Grenze International Journal of Engineering and Technology, Jan Issue

Air Quality Monitoring and Predictions

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***Abstract*—Air pollution is a major concern in the mining industry, and it's vital that workers have access to information about the air quality in their workplace. To address this issue, we're developing an Air Quality Monitoring and Prediction system that utilizes sensors like MQ135, DHT11, buzzer, and LED to detect various pollutants in the air, including carbon monoxide, Sulphur dioxide, and nitrogen oxide. The collected data will be transmitted wirelessly to a central server for analysis and visualization. The proposed system will provide real-time data on air pollution levels to operators, enabling them to take proactive measures to mitigate potential risks to human health and the environment. The forecast was done on the collected data with the help of excel. As per the forecast the carbon dioxide in air was about 500 to 600 ppm which is around the real value. Our project aims to enhance transparency and promote better decision-making by providing accurate and up-to-date information about air quality in the mining industry.**

***Index Terms*— Air pollution monitoring, Forecast, Mine industry, Real-time monitoring, Sensors, ThingSpeak.**

I. INTRODUCTION

The mining industry is a critical sector for many economies worldwide, but it also contributes significantly to air pollution. The release of pollutants such as carbon monoxide, sulphur dioxide, and nitrogen oxide from mining operations can have severe impacts on the health of workers and nearby communities, with long-term exposure potentially leading to chronic health problems. To address this challenge, our project focuses on developing an Air Quality Monitoring and Prediction system that utilizes sensors like MQ135, DHT11, buzzer, and led to detect various pollutants in the air. By providing real-time data on air pollution levels to operators, our system aims to empower proactive measures to mitigate potential risks to human health and the environment. Through promoting transparency and enabling better decision-making, our system can contribute to promoting sustainable mining practices and safeguarding the health and wellbeing of workers and nearby communities.

The data collected from air quality monitoring systems is vital for generating accurate forecasts, and the incorporation of sensors such as MQ135 and DHT11 plays a crucial role in this process. These sensors continuously measure various pollutants in the air, providing essential data on temperature, humidity, and other environmental factors. The collected data is then transmitted to a central server for analysis, where advanced algorithms process the information to generate both real-time and future air quality predictions.

Furthermore, Excel can serve as a valuable tool for analyzing and forecasting air quality data. Utilizing statistical functions like forecast, Excel can make predictions based on historical data trends, thus facilitating better decision-making and planning processes.

By combining the data collected through air quality monitoring sensors and employing Excel's statistical

Grenze ID: 01.GIJET.10.1.563_1

capabilities, industries and communities can gain insights into air pollution patterns and trends. This information empowers them to take proactive measures, such as optimizing emission control strategies, complying with environmental regulations, and safeguarding public health.

