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Real-Time Detection of Water Stress in Corn Using Image Processing and Deep Learning

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Water limitation is one of the main environmental constraints that adversely affects agricultural crop production around the world. Precise and rapid detection of plant water stress is critical for increasing agricultural productivity and water use efficiency. Numerous studies conducted over the years have attempted to find effective ways to correctly recognize situations of water stress in order to determine irrigation regimes.

Water stress detection is currently done by various methods that are not ideal; these methods are often very expensive, destructive and cumbersome. Water stress in plants is also expressed at different visual levels. Image processing is alternative way to visually recognize water stress levels. Such analysis is non-destructive, inexpensive and allows to examine the spatial variability of stress level under field conditions.

In our study, we propose a new method for detecting water stress in corn using image processing and deep learning. For the purpose of collecting the images, we performed a three-months experiment, in which we took images of five different groups of corn. Each group had a different irrigation treatment, which led to five different levels of water stress. The images were collected using a web camera located approximately 2 m from the plants.

Stress classification was done by inserting processed images into a Convolutional Neural Network (CNN). Training the network was done using transfer-learning techniques in order to exploit the performance of an already trained CNN, for a fast and efficient training over the dataset. Testing the quality of classification was done using extra camera which took a different set of images.

Results were tested upon two sub-experiments - classification of three types of treatments and classification of five types of treatments; the results were 98% accuracy in classification into three types of treatments (well-watered, reduced-watered and draught stressed treatment), and 85% accuracy in classification into five different treatments. These initial results are definitely excellent and can certainly serve decision making for optimal irrigation.