# THE PONTENTIAL OF USING AND EXPANDING THE HYPERSPECTRAL APPLICATIONS IN HUNGARY

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**Abstract:** The hyperspectral remote sensing has greatly improved the efficiency of remote sensing technology, which incidentally proved to be appropriate to analyse large areas according to different quantity and quality parameters in a fast and economic way. Hyperspectral technology can be fitted exquisitely in the agricultural production, in the environment protection and in several other industrial applications. The Hungarian Institute of Agricultural Engineering established the Hyperspectral Working Group, which aims to work out the methodology of the airborne, the field and the laboratory refelectance measurments that will be the basis of future Hungarian hyperspectral technology services, further connections to international research projects, and the theoretical and practical educational framework for training the technology as a part of university education.

**Key words:** hyperspectral technology, remote sensing, white reference

## 1. INTRODUCTION

The hyperspectral imaginery technology in the last five years showed up in the precision agriculture, too. The University of Debrecen, Centre For Agricultural and Applied Economic Sciences, Department of Water and Environmental Management [1; 2; 3] and the Hungarian Ministry of Agriculture and Rural Development, Institute of Agricultural Engineering [4; 5] operate the finnish Specim AISA DUAL sensor system collectively, possessing a unique remote sensing system in all Europe. In the year of 2010, the Institute of Agricultural Engineering bought an ASD field spectroradiometer expanding the available systems, which are now adequate to identify and solve the problems which are current in the methodology and the data processing of hyperspectral remote sensing. In order to do so, developing new measuring technologies are needed.

## 2. MATERIALS AND METHODS

Both institutes above won the tender of European Union Economical Competitive Operational Program in the year of 2006. Within this tender the two institutes assembled their separately purchased different sensors to use them

together in dual mode, twinsensor system so called AISA DUAL (figure 1.) providing possibility to analyse spectral bands from 400 to 2450 nm.

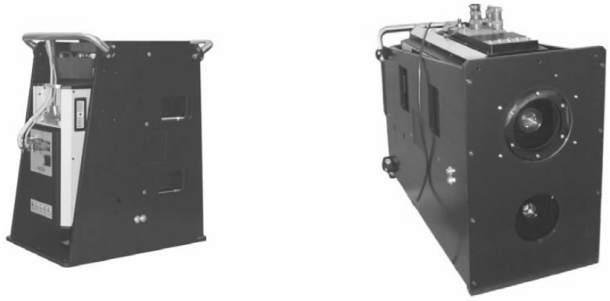

Figure 1. The AISA DUAL twinsensor.

*2.1 The main parts of the AISA DUAL system*

- The VNIR (Eagle) sensor (figure 2.)
- The SWIR (Hawk) sensor (figure 3.)
- GPS/INS system type C-MIGITS III or OXFORD RT3000
- Fodis sensors (figure 4.)
- Rack computer and hight contrast LCD monitor

Figure 2. The Eagle sensor

Figure 4. Fodis sensor

Figure 3. The Hawk sensor

The main parameters of the separate and the combined sensor systems are summarized in the following table (table 1.).

| | AISA Eagle | AISA Hawk | AISA Dual |
|---|---|---|---|
| Spectral range (nm) | 400-970 | 970-2450 | 400-2450 |
| Spectral sampling band (nm) | 2,3 | 5,8 | 2,3/5,8 |
| Spectral bands | 244 | 254 | 498 |
| Spatila pixels | 1024 | 320 | 320 |
| Spectral depth (bit) | 12 | 14 | 12 |
| Image rate (image/sec.) | up to 100 | up to 100 | up to 100 |
| FOV (degree) | 37,7 | 24 | 24 |
| IFOV (degree) | 0,037 | 0,075 | 0,075 |
| Camera | CCD | MCT | CCD&MCT |

Table 1. System parameters

## 3. RESULTS AND DISCUSSIONS

The first experimental results showed that the C-MIGITS III GPS/INS system works with measuring errors above the required level, that could be increased by the further processing periods. Therefor to rule out the errors and to improve the accuracy, instead of the C-MIGITS III, OXFORD RT3000 GPS/INS system is used. The measuring experience with the sensor system was greatly enhanced by foreign commissions as well. The airborne imaginary expands with surface measuring with applying the new ASD Fieldspec spectroradiometer (figure 5.) and the ground reference surfaces (figure 6.) which highly improve the effectiveness of the remote sensing technology.

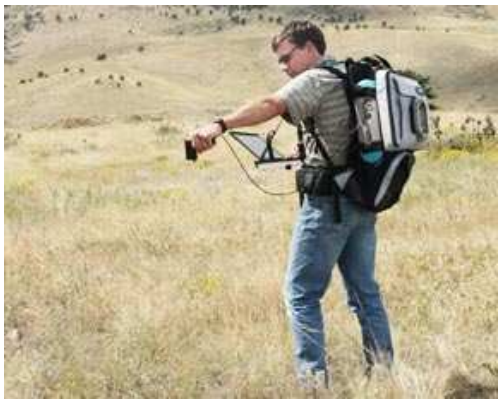

Figure 5. ASD Fieldspec spectroradiometer

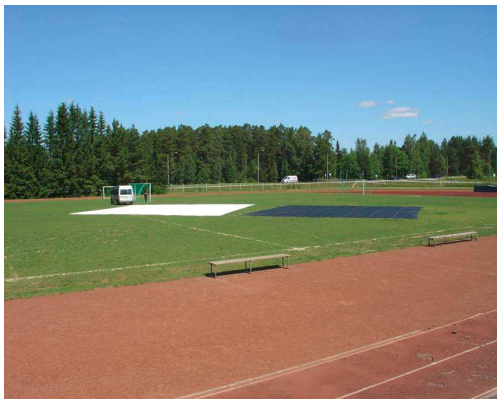

Figure 6. Ground reference panels

The aim of the Institute is to create an Hyperspectral Knowledge and Education Centre working with international researchers and researh centres. Beyond the scientific works the establishment will function as a service and reference centre. In the year of 2010 the Institute established a Hyperspectral Workging Group.