II. Literature Review

For the literature review purpose, we have referred to the following papers. [1] The 2020 paper presents a prototype for an air quality monitoring system utilizing different sensor module. In comparison to other similar devices on the market, this proposed system boasts a smaller form factor, efficient power usage, and reduced cost. [2] The system collects data to identify trends in air pollution over a specific period of time. This system can be deployed in large numbers to create a monitoring sensor network. In addition, neural network technology is used to analyze data gathered.[3] In this paper, the authors discuss the fundamental characteristics of IoT, and conduct a comparison and analysis of radio frequency identification (RFID), M2M, and sensor networks. The authors then propose a multifunctional and intelligent monitoring platform for the purpose of reducing air pollution. The study highlights the importance of establishing comprehensive network communication systems, cloud-based decision making, online management, and information tracking, which are based on these technologies, for more efficient improvement of the ambient air quality.[4] A study was conducted to monitor and analyze air pollution levels in Greater Noida, with a focus on emissions from vehicles, industries, and population growth. The research employed IoT technology to collect data and offer real-time monitoring of air quality levels in the vicinity. The findings of the study highlight the need for effective measures to control air pollution in Greater Noida.[5] The authors of this paper intend to leverage the capabilities of the Internet of Things (IoT) to monitor the levels of air pollution generated by vehicles on urban roads. The primary objective of the system is to provide real-time reports on air quality to the traffic department, relevant agencies, and vehicle owners. The proposed solution incorporates low-cost sensors that have been proven to be effective in reducing air pollution, thus providing a cost-effective approach to air quality monitoring.[6] The authors' research presents a practical solution using IoT-based sensors installed at specific locations to monitor air pollution levels and mitigate traffic congestion in highly polluted areas in real-time. The algorithm is designed to predict air quality, and the system then transmits the collected data to traffic control authorities through a mobile application, enabling prompt action to be taken in response. This approach helps to ensure that the air quality in the area is closely monitored and effectively managed, reducing the negative impact of pollution on both the environment and public health. The low-cost sensors employed in the proposed system deliver reliable results and contribute to effective pollution control measures. [7] The proposed paper introduces an IoT-based air quality monitoring and prediction system developed by the authors. The system utilizes IoT technology to collect and analyze real-time data from air quality sensors. The collected data is then used to predict air quality levels in the future. This system offers a cost-effective and efficient solution to monitor and predict air quality levels, which can aid in making informed decisions to improve air quality and public health The system involves the use of air sensors to collect data, which is then communicated to a microcontroller for analysis and prediction. To predict air quality, the authors use a Long Short-Term Memory (LSTM) algorithm [8] The aim of this study is to introduce a real-time wireless air pollution monitoring system that employs wireless sensor networks (WSN) for monitoring pollution levels. The system uses commercially available gas sensors to detect the concentration of gases such as CO and CO_2, which are then calibrated using appropriate calibration technologies. [9] The authors have designed and implemented a real-time air quality monitoring system that can simultaneously measure multiple air pollutants. The system can transmit the collected data to both a server and a smartphone application. The primary objective of the system is to mitigate the adverse effects of air pollutants on human health by delivering emergency alerts via the smartphone application.[10] The authors developed a system using Arduino microprocessors and sensors to monitor air quality in real time. The system transmitted data to the internet and visualized it in real-time graphs on a website. There were no apparent issues with the data transmission, and the website displayed the data accurately, allowing for easy monitoring and analysis of the air pollution levels. The system was deployed at the Tasikmalaya Bypass Roundabout for a period of ten days to collect data. Based on the collected data, the authors concluded that the air quality in Tasikmalaya was good.

III. Methodology

Our Air Quality Monitoring and Prediction project for the mining industry will consist of sensors, micro-controllers, and power sources. The sensors, such as MQ135 and DHT11, will be placed in various locations to collect data on air pollution levels. This data will be transmitted wirelessly to a central server for analysis and visualization.

Using the ThingSpeak platform, the microprocessor will process the collected data and execute algorithms to evaluate and interpret it, providing valuable information about the air quality present in the atmosphere. Additionally, the system will incorporate a buzzer and LED to immediately notify workers and management in real-time if pollution levels exceed safe limits.

Our system aims to provide real-time monitoring of air pollution levels in the mining industry and facilitate proactive measures to ensure the safety and well-being of workers and nearby communities. Fig1 is the block diagram for proposed model.

A. Proposed System

Our Air Quality Monitoring and Prediction project will introduce a proposed system that will incorporate the MQ135 and DHT11 sensors, coupled with a buzzer and LED, to monitor air pollution levels in the mining industry. The MQ135 sensor will detect hazardous gases, such as carbon monoxide, nitrogen oxide, and sulphur dioxide, while the DHT11 sensor will measure temperature and humidity.

