THEMATICALLY ORIENTED MULTICHANNEL SPECTROMETER (TOMS)

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Abstract

The goal of the study is describe the key parameters and the process of working out a multichannel spectrometric system in the visible and near infrared bands of the electromagnetic spectrum. This system will be used for remote sensing investigations:

- *recognition of main land covers (soils, natural and agricultural vegetation, water areas)*
- *state assessment and monitoring of the studied objects.*
- *Investigation of the relationships between the reflectance and spectral features of the studied objects; development and validation of spectral-biophysical models for estimation of land cover parameters.*
- *Soil state assessment – type, moisture content, surface texture.*

Description of spectrometric system

The multichannel spectrometric system has been designed to measure the reflected by ground objects solar radiation in the visible and near infrared range of the electromagnetic spectrum on board of a remotely-controlled airborne platform.

The measurements are performed in a basic working regimen - nadir, platform velocity – up to 20 km/h, height – up to 1000 m (optimal 200 m), flight duration - up to 30 min.

Components of the system

- VIS-NIR multichannel spectrometer - optical unit – lenses and fiber; optional color digital still camera -
- control of the on-board system – spectrometer control unit, onboard storage module (flash disk), GPS (for Earth investigations);
- on-board power supply device – litium battery; fitting elements for installation of the system on board of the airborne platform;
- unit for on-board pre-processing of spectrometric data;

- communication unit for data transmission;

The technical specification of the spectrometric system are summarized in table below:

Spectral VIS- NIR range:	(450 ÷ 900) nm
Number of spectral channels:	128 / 64
Channel location:	even
Spectral resolution:	(3 ÷ 10) nm
Spatial resolution:	(1 ÷ 25) m^2
CCD line elements:	2048
Dynamic range: of the system	4 x 10^4
per scan	2000 : 1
Exposure time:	(3 ÷ 60) ms
Measurement duration:	(10 ÷ 30) min

Technical requirements and characteristics of the platform:

Navigational (flight conditions and spectrometric system operational regimen) - composition and relief of the studied territories

Constructional (location and installation of the spectrometric system):

- Necessity of a digital camera and requirements for linking the spectrometric data with the regional map;
- Requirements for geometric corrections, radiometric calibration, map and time control of the spectrometric data (technical parameters of the GPS interface);
- Requirements to the data processing system (hardware, software) - development of data processing and interpretation algorithms (digital filtration, visualization, user interpretation, etc.);
- Laboratory investigations with the system.

In the visible (VIS) spectral band (400÷710 nm) vegetation optical properties depend mainly on plant pigment content and concentration. The reflectance maximum is observed at 550 nm, i.e. in the green region where the absorption of the incident radiation is relatively low. Plant senescence or stress factors inhibiting chlorophyll synthesis or causing chlorophyll destruction decrease the amount of the absorbed solar radiation in the red (670 nm) spectral band where the zone of vegetation minimum reflection is located.

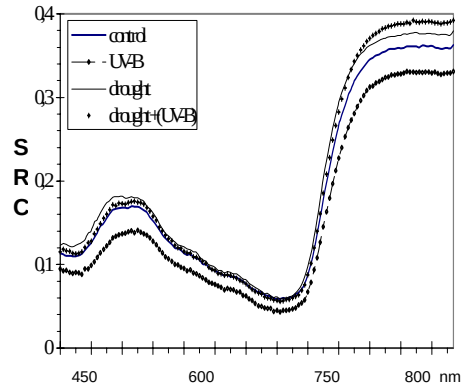

Fig.1The reflected by vegetation solar radiation () has a specific spectral distribution.

