A Machine Learning Approach for Air Pollution Analysis

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Abstract--- **Air pollution occurs due to presence of harmful gases like dust and smoke. Inhaling these gases leads to health problem. The inhaling of dust leads to breathing problems and lung issues which are of major concern in human life. The green house gases like synthetic chemicals present due to emission of human activities. The major green house gases are Carbon dioxide, chlorofluorocarbons, water vapour, ozone, methane and Nitrous Oxide. Greenhouse gases absorb infrared radiation. Air pollution is monitored by Governments and various local agencies. The prime responsibility of the proposed system is to detect the concentrations of major air pollutant gases that are present in the air which cause harm to humans. Air Pollution Detection is developed using IoT for detecting pollutant gases using MQ2 and MQ135 sensors. The gases like Carbon Dioxide (CO_2), Carbon Monoxide (CO), Ethyl Alcohol, Nitric Oxide, Nitrogen Dioxide (NO_2) and Sulfur Dioxide (SO_2) will be detected using these sensors. The detected parameters are analyzed using Machine Learning (ML) algorithms to estimate air quality. The ecosystem developed helps in learning correlation among gases. This helps in estimating impact and level of air pollutants to measure air quality.**

Keywords---**Air pollution, Internet of Things, MQ2,MQ135 and Correlation.**

I. INTRODUCTION

In order to protect our Environment we need to monitor the pollutant gases. Several epidemiological studies have been taken up for formulation of air pollution analysis. Air pollution is one of the factors that cause deaths from lung cancer and respiratory diseases. Air pollution may have direct impact on adult deaths. World Health Organization (WHO) says that air pollution has impact on environment related deaths. Air pollution analysis assists in reducing mortality risk of individual death rate. The prediction analysis is done using ML to take preventive measures to increase life span of individuals. IOT based Air Pollution Detection measures presence of dangerous gases in the air. The ecosystem is developed using Raspberry PI 3, MQ2 and MQ135 sensors. WiFi module is used to upload detected parameters to ThingSpeak cloud for storing them in database. A web server is used to deploy data from ThingSpeak for analyzing it through ML. The paper is organized into four sections. Section 1 stated the significance of air pollution detection. In Section 2 the previous research works are discussed. The design and implementation details are given in Section 3. And the Machine Learning based analysis is done in Section 4. Conclusion states the role and impact of air pollution analysis for protecting human lives.

II. RELATED WORK

Diffusion tubes are usually used to monitor air pollution. They are made of plastic material with a rubber stopper attached at each end. These are designed for detecting NO_2. They are large in size and are not efficient. The materials need to perform sampling process are diffusion tubes, tube holders, survey sheet, maps, clip board, Re-sealable samples bag1 and a pen. Initially, diffusion tubes are located in a specific area which is divided into grids. Then position tubes are positioned vertically downwards and cable ties are attached if it is fixing to a pipe. Fix sample in a specific location where free circulation of air around the tube. Remove the white cap allow it for exposure. Fill date and times in the record sheet. Note the tube condition, changes in site conditions, or anything that might affect the results. D.Arun Kumar(2018) presented IoT based eco system to estimate quality of the air using various sensors like gas, temperature, humidity, rain and smoke. By detecting air pollution measures can be taken to safeguard the health of people residing in that area[1]. Harsh N. Shah(2018) presented IoT based air pollution system using MQ135 sensor, LPG sensor, Humidity sensor and Temperature sensor. The circuitry uses Arduino UNO micro controller for connecting processing all the components data[2]. Chandana B(2018) designed air pollution detection system using MQ135, MQ4, MQ5, MQ9 using Arduino UNO. The data collected by the sensors will be informed to higher authorities[3]. F N Setiawan, I Kustiawan (2018) proposed IoT based Air quality system. MQ2, MQ9 sensors, ZH03A dust sensor are used for measuring air quality. The results are processed using ThingSpeak API[4]. Mohamed El Khaili(2019) presented air quality design for urban traffic flow management for data analysis. Zeba Idrees(2018) designed IoT architecture for detecting pollution in the air. Pollution sensors and electro chemical sensors are used to detect air pollution and IBM cloud is used for analysis. Gonçalo Marques(2018) proposed a system to using IoT for real time monitoring in Buildings. iDust sensors are used to detect dust[7]. SQL server is used to store data and e-mail notification facility is also included. Zhihe Zhao(2018) designed a smart sensor network for monitoring air quality. The information can be monitored by a web application. PHP and nodejs are used for developing web application and PM2.5 is used to sense air data. MQTT protocol is used to transmit messages across IoT device and web application[8]. Arunava Mukhopadhyay(2017) proposed design of air pollution detector and air quality meter with Arduino. Temperature sensor, humidity sensor and gas sensors used to sense air pollution[9]. Nitin Sadashiv Desai(2017) proposed a method for urban air pollution system. The system acquires CO_2 and CO levels in the air. The collected data will be stored in the Microsoft Azure services and Power BI tool is used to transform data into information [10].