The resistance change of the MQ135 sensor will estimate the concentration of hazardous gases present in the air. When exposed to carbon monoxide, nitrogen oxide, and sulfur dioxide, the sensor's resistance decreases, enabling the system to estimate the concentration of these gases present in the air. The formulas are relate to sensor's resistance, load resistance and air concentration in terms of voltage constants (V_{const}), output voltage(V_{out}) and indoor(C_{indoor}) and outdoor air concentrations ($C_{outdoor}$) and decay factor ($1 - 1/e^{nt}$)

$$Sensor_{Resistance} = \frac{V_{const} \times Resistance_{Load}}{V_{out}} - Resistance_{Load} \qquad (1)$$

$$Air_{conc} = \left[\frac{Gas_{emission}}{air_{exchamge} \times volume}\right]\left[1 - \frac{1}{e^{nt}}\right] + \frac{(C_{indoor} - C_{outdoor})}{e^{nt}} + C_{outdoor} \qquad (2)$$

Simultaneously, the DHT11 sensor will provide real-time data on temperature and humidity, which are critical factors affecting air quality. The system will include a buzzer and LED to notify workers and management when pollution levels exceed acceptable limits.

The collected data will be wirelessly transmitted to a central server for analysis and visualization. The system aims to provide mining plant operators with real-time information on air pollution levels, enabling them to take proactive measures to promote sustainable mining practices and ensure the safety and health of workers and nearby communities. By providing accurate and up-to-date information, our project promotes transparency and accountability in the mining industry.

B. Excel

The use of Excel for forecasting by analyzing data obtained from the MQ135 sensor is been done in the project. Excel, a popular spreadsheet program developed by Microsoft, offers various features that are helpful for data analysis, including forecasting. The goal of this analysis is to leverage Excel's built-in forecasting capabilities to generate accurate forecasts and valuable insights for informed decision-making.

The forecast function in excel is designed to make future value predictions based on existing data. It achieves this by conducting linear regression to estimate the value of the dependent variable (Y) in relation to a given independent variable (X). The function employs the "least squares" method to determine the best-fitting straight line that represents the data points.

Using this calculated linear regression line, the forecast function can predict the value (Y) corresponding to a specified X value. It is important to note that the accuracy of the forecast relies on the quality and nature of the data used in the linear regression analysis. As with any predictive model, it is essential to consider the context and reliability of the data to validate the forecasted results.

The Forecast function in Excel provides a straightforward approach to conduct linear regression and make predictions without requiring in-depth statistical knowledge or complex calculations. Linear regression is a statistical method utilized to model the relationship between a dependent variable and one or more independent variables. It serves as a fundamental technique in data analysis, widely employed for prediction and forecasting purposes. The main objective of linear regression is to determine the best-fitting straight line (linear equation) that accurately represents the relationship between the variables.

Linear regression aims to minimize the differences between the observed values of the dependent variable and the values predicted by the linear equation. By doing so, it finds the optimal values for the intercept and slope of the regression line, enabling future predictions based on given independent variable values.

The Forecast function in Excel streamlines this process, making it accessible to users without extensive statistical expertise. By incorporating linear regression within the function, Excel allows users to forecast future values of a dependent variable based on data trends. This simplified approach helps individuals and businesses make informed decisions and plan for future scenarios effectively.

IV. HARDWARE AND MODEL PROTOTYPE

Our Air Quality Monitoring and Prediction project in the mining industry will utilize a hardware model prototype consisting of a NodeMCU micro-controller, DHT11 sensor, MQ135 sensor, and ThingSpeak software.
The NodeMCU micro-controller will serve as the central hub for all the sensors, collecting and processing the data they gather. The DHT11 sensor will measure temperature and humidity levels, while the MQ135 sensor will detect hazardous gases such as carbon monoxide, nitrogen oxide, and sulphur dioxide.
To enable real-time monitoring of air pollution levels, the collected data will be wirelessly transmitted to a central server for analysis and visualization using ThingSpeak software. With this system in place, mining plant operators will have access to up-to-date information about air pollution levels, allowing them to take proactive measures to ensure the safety and well-being of workers and nearby communities.

