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A Vision of Agriculture 4.0

: Constructing Smart Agriculture through Artificial Intelligent

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Abstract

Since climate change has become more apparent and uncertainties in climate variations have increased over the years, the agricultural climate has posed significant challenges. Three key microclimate factors - temperature, relative humidity (RH), and photosynthetically active radiation (PAR) - are essential for crop growth. Maintaining a stable microclimate in a greenhouse is crucial to sustaining environmental suitability for crops. Machine learning is highly suitable for this purpose since the relationship between greenhouse operation and microclimate is nonlinear. We propose a novel hybrid machine learning approach (ConvLSTM*CNN-BP) for short-term (1-hour-ahead to 3-hour-ahead) microclimate forecasting to achieve these purposes. The ConvLSTM and CNN modules in the hybrid model are used to extract deep underlying features from input datasets, and BP is further applied to integrate the ConvLSTM and CNN extracted features for microclimate forecasting. An accurate and reliable microclimate forecast is a valuable reference for decision-makers to optimize greenhouse operations. This forecast is fed into the crop production model to calculate the photosynthesis rate, enabling the optimization of greenhouse operations to maximize both the photosynthesis rate of the crops and energy efficiency. The final greenhouse operation plan can be available on a website, allowing farmers to access a smart greenhouse management system.

Keywords: Machine learning; Deep learning; Greenhouse; Smart agriculture; Microclimate