Abstract for 11th Low Cost Planetary Missions Conference
June 9-11, 2015, Berlin, Germany

Low Cost Hyperspectral Systems for Planetary Atmospheric and Surface Studies in the Visible, NIR and SWIR Range

Andreas Eckardt, Ralf Reulke
DLR German Aerospace Center, Institute of Optical Sensor Systems, Rutherfordstr. 2, 12489 Berlin, Germany

Each object has a specific spectral signature in terms of its light emission or reflection. Therefore spectral measurement can provide information relating to classification in remote sensing tasks. High resolution imaging spectrometry or Hyperspectral Imaging (HSI) requires sophisticated solutions both for the detector and its operation as well as for the hardware and mechanics. Key features essential for a reliable and stable high performance operation are describbed and explained in detail. New developments of CCD/CMOS high resolution line and matrix detector technology in combination with high-sophisticated telescopes are key components for new remote sensing instruments. In case of spectral resolution systems the ground sampling distance will be in the range of 10 up to 30 m, but the number of spectral bands is more than 100 and spectral resolution is in the range of few nm.
For orbiting systems a line-scan device is suitable. If the hyperspectral sensor could be mounted on a (rover) platform for surface analysis, a snapshot devise would be necessary.
For these applications the design should be able to keep the required science performance under different environmental, mission and illumination conditions inside by a self-calibration capability ac.
Another challenge for such instruments is the noise and contrast problem, because of the optics and the design for reflective or refractive device. For all of these design aspects it is absolutely necessary to trace all of the performance related parameters especially the SNR and MTF values throughout the whole development and look for the best compromise to keep the imaging performance high.
The current method for HSI relies on the use of optical diffraction gratings (or prisms) to disperse light so that different optical wavelengths fall on different pixels of the detector array. Alternative approaches based on Fourier-Tranform (FT) Spectroscopy.
The main disadvantage of todays HSI cameras using the diffraction grating approach is their bulkiness and price. Another drawback of using the grating approach is the requirement for special design of the camera's entire optical system to adapt to the diffraction grating inside the camera. FT cameras often use mechanic parts in the spectrometer.
Recently, new HSI methods are introduced. Company IMEC has a technology of +100 bands line-scan spectral imager solution. They provide a chip of 2-4 MPx, so that the spatial resolution with +2k Pixel is also sufficient. Similar trends are also found in FT spectrometers (with no moving parts). A clear advantage of this method is its robustness and versatility. This paper gives a compilation of recent trends for different HSI application capabilities for planetary science.