

IoT Enabled Hyperlocal Weather Monitoring and Prediction System Using ESP32 and Machine Learning

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Department of Electronics & Telecommunication Engineering
Mini Project Report

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Certificate

This is to certify that the mini project report entitled

IoT Enabled Hyperlocal Weather Monitoring and Prediction System Using ESP32 and Machine Learning

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To

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With Deep Reverence,

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ABSTRACT

Environmental pollution and climate variability have become critical challenges in rapidly urbanizing regions, particularly in densely populated cities where localized pollution spikes often go unnoticed by conventional monitoring systems. Traditional air quality monitoring stations, although highly accurate, are expensive to deploy and maintain, limiting their use to only a few fixed locations. This creates significant blind spots in environmental assessment, especially at the community and street level. To address this limitation, the present work proposes an IoT-enabled Hyperlocal Air Quality and Weather Monitoring System that utilizes low-cost hardware to provide location-specific environmental data accessible in real-time to the public.

The system is built using an ESP32 microcontroller, chosen for its low power consumption, integrated Wi-Fi module, and support for multiple sensor interfaces. It integrates sensors including MQ-135 for air quality measurement and DHT22 for temperature and humidity monitoring. These sensors continuously capture environmental parameters, which are processed and transmitted to a cloud platform at regular intervals. A lightweight data pipeline was established using Google Sheets as a cloud database, enabling structured storage and seamless backend integration. Additionally, preprocessing techniques such as noise filtering and calibration were applied to enhance reliability and maintain consistency across multiple readings.

On the user interface side, a responsive, real-time web dashboard has been developed using HTML, CSS, JavaScript, and Chart.js to visualize key environmental parameters. Each recorded data point is plotted dynamically on interactive charts that update every few seconds. The system also incorporates geolocation tracking, enabling the dashboard to map sensor readings to the user's actual physical location when accessed through a browser or mobile device. This provides a hyperlocal perspective of environmental conditions, giving users personalized insights rather than generalized city-wide averages. Such a design significantly improves public accessibility to environmental data.

The proposed system demonstrates the potential of combining IoT, cloud computing, and web visualization technologies to create cost-effective and scalable environmental monitoring networks. By leveraging open-source tools and affordable components, the solution can be easily replicated and expanded across multiple zones within a city. This work lays the foundation for further enhancements such as machine learning-based prediction models, automated alert systems, and integration with GIS platforms for large-scale environmental mapping. Ultimately, the project aims to empower communities, researchers and decision-makers with reliable, localized, and actionable data for environmental awareness and pollution mitigation.