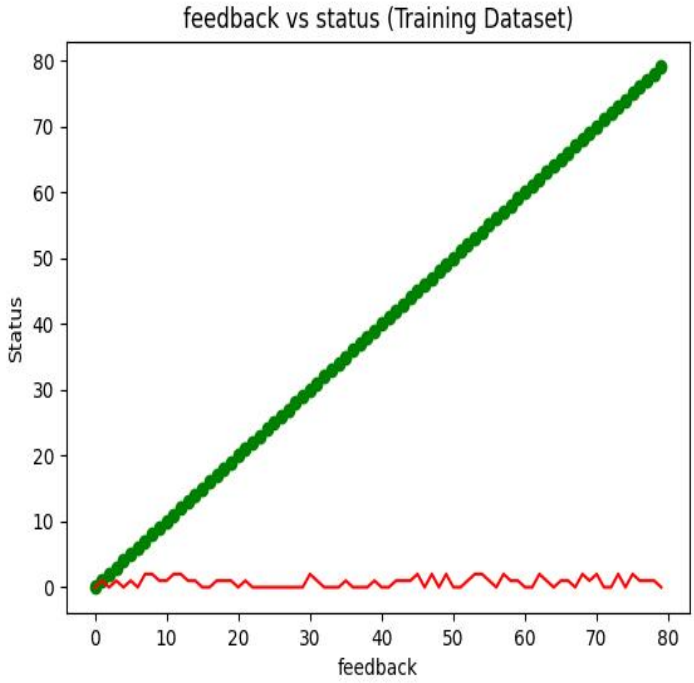

Fig 3. Shows The Photo of Training Datasheet Through SVM Algorithm

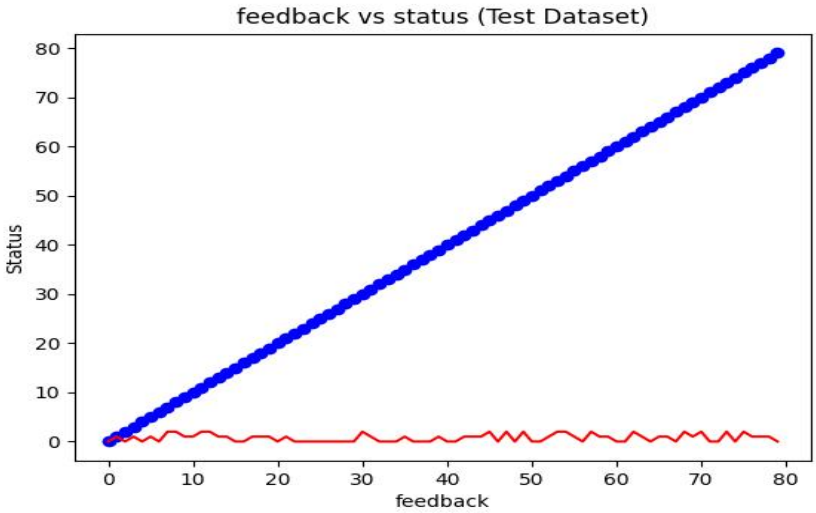

Fig 4. Shows The Photo of Testing Datasheet Through SVM Algorithm

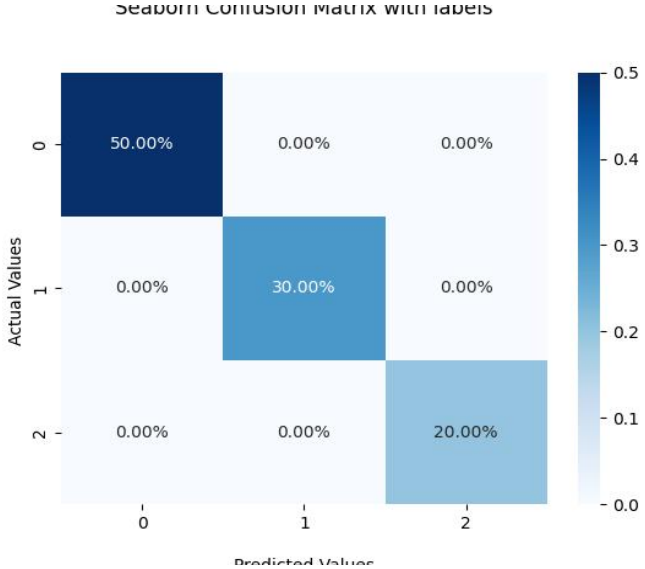

Fig 5. Shows The Photo of Confusion Matrix Through SVM Algorithm

```
Printing Confusion matrix
 [[10  0  0]
 [ 0  6  0]
 [ 0  0  4]]
Printing Accuracy
 1.0
```

Fig 6. Shows The Photo of Accuracy Through SVM Algorithm

V. CONCLUSION

We have developed a system that detects smoke, carbon monoxide, and particulate matter levels in the environment in real time, notifies users when these levels exceed a certain threshold, and displays data in an intuitive manner. The system can be expanded in the future by adding more sensing nodes. The main benefits of this system are that it is lightweight, compact, and affordable. The suggested system makes use of "Thing Speak," where different parameter of sensor can be seen through graph and also used by latest model i.e., node, ruby etc. In addition to being less expensive and consuming less power than

conventional cable techniques, wireless technology also occupies less space, can be put virtually anywhere, and offers greater operational flexibility. In addition to its low.

References

[1]. Poonam Pal et al., "IoT Based Air Pollution Monitoring System Using Arduino", IRJET Journal, Vol 4 Issue 10, October, 2017.

[2]. Saikumar, C. V., Reji, M., & Kishoreraja, P. C. (2017). IOT Based Air Quality Monitoring System. International Journal of Pure and Applied Mathematics, 117(9), 53-57.

[3]. K.A. Delin, and S.P. Jackson, "The Sensor Web: A New Instrument Concept," SPIE Symposium on Integrated Optics, San Jose, CA. Jan 2003.

