

A Hybrid CNN-LSTM Framework for Spatio-Temporal Crop Yield Prediction Integrating Satellite Imagery and IoT Sensor Data

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Abstract

Precise yield forecasting is a key factor for environmentally friendly precision agriculture, however, most AI models are not able to understand both the spatial patterns of the field and the temporal dynamics of the crop at the same time. To fill this gap, the research presented in this paper constructed a hybrid deep learning model combining Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks. The CNN is responsible for extracting spatial features from the satellite images (NDVI), and the LSTM captures the temporal sequences from the IoT sensor data (soil moisture, temperature). The hybrid model trained from a multi-source dataset in the U.S. Corn Belt (2021-2023) was compared with individual models. The outcomes show its excellent performance, where it achieved a Root Mean Square Error of 1.8 bushels/acre and an R^2 of 0.95. This work demonstrates that combining spatio-temporal data leads to yield prediction that is resistant to noise, thus, it is a handy instrument for the optimization of farm management and the allocation of the resources.

Keywords

Artificial Intelligence, Precision Agriculture, Convolutional Neural Network (CNN), Long Short-Term Memory (LSTM), Internet of Things (IoT).