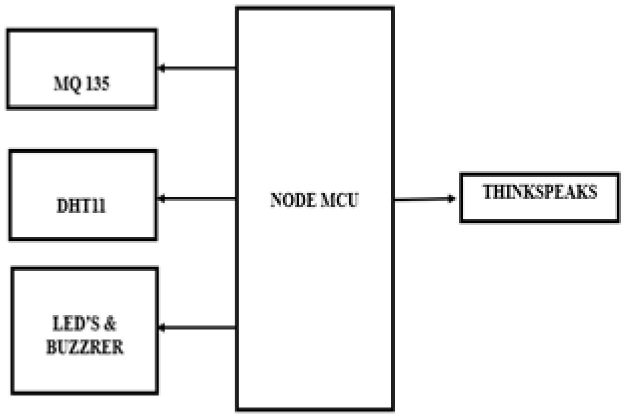

Figure 1: Block Diagram of Proposed Model

V. DEVICE AND COMPONENT INTEGRATION

Device and component integration Air Quality Monitoring and Prediction involves integrating various sensors and devices into the system, as well as developing and integrating the software components required to enable the sensors and devices to function together as a system. Here is an overview of the components used and how they are integrated:
NodeMCU: The NodeMCU is a microcontroller board that is used to control the sensors and devices integrated into the pollution monitoring system. It is programmed using the Arduino IDE and can be connected to the internet using Wi-Fi. DHT11
Sensor: A DHT11 sensor is used to measure temperature, humidity in the mine industry. This data is used to identify potential pollution hazards and to alert workers to take appropriate action.
MQ135 Sensor: The MQ135 sensor is utilized to detect the presence of hazardous gases within the industry. When harmful gases are detected, an alert is triggered to inform the workers to evacuate.
LED Light: An LED light is used to provide visual alerts to the workers. For example, if harmful gases are detected, the LED light will turn red to inform the workers that they need to take action.
ThingSpeak: It is a graphical user interface for the workers to view the data collected by the sensors and devices. This component is integrated with the NodeMCU to enable the data to be transmitted from the pollution monitoring system to the web application.

VI. RESULTS

The Air Quality Monitoring and Prediction system deployed in the mining industry has effectively predicted the carbon dioxide (CO_2) concentration in the air. By utilizing the data collected from the sensors, the forecast reveals that the CO_2 levels lie within the range of 500 to 600 parts per million (ppm).

The temperature sensor graph displays the temperature readings taken at that instance by the sensor integrated into the smart pollution monitoring system. The gas sensor graph shows the gas concentration readings taken at regular intervals by the sensor integrated into the smart pollution monitoring system. The graph displays the gas data over a specific period, with time and gas concentration on the x-axis and y-axis respectively. The gas data is represented by a line graph, with each point on the graph representing the gas concentration reading at that time. The graph can identify sudden changes in gas concentration that could indicate potential pollution incidents and monitor the overall level of pollution within the industry environment.