[4]. Völgyesi, P., Nádas, A., Koutsoukos, X., and Lédeczi, Á. 2008, "Air Quality Monitoring with Sensor Map", In Proceedings of the 7thinternational Conference on information Processing in Sensor Networks, pp.529-530, April 2008.

[5]. Sonal A. Mishra, Dhanashree S. Tijare and Dr. G. M. Asutkar, "Design of Energy Aware Air pollution Monitoring System using WSN ", International Journal of Advances in Engineering & Technology, Vol.1, Issue 2, May 2011, pp.107-116.

[6]. Dr. P. P. Ponmalar, "IOT based Air Pollution Monitoring System with Machine Learning Techniques," Interantional Journal Of Scientific Research In Engineering And Management, vol. 06, no. 05, May 2022, doi: 10.55041/ijsrem13313.

[7]. "Intelligent Air Pollution Monitoring System for Smart Cities Using IoT and Machine Learning," International Journal of Advanced Trends in Computer Science and Engineering, vol. 10, no. 2, pp. 1399–1407, Apr. 2021, doi: 10.30534/ijatcse/2021/1281022021.

[8]. "Intelligent Air Pollution Monitoring System for Smart Cities Using IoT and Machine Learning," International Journal of Advanced Trends in Computer Science and Engineering, vol. 10, no. 2, pp. 1399–1407, Apr. 2021, doi: 10.30534/ijatcse/2021/1281022021.

[9]. S. Arulmozhiselvi and G. Indirani, "Environmental air pollution monitoring in non-industrial area using machine learning techniques and IOT," International journal of health sciences, pp. 2115–2130, Aug. 2022, doi: 10.53730/ijhs.v6ns7.11769.

[10]. "Intelligent Air Pollution Monitoring System for Smart Cities Using IoT and Machine Learning," International Journal of Advanced Trends in Computer Science and Engineering, vol. 10, no. 2, pp. 1399–1407, Apr. 2021, doi: 10.30534/ijatcse/2021/1281022021.