III. METHODOLOGY

A. Circuit Analysis of IoT based Air Pollution Detection System

The Internet of Things based Air Pollution Detection is designed using the sensors MQ2 and MQ135 sensors. The ecosystem is developed using Raspberry PI 3 B model, MQ2, MQ135 sensors, 840-point Bread board, GPIO extension board and MCP 3008 ADC. MQ2 detects CO_2, NO_2 and NH_3. MQ135 detects CO, Smoke and LPG. ThingSpeak cloud is used to store data captured by the sensors. A web server is used to display air pollution information and make it available over Internet. The gases sensed by the MQ2 and MQ135 are shown in Fig.1. and circuit connections are shown in Fig.2.

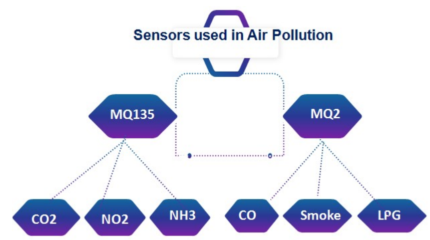

Fig.1. Gases sensed by MQ2 and MQ135

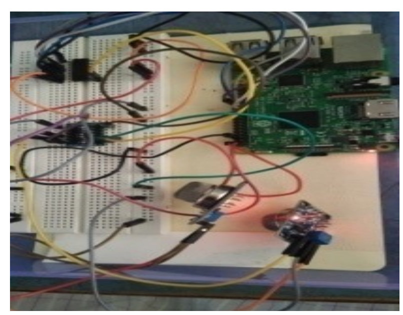

Fig.2. Circuit connecting MQ2 and MQ135 to Raspberry PI.

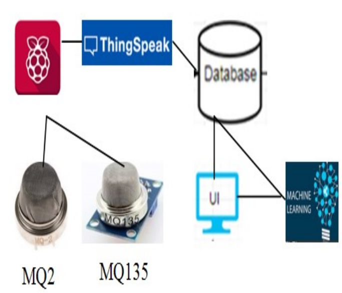

Fig.3. Sensing, Storing in Cloud and Data analytics using Machine Learning.

The information sensed by MQ2 and MQ135 are uploaded in the ThingSpeak cloud instantly and stored in the database.

B. Detection of pollutants using MQ2 and MQ135 Sensors.

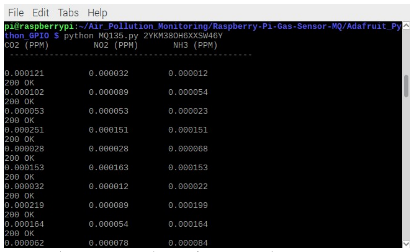

Fig.4. Detection of gases using MQ135

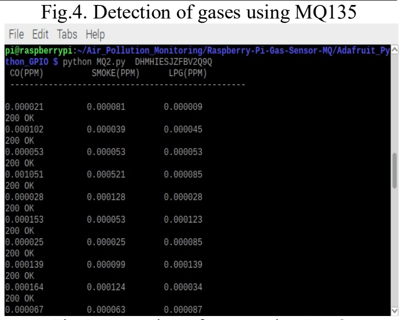

Fig.5. Detection of gases using MQ2

MQ2 sensor detects gases CO2, NO2 and NH3. This real time values detected by sensor are shown in Fig.4. And the gases CO, SMOKE and LPG detected by MQ2 are shown in Fig.5.

C. Real time sensing of gases using MQ2 and MQ135 sensors

The information sensed by MQ2 and MQ135 in ThingSpeak cloud is depicted as below (Fig.[6-12])for real time statistics.