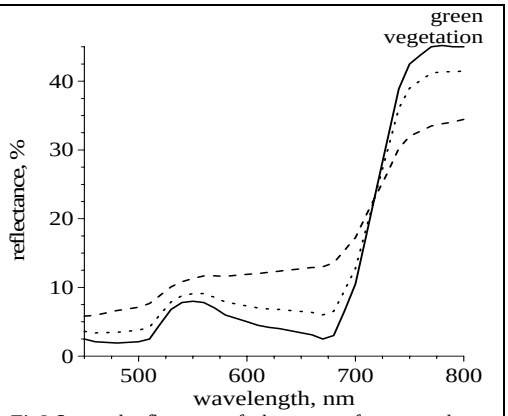

Fig2 Spectral reflectance of wheat crops for green plants and plants with different degree of senescence

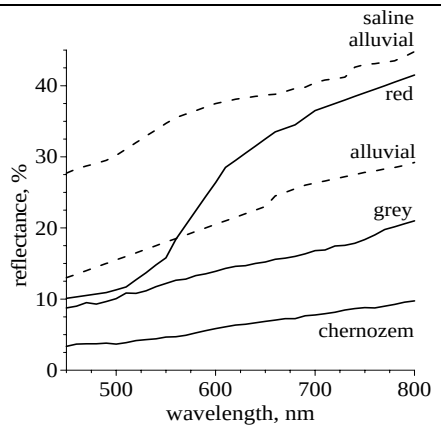

Fig.3 Spectral reflectance of various soil types

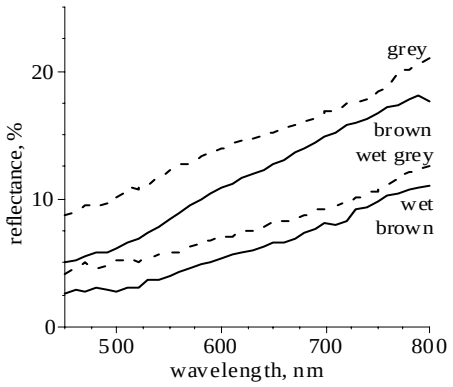

Fig. 4 Spectral reflectance of two soil types with different water content

This leads to higher reflectance values in this spectral band (Fig.2). This leads to higher reflectance values in this spectral band (Fig.2).

In the near infrared region (NIR) of the spectrum (710÷1300 nm) the vegetation reflectance ability increases, a steep slope being observed in the wavelength range 700 ÷ 760 nm. Reflectance variation in the NIR band depends on plant structural parameters and can be used for vegetation

classification and state assessment. In Fig.1 the spectral reflectance curves of maize leaves are shown for the case of plant normal (control) and stress growing conditions. In Fig. 2 the reflectance spectra of wheat crops are presented for green plants and plants with different degree of senescence.

Soils have a reflectance increase in the VIS-NIR spectral range. The reflectance behavior is a function of various soil parameters (mineral composition, organic matter content, surface moisture and roughness, etc.).

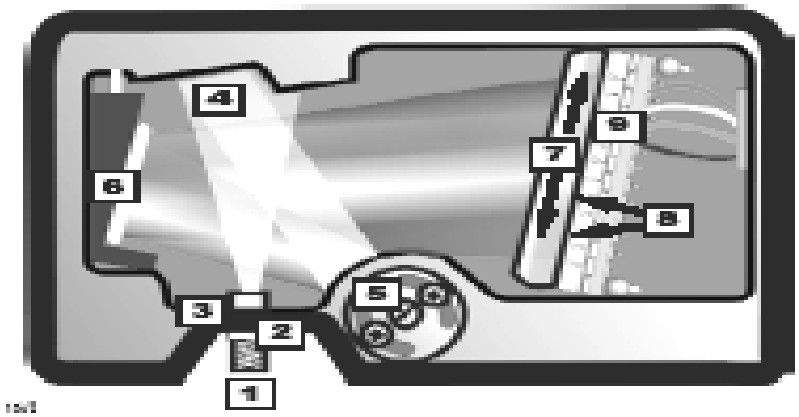

Fig5. Diagram of the optical unit 1. SMA connector; 2. Fixed slit; 3. Absorbance filter; 4. Collimating mirror; 5. Grating; 6. Focusing mirror; 7. Detector collection lens 8. OVLF filter; 9. UV detector.

Conclusion

The idea in designing multichannel a spectrometric system is to provide large number of scientists and specialists with reliable device for measuring different types of natural and anthropogenic origin. As it was shown by the laboratory investigations the results are promising since the spectral accuracy of the spectrometer is comparable with this of similar commercial systems.

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