Vegetation classification using hyperspectral and multi-angular remote sensing data

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Abstract— **In this study, vegetation cover type classification was investigated using CHRIS data over agricultural scenes acquired across the 2004 growing season. Spectral indices sensitive to crop chlorophyll content and leaf area index were first calculated from CHRIS nadir data in May, June and July. The seasonality of these indices was analyzed and employed to identify crop types in the study area. To further improve the classification accuracy, the angular signatures of the vegetation canopies were derived from the nadir and off-nadir data in the red and near-infrared band using the kernel-driven Ross_Thick and Li-Sparse model. The coefficients of the kernel-based model were then used for crop type classification, together with the spectral indices derived from nadir data. Preliminary results show that the additional angular information can slightly improve the classification accuracy.**

Keywords-Hyperspectral; Multi-angular; vegetation classification;

I. INTRODUCTION

Knowledge of the spatial distribution of crop types is important for decision farming and management, and environmental studies. Remote sensing data have been exploited as cost-effective means of classifying crop types in a spatially and temporally continuous manner. However, the classification accuracies based on multi-spectral remote sensing data remain unsatisfactory. The development of hyperspectral and multi-angular remote sensing provides an opportunity to considerably improve the accuracy of forest vegetation classification. This is because the fine spectral resolution of hyperspectral remote sensing data offers the potential to discriminate between species with subtle spectral signature differences. The multi-angular data can be used to derive canopy structures, an important information for vegetation classification. In this study, we exploit the applications of multi-angular hyperspectral CHRIS (Compact High Resolution Imaging Spectrometer) in identifying agricultural crops.

II. CHRIS DATA AND DATA PRE-PROCESSING

The CHRIS data used for this study were acquired over agricultural fields, Alberta, Canada in May, June, and July, 2004 at 5 view angles. The data have 62 spectral bands covering from 410 nm to 1002 nm and have a nominal spatial resolution of 36 m by 36 m. Atmospheric correction and geo-reference were performed on the original data. The resulting reflectance data are shown in Figure 1.

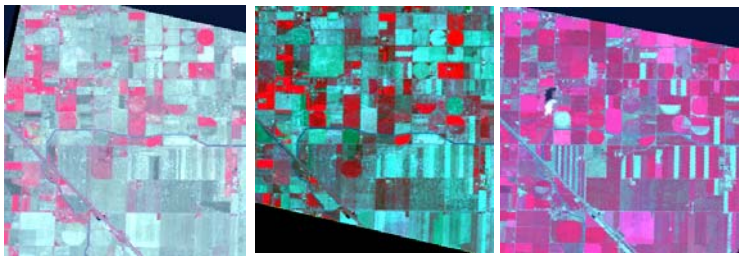

Figure 1: Color composite images of the CHRIS data acquired over agricultural fields, Alberta, Canada in May (left), June (middle) and July (right). Bands 44 (803 nm), 26 (683 nm), and 13 (553 nm) were printed as red, green, and blue, respectively.

III. CLASSIFICATION USING HYPERSPECTRAL CHRIS DATA

Three normalized difference vegetation indices (mNDVIs) were calculated for the data acquired in May, June, and July [1]. Supervised classification was performed based on these mNDVIs images. The training area and classification results are shown in Figure 2. There are totally 12 crop types were classified. The overall accuracy based on 49 testing fields is 88%.

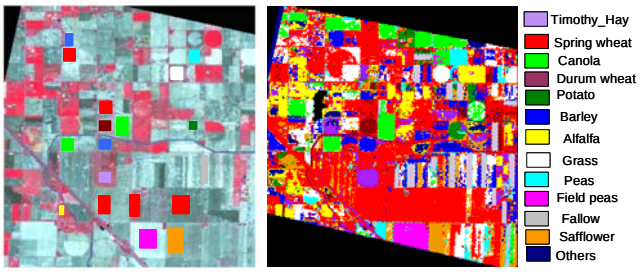

Figure 2: The training areas and classification results using the reflectance acquired in May, June and July.

IV. CLASSIFICATION USING MULTI-ANGULAR CHRIS DATA

The angular signatures of the crop canopies were also exploited to improve the classification accuracies in this study. In order to get enough coverage, only the data with the "Fly-by-Zenith" angles of $\pm 36^0$ and nadir were used. The kernel-driven Ross_Thick-Li_Sparse model [2] was fitted to the angular CHRIS data in the red and near-infrared bands. The coefficients for the isotropic, volume, and surface scatterings derived from the June data in the near-infrared band are shown in Figure 3, as an example. Comparing with middle panel in Figure 1, it is clear that for homogeneous crop fields, the surface scattering coefficient is large, while the volume scattering coefficient is small. The edges or the boundaries of the fields are more evident in the images of coefficients. The coefficient images for May, June, and July in the red and near-infrared bands were used for supervised classification, together with the mNDVI images. The classification results are shown in Figure 4. The fields marked in back are spring wheat and they were correctly identified with the additional angular information. The road and some field boundaries were not classified into any crops by using the spectral and angular information.

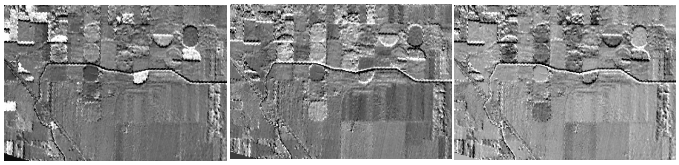

Figure 3: The coefficients for isotropic (left), volume (middle), and surface (right) scatterings derived from the angular data acquired in June 2004 in the near-infrared band.

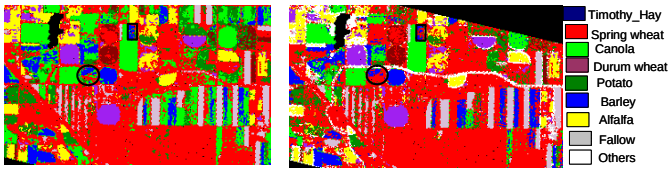

Figure 4: The classification results using the mNDVIs derived from nadir image (left) and using both the mNDVIs and the coefficients of Ross-Thick-Li-Sparse model derived from multi-angular data.

V. CONCLUSION

In this study, crop type classification was investigated using the multi-angular and hyperspectral CHRIS data acquired across the 2004 growing season. The preliminary results show that the hyperspectral data at nadir angle can identify 12 crop types in the study area with reasonable accuracy. The overall accuracy is 88%. The angular information derived from nadir/off-nadir CHRIS data in the red and near-infrared bands can improve the classification accuracy, especially for spring wheat and the field boundaries.

In future study, detailed interpretation of the kernel coefficients of the Ross-Thick_Li-Sparse model will be carried out. More advanced features will be derived from these coefficients and used for classifications.

ACKNOWLEDGMENT

The authors gratefully acknowledge the financial support provided for this research through Natural Sciences and Engineering Research Council of Canada (NSERC). We also thank ESA for the CHRIS data.

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