GROUND LEVEL HYPERSPECTRAL IMAGERY FOR WEEDS DETECTION IN WHEAT FIELDS

I. Herrmann, U. Shapira, and A. Karnieli

The Remote Sensing Laboratory, Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, 84990, Israel

S. Kinast

Dept. of Solar Energy and Environmental Physics, Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, 84990, Israel

D.J. Bonfil

Field Crops and Natural Resources Department, Agricultural Research Organization, Gilat Research Center, 85280, Israel

SUMMARY

Weeds are a severe pest in agriculture, resulting in extensive yield loss. Applying precise weed control has economical as well as environmental benefits. Imaging spectrometry or hyperspectral remote sensing is an advanced technology that has attracted the attention of many professionals during the past decade. Combining remote sensing tools and techniques with the concept of precision agriculture, has the potential to automatically locate and identify weeds in order to allow precise control. The objective of the current work is to detect annual grasses and broadleaf weeds among cereal, as well as broadleaf crops, by implementing field spectroscopy tools. The study used ground-level image spectroscopy data, with high spectral and spatial resolutions, for detecting annual grasses and broadleaf weeds in wheat fields. The Spectral Camera HS (Specim) with 1600 pixel per line and 849 bands in the range of 400-1000 nm was selected to obtain ground level images in wheat fields. For each image, Fractional Coverage (FC) assessment was implemented for four classes: wheat; soil; grass weed (GW); and broadleaf weed (BLW). The images were radiometrically corrected, transformed to relative reflectance values, and spectrally resampled to 91 continuous bands in the range of 400-850 nm. Spectra from 21 images, all together more than 1800 pure pixels, of the four classes were obtained. The image pixels were used to cross validate Partial Least Squares Discriminant Analysis (PLS-DA) classification models. The best model (Table 1) was chosen by comparing the cross validation confusion matrices, use four classes: broadleaf weeds, grass weeds, soil, and wheat. Each of the classes contains sunlit and shaded data together, although sunlit vegetation can be better separated to classes than shaded vegetation. The Variable Importance in Projection (VIP) analysis has shown that the red-edge is the most important region for the three vegetation classes. The highest VIP bands used for separation were 730, 550, 440 and 685 nm total vegetation, grass weeds, wheat, and soil

classes respectively. Validation pixels (randomly selected) achieved in their confusion matrix total accuracy of 72%. The results (Figure 1) obtained are reasonable although the model based on wheat and weeds from different growth stages, acquiring dates, and fields. It is concluded that high spectral and spatial resolutions can provide separation between wheat and weeds based on their spectral data. The results show feasibility for up-scaling the spectral methods to air or spaceborne sensors as well as developing ground-level site specific weed application, and the hyper versus multi spectral data requirement is discussed.

Table 1. Cross validation of PLSDA classification model of four classes: broadleaf weeds, grass weeds, soil and wheat. The model is based on seven latent variables resulting in confidence interval of +/- 1.6% for the overall accuracy, and Kappa = 0.79.

		Ground truth					
		BLW	GW	Soil	Wheat	Total # of classified samples	User's accuracy % correct
Classific-ation results	BLW	**695**	15	0	28	738	**94**
	GW	41	**297**	0	53	391	**76**
	Soil	7	0	**330**	25	362	**91**
	Wheat	56	52	0	**258**	366	**70**
Total # of ground truth samples		799	364	330	364		
Producer's accuracy % correct		**87**	**82**	**100**	**71**		**85**

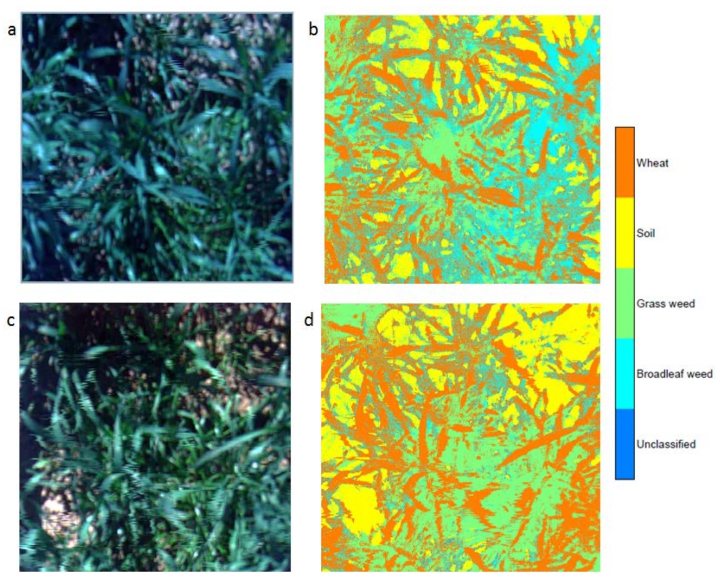

Figure 1. A hyperspectral ground-level image with the lowest (a) and with above the average total accuracy (c) and its classification ((b) and (d) respectively).

Keywords: Remote Sensing, Hyperspectral, Vegetation, Classification, Weed detection**.**