

ABSTRAK

Perubahan iklim global memicu dinamika cuaca mikro-lokal yang fluktuatif, sementara penggunaan stasiun pemantau tunggal (*single-node*) konvensional menyisakan masalah titik buta (*blind spot*) spasial. Penelitian ini bertujuan untuk merancang dan membangun sistem prediksi cuaca berbasis *multinode* menggunakan algoritma *eXtreme Gradient Boosting* (XGBoost) guna memprediksi suhu dan kondisi hujan berskala mikro secara *real-time*. Sistem dibangun mengintegrasikan tiga unit *node sensor* berbasis mikrokontroler Wemos D1 Mini (ESP8266), sensor DHT11, BMP280, LDR, sensor hujan, RTC DS3231, dan *MicroSD Card*. Data ditransmisikan secara nirkabel ke *Firestore Realtime Database*, diproses melalui *backend server* berbasis *FastAPI Framework*, dan dimodelkan dengan algoritma XGBoost melalui evaluasi *5-Fold Cross Validation* terhadap 27.436 baris data, lalu ditayangkan pada *web dashboard*. Hasil pengujian *Quality of Service* (QoS) jaringan menunjukkan *Delivery Rate* sebesar 92,26%, *Packet Loss* 7,74%, dan rata-rata *latency* 235 ms. Evaluasi pemodelan XGBoost menghasilkan performa regresi suhu dengan *Root Mean Square Error* (RMSE) sebesar 0,89°C dan *R² score* sebesar 90,25%, serta klasifikasi cuaca dengan Akurasi Total 96% dan *Recall* hujan 98%. Pengujian *black-box* antarmuka *dashboard* menunjukkan tingkat keberhasilan 100%. Sistem terbukti presisi dan andal dalam mengeliminasi *blind spot* spasial serta menyajikan informasi peringatan dini cuaca mikro-lokal secara *real-time*.

Kata kunci: Prediksi Cuaca, Multinode IoT, XGBoost, FastAPI, Firestore

ABSTRACT

Global climate change triggers volatile micro-local weather dynamics, while conventional single-node monitoring stations leave spatial blind spot issues. This study aims to design and build a multinode-based weather prediction system using the eXtreme Gradient Boosting (XGBoost) algorithm to predict micro-scale temperature and rain conditions in real time. The system integrates three sensor node units based on Wemos D1 Mini (ESP8266) microcontrollers, DHT11, BMP280, LDR, rain sensors, RTC DS3231, and MicroSD Cards. Data is transmitted wirelessly to the Firebase Realtime Database, processed via a FastAPI Framework backend server, and modeled with the XGBoost algorithm through a 5-Fold Cross Validation evaluation on 27,436 data rows, then displayed on a web dashboard. Quality of Service (QoS) network test results showed a Delivery Rate of 92.26%, Packet Loss of 7.74%, and an average latency of 235 ms. XGBoost model evaluation yielded temperature regression performance with a Root Mean Square Error (RMSE) of 0.89°C and an R^2 score of 90.25%, as well as weather classification with 96% Total Accuracy and 98% Rain Recall. Black-box testing of the dashboard interface demonstrated a 100% success rate. The system is proven to be precise and reliable in eliminating spatial blind spots and providing real-time micro-local weather early warning information.

Keywords: Weather Prediction, Multinode IoT, XGBoost, FastAPI, Firebase