ABSTRACT

Air pollution is an increasing environmental problem, especially in urban areas with high levels of emissions from industry and transportation. To address this issue, air quality monitoring systems are developed to provide real-time information on air pollutant parameters, such as $PM_{2.5}$ and CO_2. However, the main challenges faced are data instability due to loss of sensor data at certain times as well as the need to improve the accuracy of prediction and early warning systems to support more reliable monitoring and rapid response to air quality changes.

This research proposes the development of a microsensor-based air quality monitoring system capable of predicting $PM_{2.5}$ and CO_2 concentrations using the CNN-LSTM model. The system is also equipped with a data loss detection mechanism using a flagging system and an early warning system integrated with WhatsApp to deliver real-time information to the public. In addition, a website-based visualization platform was developed to display air quality information in a more informative and interactive manner for users.

The implementation results show that the CNN-LSTM model is able to improve prediction accuracy compared to previous methods. The best performance for $PM_{2.5}$ was obtained at Deli station in November 2024 with an R-square value of 0.59, while for CO_2, the best performance was found in January 2024 at Deli station with an R-square value of 0.47. The flagging system successfully detects data loss with a high level of accuracy, while the early warning system can provide notifications quickly and effectively via WhatsApp. With this system, air quality monitoring can be done more accurately, responsively, and easily accessible to the public and related stakeholders.

Keywords: *air pollution, CNN-LSTM, CO_2, early warning system, flagging system, $PM_{2.5}$.*