In charge of the coordination and development Peter Kardevan [6; 7; 8] Hungarian hyperspectral expert was requested. The members of the group participate in one year project to improve their knowledge that is necessary for further developments. This program consists of software application and system management with the essential mathematical and statistical methodology for image processing and working out an own method for hyperspectral laboratory experiments. Furthermore to improve the speed and the effectiveness of the analysis and data processing appropriate programs will be developed.

The Institute will change the so far used lease practice based on flying costs. The system has calibration, maintenance and operational costs, too. In order to avoid any damage caused by improper use the systems will be maintained by the trained operational crew of the Institute.

The Institute establishes hyperspetral laboratory and strictly regularize white reference calibration using white reference panel, working out precision measuring methodology assisting Andras Jung’s [9; 10; 11] White Reference Program, to became an acknowledged hyperspectral research and calibration centre of Europe.

## 4. CONCLUSIONS

The Hungarian Ministry of Agriculture and Rural Development, Institute of Agricultural Engineering expanded the hyperspectral remote sensing system with ASD Fieldspec spektoradiometer and ground control reference panels which can be used successfully in the geographical aptitude of Hungary. On account of the technology's large supplying data ability it can be widely used in agriculture, in environment protection and climate change monitoring [12], furthermore in several other industrial applications. Depending on the market demands theoretical and practical educational framework for training the technology as a part of university education will be started.

## 5. REFERENCES


[1] BURAI P. - TAMÁS J. (2005): **Talajdegradációs folyamatok vizsgálata nagy felbontású távérzékelt adatforrások alapján.** Agrártudományi Közlemények, no. 16 különszám (2005): 145-148.

[2] BURAI P. (2007): **Távérzékelési módszerek alkalmazási lehetőségei a mezőgazdaságban mintaterületeken** .(Debreceni Egyetem Agrártudományi centrum, Mezőgazdaságtudományi kar, Víz-és Könyezetgazdálkodási Tanszék, 2007).

[3] KŐMÍVES T. - BÉRES I. - REISINGER P. - LEHOCZKY É. - BERKE J. - TAMÁS J. - PÁLDY A. - CSORNAI G. - NÁDOR G. - KARDEVÁN P. - MIKULÁS J.- GÓLYA G.- MOLNÁR J. (2006): **A parlagfű (Ambrosia artemisiifolia) elleni integrált védekezés új stratégiai programja.** Magyar Gyomkutatás és Technológia, 7 (1): 5-49., 2006.

[4] ERDEINÉ KÉSMÁRKI-GALLY SZ. - PAPP Z. - FENYVESI L. (2009): **Agro-ökorend-szerek vizsgálata távérzékelésse**l. Növénytermelés 58, no. 1 (Március 1, 2009): 11-24.

[5] FENYVESI L (2008): Characterization of **the soil - plant condition with hyperspectral analysis of the leaf and land surface.** Cereal Res. Com., (Supp 5) 659-663 pp.

[6] KARDEVÁN P. - RÓTH L. - VEKERDY Z. (2000): **Terepi spektroradiométeres mérések a 2000. márciusi, bányászati tevékenység okozta tiszai nehézfém szennyeződések hatásának vizsgálatára.** Földtani kutatás, 2000. IV.

[7] KARDEVÁN P. – JUNG A. – REISINGER P. – Nagy S. (2004): **Determining the reflectance spectra of common ragweed (Ambrosia artemisiifolia L) by field measurements (in Hungarian).** Magyar Gyomkutatás és Technológia, 5 (1), 15–31.

[8] KARDEVÁN P. - VEKERDY Z. - RÓTH L. - SOMMER S. - KEMPER T. - JORDÁN G. - TAMÁS J. - PECHMANN I. - KOVÁCS E. - HARGITAI H. – LÁSZLÓ F. (2003): **Outline of scientific aims and data processing status of the first Hungarian hyperspectral data acquisition flight campaign.** HySens 2002 Hungary. Proceedings of the 3rd EARSeL Workshop on Imaging Spectrometry, Herssching, Germany

[9] JUNG A. - KARDEVÁN P. – TŐKEI L. (2005): **Detection of urban effect on vegetation in a less build-up Hungarian city by hyperspectral remote sensing.** Physics and Chemistry of the Earth, 30, 255–259. Impact factor: 0,653

[10] JUNG A. – KARDEVÁN P. – TŐKEI L. (2006): **Hyperspectral Technology in Vegetation Analysis.** Progress in Agricultural Engineering Sciences Vol 2 (No.1), December, 93-115. http://www.akademiai.com/content/276511331ql76777/

[11] JUNG A. - TŐKEI L. - KARDEVÁN P. (2006): **Application of airborne hyperspectral and thermal images to analyse urban microclimate.** Applied Ecology and Environmental Research. Applied Ecology and Environmental Research 5 (1): 165-175 http://www.ecology.kee.hu/

[12] ERDÉLYI, É. (2009): **Sensitivity to Climate Change with Respect to Agriculture Production in Hungary** (2009) Precision Agriculture '09 Edited by: E.J. van Henten, D. Goense and C. Lokhorst, Wageningen Academic Publisher, p. 559-567.