DATA REDUCTION OF HYPERSPECTRAL REMOTE SENSING DATA FOR CROP STRESS DETECTION USING DIFFERENT BAND SELECTION METHODS

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Abstract

The demand of sensor-based decision support in Agriculture is rapidly growing and enhances various applications in agricultural management. A fast and precise identification of fungal pathogen infections in crops is essential for the implementation of site-specific fungicide applications. The precise knowledge of stress-dependent shifting in certain spectral wavelengths provides great advantages in detecting fungal infections. Several studies have shown possibilities and limitations for the detection of plant stress using spectral sensor data. Hyperspectral data provide the opportunity to collect spectral reflectance in contiguous bands over a broad range of the electromagnetic spectrum.

This study focuses on band selection techniques on hyperspectral data for the identification of relevant and redundant information within the spectrum, in addition to an accompanied study that addressed the spectral resolution of hyperspectral data in regard to crop stress detection (abstract submitted). In 2008, a field experiment was carried out to prove the possibilities of hyperspectral remote sensing data and to validate different band selection methods in respect to the detection of infected wheat stands. A field with 4ha in size was divided into 12 subplots with 40*60m to ensure different disease severities. On variant 1 and 2 common fungicide doses were applied, whereas variant 3 and 4 received no fungicide application. The fertilization also differed: Variant 1 and 3 received common doses and stands of variant 2 and 4 were treated with reduced doses. Each variant was repeated three times, resulting in 12 subplots.

On July 1st 2008, the area was covered by the Airborne Hyperspectral Spectroradiometer for Applications (AISA Dual). The flight campaign was realized in cooperation with the Department of Water and Environmental Management, University of Debrecen, Hungary. The AISA Dual system combines two stand-alone sensors, AISA Eagle and AISA Hawk. The AISA Eagle covers the spectral range between 400 and 970nm with a spectral resolution of 2.5nm, whereas the AISA Hawk records the SWIR range between 970 and 2400nm with 5.8nm spectral resolution. This results in 498 spectral bands over the entire covered spectrum. The data were collected at a flight altitude of 2300m, resulting in 1.5m spatial resolution. Small, individual spectral phenomena and the effect of a pathogen infection could thus be examined. However, a fast and precise data processing method is essential for Precision Agriculture. To reduce the high and complex amount of spectral data, different band selection methods (e.g., the Bhattacharyya Distance, Decision Tree Analyzers) were therefore applied and tested. Results of the different methods were compared and the most frequented bands were selected for further data processing. Redundant or highly correlated bands for crop stress detection could thus be filtered. A Maximum likelihood classifier was used to validate the significance of the selection procedure. By applying band selection techniques, the different variants could be accurately differentiated and infected areas could be localized. The reduction of the spectral dimension of sensor data by means of band selection procedures is an appropriate method to speed up the data supply for precision agriculture and to give suggestions for future sensor techniques costumed for agricultural applications.