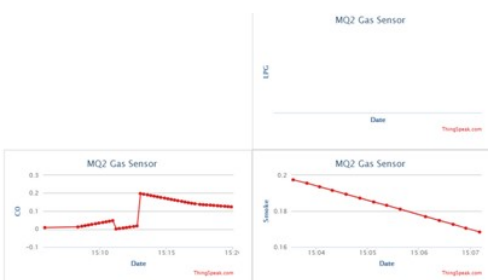

Fig.6. Air pollution monitoring using MQ2.

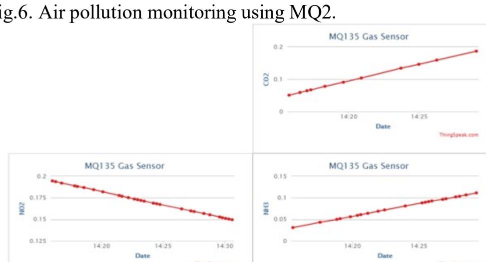

Fig.7. Air pollution monitoring using MQ135.

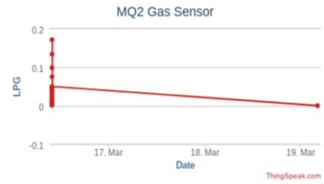

Fig.8. LPG Detection using MQ2

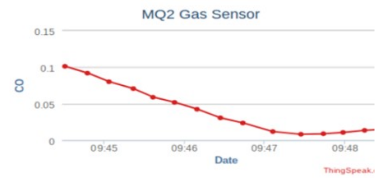

Fig.9. CO detection using MQ2

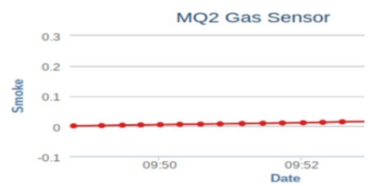

Fig.10. Smoke detection using MQ2

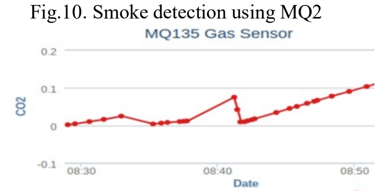

Fig.11.CO_2Detection using MQ135

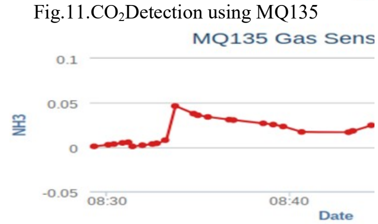

Fig.12. NH_3 Detection using MQ135.