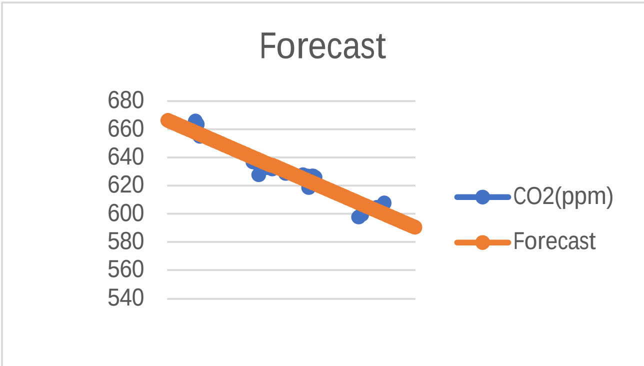

Figure 2: Excel Forecast

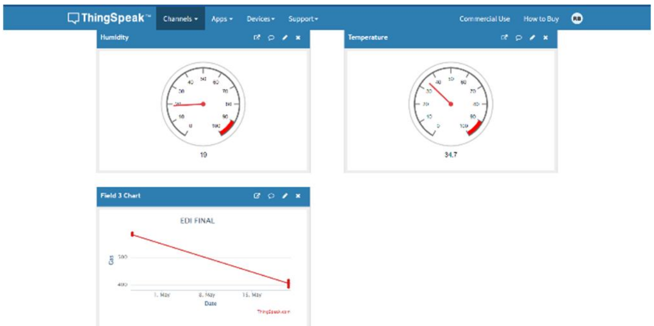

Figure 3: Result on ThingSpeak

VII. Conclusion

The concentration of carbon dioxide (CO2) in outdoor air usually varies from 300 to 400 parts per million (ppm) or 0.03% to 0.04%. In metropolitan areas, CO2 levels can rise to as high as 600-900 ppm. Indoors, in occupied buildings, the typical range of CO2 levels is around 600 ppm to 800 ppm or 0.06% to 0.08% in concentration. The forecast reveals that the CO2 levels lie within the range of 500 to 600 parts per million (ppm).

Our IOT-model solves actual issues used in public and industrial settings. A user-friendly interaction connecting users and industries is created by this concept. The user doesn't need any special training to use this model. Whenever time a model fault occurs, it is displayed on the monitor. It is possible to build this model utilizing a variety of sensors.

In conclusion, the proposed IoT-based system has the potential to offer crucial information to plant operators about the quality of air within the plant. The utilization of MQ-135 and DHT11 sensors along with LEDs enables the system to detect and measure various environmental conditions and pollutants. The real-time data generated by the system can help plant operators take proactive measures to mitigate potential risks to human health and the environment. It can also contribute to the overall safety and well-being of workers and the surrounding community.

Acknowledgment

The authors are thankful to their guide Prof. Rajesh Dhake, for his guidance and critical evaluation of this project. We are thankful to the Department of Chemical Engineering, VIT Pune, for providing us with the essential prerequisites for these efforts. Special thanks go to the team members for their availability and active

participation for the project.

REFERENCES

[1] B. K. Moharana, P. Anand, S. Kumar and P. Kodali, "Development of an IoT-based Real-Time Air Quality Monitoring Device," IEEE, 2020.

[2] C. Xiaojun, L. Xianpeng and X. Peng, "IOT-based air pollution monitoring and forecasting system," IEEE, 2015.

[3] Yu-Lin Zhao1, "Development of IoT Technologies for Air Pollution Prevention and Improvement," Taiwan Association for Aerosol Research, p. 15, 2020.

[4] Iqra Javid, Sushant Bakshi, Aparna Mishra, Rashmi Priyadarshini, "Air Pollution Monitoring System using IoT," International Journal of Engineering and Advanced Technology (IJEAT) ,2019.

[5] Ramagiri Rushikesh, Chandra Mohan Reddy Sivappagari, “Development of IoT based Vehicular Pollution Monitoring System,” IEEE, 2015.

[6] S. Muthukumar, W. Sherine, S Jayanthi, R Kiruthiga, M Mahalakshmi "IoT based air pollution monitoring and control," IEEE, 2017.

[7] Temesegan Walelign Ayele, Rutvik Mehta, "Air pollution monitoring and prediction using IoT," IEEE, 2018.

[8] V.S.Revathy, K.Ganesan, K.Rohini, S.Tamil Chindhu, T.Boobalan, "Air Pollution Monitoring System," IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), 2016.

[9] Beomseok Park, Sebin Kim, Seoryeong Park, Minji Kim, Tae Yoo Kim, Hanbai Park, "Development of Multi-Item Air Quality Monitoring System Based on Real-Time Data," MDPI, 2021.

[10] Aditiyo Hermawan Kuncoro, Melly Mellyanawaty, Aceng Sambas, Dian Syan Maulana, Subiyanto, Mustafar Mamat, "Air Quality Monitoring System in the City of Tasikmalaya based on the Internet of Things (IoT)," Journal of Adv Research in Dynamical & Control Systems, 2020.