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Identification of water stressed leaves using Artificial Intelligence: The case of eggplant

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Abstract

Identification of water stress of leaves from the photos taken has a long history. Researchers have defined a parameter called Leaf Water Content (LWC) to quantify the dryness of leaves. However, in the case of automatic watering of plants, such high accuracy of LWC is not needed as a decision to water or not alone is sufficient. Furthermore, the agricultural industry cannot use methods of remote sensing that are required to find LWC as they are complex and costly. In the current practice, farmers use their knowledge and experience together with the appearance of plants to estimate the water stress and watering time point of plants. The approach presented in this paper is easily implemented and requires only a series of photos taken by a smartphone or a camera and a software app. In this paper, a method s introduced using Artificial Intelligence (AI) where the images of leaves are directly used to determine whether the leaves are water stressed. We could identify the water stressed leaves accurately using this method. Once an app based on our method is developed, it could easily be used by farmers to automatically identify whether the eggplants are water stressed and need watering.

Keywords: Image classification, Image filtering, Leaf water content, Leaf water stress recognition

Introduction

Plants lose water that they absorb through the roots during photosynthesis and respiration as well as through transpiration. About 90 percent of the water that enters the plant is lost through transpiration. When the plants do not receive enough water, leaves of the plants droop, showing water stress. Both overwatering and underwatering can damage plant growth. As such, for better yields, the farmers need to determine the exact time point to water the plants and the quantity of water supplied. In some advanced irrigation systems, the soil moisture content is used to determine these two. But most farmers water the plants at regular time points or when they notice the drooping of leaves.

The amount of water found in a leaf is called LWC. Some methods of measuring LWC require a leaf to be removed from the plant, but the majority that use advanced spectrophotometers do not. A related variable to LWC is the Equivalent Water Thickness (EWT), which is defined as the volume of water per unit surface area of the leaf. Continuous wavelet analysis (CWA) (Cheng et al., 2014) and a genetic algorithm (GA) (Li et al., 2008) have been used to determine spectral features of LWC. Zheng et al., (2015) describe a method based on electrical property of plants to estimate LWC. However, this is not a remote sensing method and hence, is not suitable for automated leaf water stress detection. Ge et al., (2016) report a method to predict LWCs using hyperspectral imaging but it has the drawback of needing a hyperspectral camera. Zhu et al. (2016) investigate full-waveform terrestrial laser scanning data (TLS) to estimate the LWC vertical distribution within the canopy of