IV. ANALYSIS OF LINEARITY AND CORRELATION BETWEEN GASES USING MACHINE LEARNING.

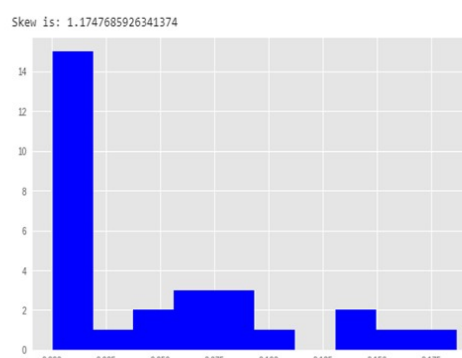

Fig.13. Skew and Histogram of CO_2

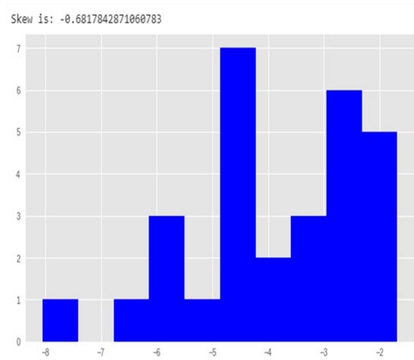

Fig.14.Skew and Histogram of CO2

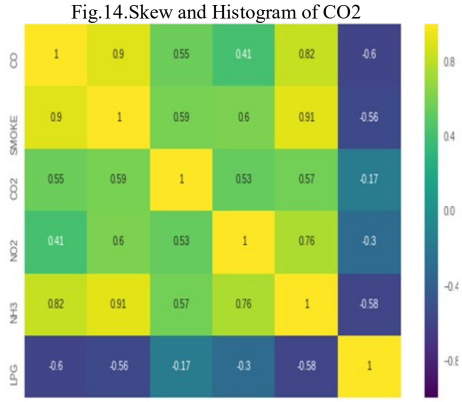

Fig.15.Correlation between pollutants

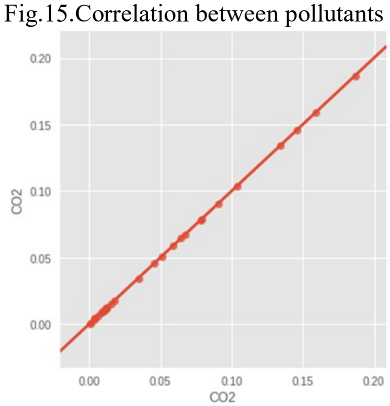

Fig.16. Linearity of CO_2 over CO_2

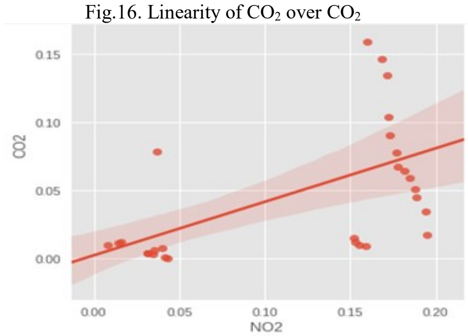

Fig.17.Linearity between CO_2 and NO_2

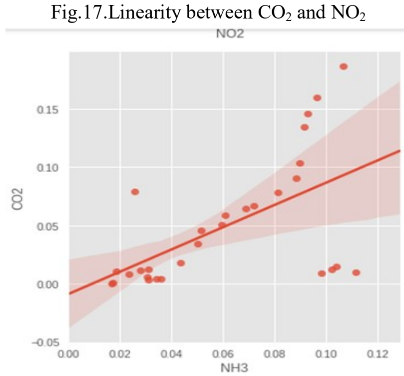

Fig.18.Correlation between CO_2, NO_2 and NH3

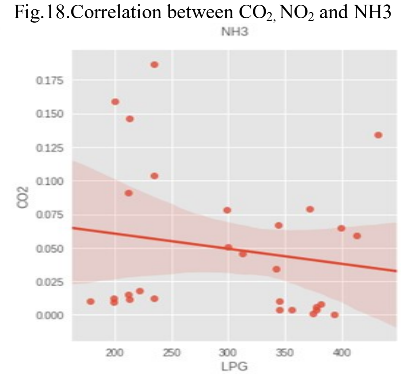

Fig.19.Correlation between CO_2, LPG and NH3

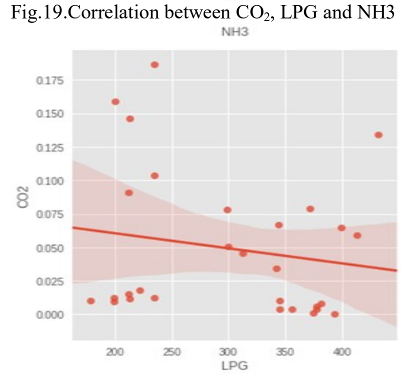

Fig.20.Predicted value of CO_2

CO, CO_2, NO_2 etc. are Primary nutrients. When they are released from identifiable sources, causes health risk. SO_3, H_2SO_4 so on comes under secondary air pollutants. Carbon Monoxide is toxic and reduces oxygen in blood. It produces from cigarette smoke and automobiles. Sulphur dioxide produces from coal burning power plants. It produces acids when it reacts with air. The major source of Nitrogen Oxide is automobiles contribute to acid rain. Ozone and H_2SO_4 are the secondary air pollutants cause photochemical reactions in air. The correlation analysis among various pollutants are shown in Fig.[13-20].

CONCLUSIONS

This ecosystem developed gives information of pollutants present in less amount of time. The information of air pollutants is available in the cloud, hence the data can be analyzed from anywhere at any time. The real time detection of air pollution levels in the environment helps Government to take necessary decisions. This system is mainly used to researchers, because testing of gases manually takes a lot of process, time etc.

