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Artificial Intelligence Models for Detecting Spatiotemporal Crop Water Stress in Automating Irrigation Scheduling: A Review

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Abstract : Water used in agricultural crops can be managed by irrigation scheduling based on soil moisture levels and plant water stress thresholds. Automated irrigation scheduling limits crop physiological damage and yield reduction. Knowledge of crop water stress monitoring approaches can be effective in optimizing the use of agricultural water. Understanding the physiological mechanisms of crop responding and adapting to water deficit ensures sustainable agricultural management and food supply. This aim could be achieved by analyzing and diagnosing crop characteristics and their interlinkage with the surrounding environment. Assessments of plant functional types (e.g., leaf area and structure, tree height, rate of evapotranspiration, rate of photosynthesis), controlling changes, and irrigated areas mapping. Calculating thresholds of soil water content parameters, crop water use efficiency, and Nitrogen status make irrigation scheduling decisions more accurate by preventing water limitations between irrigations. Combining Remote Sensing (RS), the Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning Algorithms (MLAs) can improve measurement accuracies and automate irrigation scheduling. This paper is a review structured by surveying about 100 recent research studies to analyze varied approaches in terms of providing high spatial and temporal resolution mapping, sensor-based Variable Rate Application (VRA) mapping, the relation between spectral and thermal reflectance and different features of crop and soil. The other objective is to assess RS indices formed by choosing specific reflectance bands and identifying the correct spectral band to optimize classification techniques and analyze Proximal Optical Sensors (POSs) to control changes. The innovation of this paper can be defined as categorizing evaluation methodologies of precision irrigation (applying the right practice, at the right place, at the right time, with the right quantity) controlled by soil moisture levels and sensitiveness of crops to water stress, into pre-processing, processing (retrieval algorithms), and post-processing parts. Then, the main idea of this research is to analyze the error reasons and/or values in employing different approaches in three proposed parts reported by recent studies. Additionally, as an overview conclusion tried to decompose different approaches to optimizing indices, calibration methods for the sensors, thresholding and prediction models prone to errors, and improvements in classification accuracy for mapping changes.

Keywords : agricultural crops, crop water stress detection, irrigation scheduling, precision agriculture, remote sensing
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