Hybrid Deep Learning for Portable Weather Forecasting: Real-Time Predictions Using CNN-LSTM-Transformer Models

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Accurate weather forecasting is critical for agriculture, disaster management, and transportation sectors. However, traditional forecasting systems often require extensive computational resources and centralized infrastructure, limiting their accessibility in remote and underserved regions. This study introduces a Portable Weather Forecasting Station that combines real-time sensor-based data acquisition with advanced deep learning techniques. The station integrates sensors to measure parameters like temperature, humidity, wind speed, and solar radiation, processed by a Raspberry Pi for localized predictions. A hybrid deep learning model comprising Convolutional Neural Networks (CNNs), Long Short-Term Memory Networks (LSTMs), and Transformers is developed to capture both short-term patterns and long-term dependencies in the data. The system's performance is enhanced through hyperparameter optimization using Optuna, with metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Skill Score used for evaluation. The hybrid model demonstrated superior accuracy compared to standalone architectures. Designed for autonomy with battery backup, the station operates independently of external infrastructure, making it ideal for deployment in resource-constrained environments. This research offers an innovative approach to localized, real-time weather forecasting, addressing the limitations of traditional methods while ensuring accessibility and scalability.

Keywords: *Real-time weather predictions, CNN-LSTM-transformer, localized weather forecasting, portable weather forecasting station.*

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