MONITORING AIR POLLUTION IN PERAK USING FUZZY LOGIC

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Abstract

Air pollution is a critical environmental issues that affects human health and ecological systems. Traditional air quality monitoring methods in Tasek Ipoh, Perak and Seri Manjung, Perak often face challenges such as high costs, depending on manual data collection and limited adaptability to dynamic environmental changes. This study proposes a fuzzy logic based system for monitoring air pollution which aims to develop a predictive model that assesses air quality more accurate. The result indicate that the fuzzy logic model successfully identifies areas with high risk of air pollution and generates reliable predictions of air quality levels. Among the two location studied, Tasek Ipoh was found to have a higher risk of air pollution compared to Seri Manjung, primarily due to its industrial activities. The model able to handle imprecise and complex data with cost-effective solution for air quality monitoring. This research provides valuable insights for environmental agencies, enabling more responsive decision-making and contributing to improved public health and sustainable environmental management.

***Keywords**: Air Pollution, Fuzzy Logic, Monitoring*

1. Introduction

Air pollution refers to the contamination of the indoor or outdoor environment by any physical, chemical, or biological factor that alters the natural characteristics of atmosphere (Balali-mood et al, 2016). It poses a serious threat to human health and ecosystems especially in industrial areas. Traditional air quality monitoring methods in Malaysia rely on physical sensors and manual processes, which are often costly, time consuming, and inaccurate in rapidly changing environments. This study aims to develop fuzzy logic based system to monitor air pollution in real time and identify high-risk areas. The system focuses on key pollutants such as PM2.5, PM10, CO, SO_2, and O_3 while considering environmental factors such as temperature, humidity, and wind speed. The data is limited to Ipoh (urban) and Seri Manjung (rural). This approach supports better decision-making, environmental protection, and public health management.

2. Methodology

This study applies a fuzzy logic approach to monitor and predict air pollution levels in Perak, Malaysia. Secondary data were collected from the Department of Environment (DOE) Malaysia, covering daily data for the period of January to December 2023. MATLAB software was used to develop the fuzzy inference system. The process began by identifying the input and output variables, then assigning linguistic terms such as “Very Good”, “Good”, “Moderate”, “Unhealthy”, and “Very Unhealthy” to describe pollution levels. Triangular and trapezoidal membership functions were used because they are simple, yet effective in representing fuzzy sets (Dass et al., 2021). The Mamdani inference model was selected for its suitability in environmental decision-making logic, consist of a series on if-then rules that defined the relationships between pollutant levels and air quality (Ebrahim & Mofid, 2011). The system then used the centroid method to defuzzify the results, producing a clear numerical value for the Air Pollution Index (API). This approach helped created a practical and adaptable system for a real-time air quality monitoring and forecasting.

3. Results / Findings

Using input pollutants such as PM10, PM2.5, SO_2, CO and O_3, the Air Quality Index (AQI) was classified into categories ranging from "Very Good" to "Very Unhealthy". In Tasek Ipoh, O_3 recorded the highest AQI (104.5), followed by SO_2 (92.9) and PM2.5 (84.3), which shows the high risk area in Perak. Seri Manjung recorded a significantly lower AQI of 16.4. Rule-based inference demonstrated that PM2.5 and PM10 had significant effects on AQI outputs. A comparison between actual and predicted AQI values showed consistent trends, indicating system's potential in forecasting future pollution levels. These findings demonstrate the effectiveness of fuzzy logic in environmental monitoring and in identifying the most affected areas and take action to improve air quality which was emphasized in Kravchenko et al. (2020).

4. Novelty of Research / Product / Project

This study introduces a new approach to monitoring air pollution by using a fuzzy logic system. Fuzzy logic allows for more flexible and adaptive assessment by handling uncertainty in real-time data. The use of linguistic terms and rule-based logic also makes the results easier to interpret, helping decision-makers take informed action. The study offers a smarter and more responsive way to monitor air quality, which can be scaled and applied to other regions facing similar challenges.

5. Conclusion or Future Work

This study shows that fuzzy logic is an effective tool and suitable for monitoring air pollution in Perak. Future research should combine fuzzy systems with Internet of Things and machine learning, using larger datasets to improve accuracy of prediction. This approach can support real-time monitoring, inform environmental policies, and promote healthier, more sustainable urban development.

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