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Low-Altitude Hyperspectral Imaging of Naruko Integrated Field for the Interpretation of High-Altitude Observations (Understanding for each and integrated ecosystem using remote sensing, 6th International Symposium on Integrated Field Science)

著者	KOSUGI Yukio, GUILLAUME Desjardins, TAKABAYASHI Yuji, MONTEIRO Sildomar T., YAMAKI Makoto, UTO Kuniaki, SAITO Genya
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Low-Altitude Hyperspectral Imaging of Naruko Integrated Field for the Interpretation of High-Altitude Observations

Yukio KOSUGI*, Desjardins GUILLAUME*, Yuji TAKABAYASHI*, Sildomar T. MONTEIRO****, Makoto YAMAKI*, Kuniaki UTO* and Genya SAITO****

***Tokyo Institute of Technology, Japan **Tohoku University, Japan**
***** Ecole Polytechnique de Montreal, Canada ****University of Sydney, Australia**

1. Introduction

For interpreting images obtained by satellite or airplane systems, we often encounter the mixed pixel problem, in particular when analyzing integrated fields. In order to solve unmixing problems, obtaining pure spectral signatures will allow us to make better use of linear unmixing methods.

2. Crane mounted HS observation system

When performing ground truth observations, spectrometers are often used to get spectral signatures for each pure component. However, the FOV of spectrometers is usually too wide to separate sparse plants from the soil background. To overcome this difficulty, we use a HS sensor on a track crane, as shown in Fig,1.

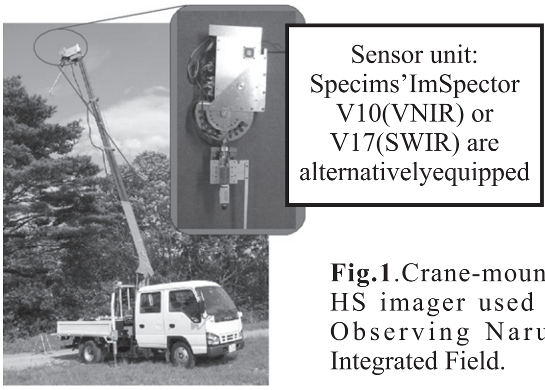

Fig.1.Crane-mounted HS imager used for Observing Naruko Integrated Field.

3. Observation results

We have conducted push-bloom HS image observations, by rotating the crane arm, on 1)trees *in-situ* and cut-down twigs, 2)grass in test meadow, and 3)pastured animals. An example of pseudo color image, reflectance and 2nd order derivative profiles are shown in Fig.2, for several kinds of grasses in the test meadow.

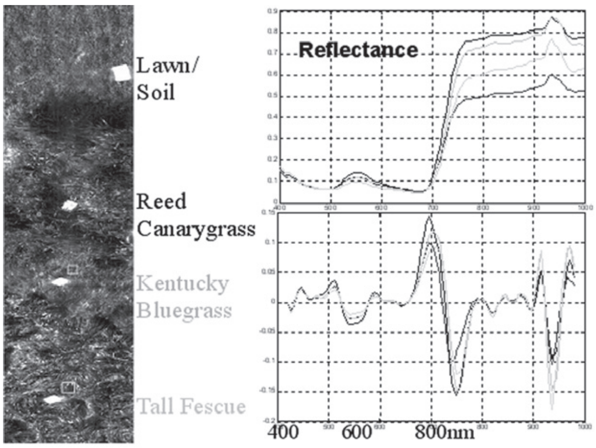

Fig.2. HS pseudo color image and the reflectance profiles of grasses. Ground pixel size is approximately 10 by 10mm.

4. Neural networks for classification of HS images

For a preliminary study of tree and grass classification, as well as for the detection of animal clusters, we have analyzed the pure spectral profiles with the aid of artificial neural networks. A standard multilayer perceptron was used for this experiment, with a single hidden layer composed of 10 sigmoid units. The network was trained using the conjugate gradient algorithm, combined with an early stopping procedure for better generalization performance.

We compared the network's performance using both the raw reflection map as input, as well as the data obtained through basic preprocessing operations, such as normalization and first/second order derivatives. This resulted in classification rates as high as 93.3% using the second order derivative on the grass classification task. The detailed results are shown in Table 1.

For the tree classification task, we further compared the sigmoid network to a radial basis function network, for both a 3 and 8 class categorization problem. For the latter task, we increased the number of hidden units to 15. The sigmoid network resulted in a classification rate of 91.5% for the 3 class problem, using the normalized data. However, this same network fared poorly with the 8 class problem, the RBF network obtaining an average of 77.3%.

Table 1. Grass Classification Results

Preproc. Method	Gen. Class. Acc.	MSE
Raw reflectance	92.66	0.037
Normalized	92.53	0.037
2^{nd} Derivative	93.46	0.033
Norm. + Deriv.	91.9	0.041

5. Conclusions and future plans

For small number of classes, we were able to perform classification on low-altitude HS images. In the future, we plan on introducing unmixing procedures to interpret aerial HS observations of the field based on the pure spectra thus obtained. Also, to tackle the relatively poor performance of our networks when dealing with a higher number of categories, we are currently exploring new developments in the field of neural networks, mainly Deep Belief Networks and Deep Auto-Associators, which have gained a lot of traction in the field of machine learning.