REFERENCES

[1] Swathi Durga, M.Raja Sekhar Babu, H.Amir Gandomi, Rizwan P,Md.Daneshmand, Internet of Things Mobile Air Pollution Montioring System(IoT-Mobair),IEEE Internet of Things, Vol6, Issue 3,2019.

[2] D.Arunkumar, K.Ajaykanth, M.Ajithkannan, M.Sivasubramanian, Smart Air Pollution Detection and Monitoring using IoT, International Journal of Pure and Applied Mathematics Volume 119, No. 15, 2018, 935-941.

[3] Harsh N. Shah, Zishan Khan, Abbas Ali Merchant, Moin Moghal, Aamir Shaikh, Priti Rane, IOT Based Air Pollution Monitoring System, International Journal of Scientific & Engineering Research Volume 9, Issue 2, February-2018.

[4] Chandana.B, Chandana.K, Jayashree.N, Anupama.M, C.K.Vanamala, Pollution Monitoring using IoT and Sensor Technology, International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, Volume: 05, Issue: 03, Mar-2018.

[5] F N Setiawan, I Kustiawan, IoT based Air Quality Monitoring, 2018, IOP Conf. Ser.: Mater. Sci. Eng. 384 012008.

[6] El Khaili M., Alloubane A., Terrada L., Khiat A. (2019) Urban Traffic Flow Management Based on Air Quality Measurement by IoT Using LabVIEW. In: Ben Ahmed M., Boudhir A., Younes A. (eds) Innovations in Smart Cities Applications Edition 2. SCA 2018. Lecture Notes in Intelligent Transportation and Infrastructure. Springer, Cham.

[7] Zeba Idrees, Zhuo Zou,Lirong Zheng, Edge Computing Based IoT Architecture for Low Cost Air Pollution Monitoring Systems: A Comprehensive System Analysis, Design considerations & Development, Sensors,18(9), 2018.

[8] Gonçalo Marques, ID , Cristina Roque Ferreira, Rui Pitarma, A System Based on the Internet of Things for Real-Time Particle Monitoring in Buildings, Int. J. Environ. Res. Public Health 2018, 15, 821.

[9]Zhihe Zhao, Jiaheng Wang, Chenxu Fu, Zhenbang Liu, Dawe i Liu,and Bailiang Li, Design of a Smart Sensor Network System for Real-Time Air Quality Monitoring on Green Roof, Journal of Sensors Volume 2018, Article ID 1987931, 13 pages.

[10] Arunava Mukhopadhyay, Abhirup Sengupta, Shuvam Paul,Debdutta Saha,Kaustav Shome,Srinwan Roy,Shreya Ghosh,Agniv Basu,Kaustavi Sen,Rajib Chatterjee, Design of air quality meter and pollution detector, 2017 8th Annual Industrial Automation and Electromechanical Engineering Conference (IEMECON), Date of Conference: 16-18 Aug. 2017, Bangkok, Thailand.

[11] Nitin Sadashiv Desai, John Sahaya Rani Alex, IoT based air pollution monitoring and predictor system on Beagle bone black, 2017 International Conference on Nextgen Electronic Technologies: Silicon to Software (ICNETS2),IEEE, Date of Conference: 23-25 March 2017, Chennai, India.

[12] S. De Vito, E. Massera, M. Piga, L. Martinotto, G. Di Francia, On field calibration of an electronic nose for benzene estimation in an urban pollution monitoring scenario, Sensors and Actuators B: Chemical, Volume 129, Issue 2, 22 February 2008, Pages 750-757, ISSN 0925-4005.

[13] Saverio De Vito, Marco Piga, Luca Martinotto, Girolamo Di Francia, CO, NO2 and NOx urban pollution monitoring with on-field calibrated electronic nose by automatic bayesian regularization, Sensors and Actuators B: Chemical, Volume 143, Issue 1, 4 December 2009, Pages 182-191, ISSN 0925-4005.

[14] S. De Vito, G. Fattoruso, M. Pardo, F. Tortorella and G. Di Francia, 'Semi-Supervised Learning Techniques in Artificial Olfaction: A Novel Approach to Classification Problems and Drift Counteraction,' in IEEE Sensors Journal, vol. 12, no. 11, pp. 3215-3224, Nov. 2012.

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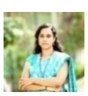

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