Fraunhofer
IOSB

FRAUNHOFER INSTITUTE OF OPTRONICS, SYSTEM TECHNOLOGIES AND IMAGE EXPLOITATION

1 Applications of material distinction.

HYPERSPECTRAL DISTINCTION OF MATERIALS

Is it ore or just some other type of rock? Which sections of the area are contaminated with oil? Certain materials look very similar, even to the experienced observer, but possess entirely different properties. Cameras with color sensitive hyperspectral sensors and efficient, innovative processing methods can detect different materials where the human eye cannot. This helps whenever the surface state is concerned – airborne for environmental monitoring, handheld when prospecting or inspecting structures, and also as part of a fixed installation for quality control at production lines.

System

Our hyperspectral sensors capture 130 color values for each pixel. These are determined for a particular range of the electromagnetic spectrum (light) that is sampled at suitably narrow intervals. In comparison, the human eye only recognizes three different colors across the entire range: red, green and blue. Interactive processing algorithms visualize the complex data and classification results in a user-friendly fashion and in real-time. With these, it is possible to detect even slight differences between materials.

Application

The airborne hyperspectral system is suitable for environmental monitoring of large or remote areas. It is able to detect oil contaminated water, wet and compromised dikes or pest infested areas. Our handheld system has excellent mobility and real-time capabilities. It is ideal for all examinations at closer range that profit from or even depend on timely available results. As an example, in mining the tunneling direction can be readily adapted to follow detected materials. During the inspection of structures, it can be used to determine areas of interest that warrant taking a sample for further analysis. Hyperspectral video systems that are part of a fixed installation at production lines can analyze even quickly moving objects in real-time. In the future, this will allow a more

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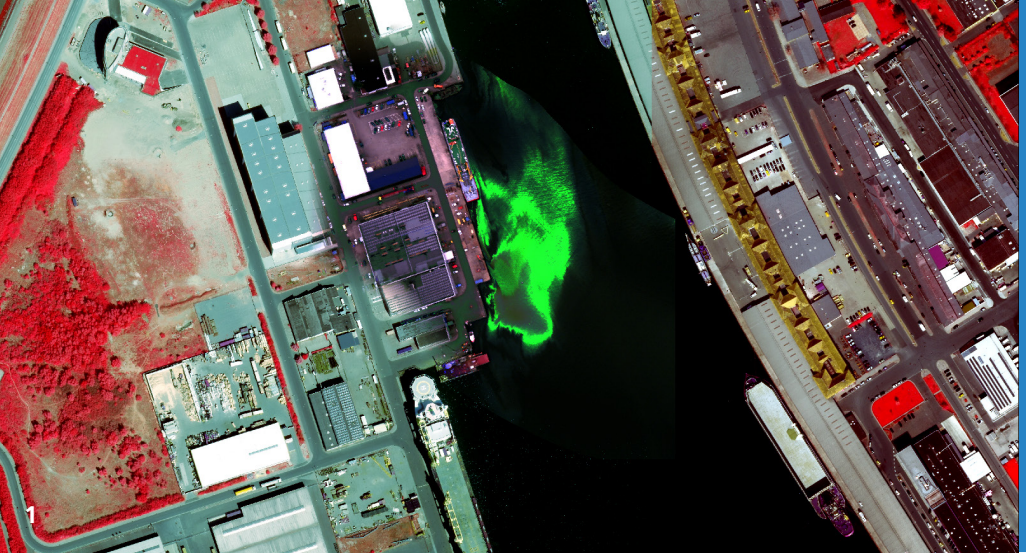
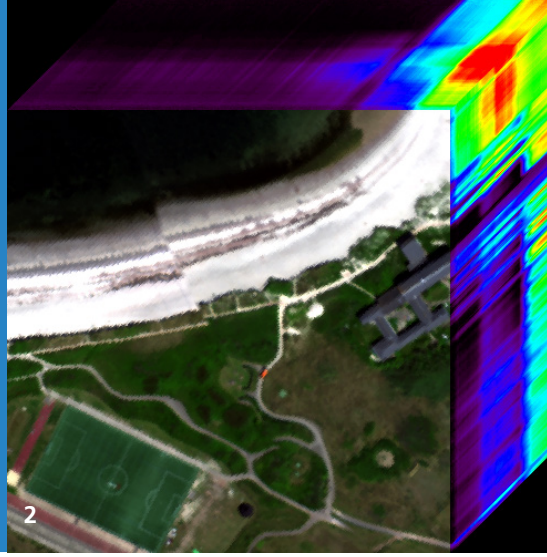




1 Detected surface contamination of water in aerial data (green).

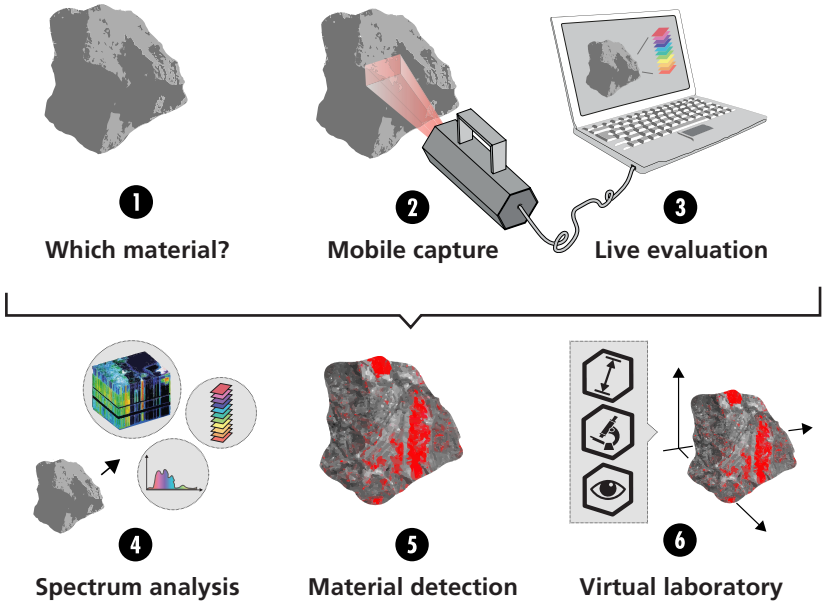
2 Hyperspectral data cube with 130 channels.

differentiated selection during automated quality control in the processing or food industry.

Efficient processing algorithms and hyperspectral technology are suitable for a variety of applications: as a handheld or airborne system, single-frame or video, real-time evaluation or post-processing.

Processing using SpectralFinder

For material detection the material ① is captured using hyperspectral full-frame video cameras or, in the case of airborne surveying, using a hyperspectral line scanner ②. Fraunhofer IOSB has developed real-time capable classification algorithms in order to process the hyperspectral data in an efficient and timely manner ③. The intuitive software for material detection, SpectralFinder, lets the user choose a section of the visible image or a known material from a database. This reference sample is used to classify the hyperspectral data ④. Whenever a material sufficiently similar to the selected reference is detected, it is highlighted in the current image sequence and thus visualizes material differences for the user ⑤. Manual adjustment of the parameters, such as how similar a material has to be in order to be highlighted, allows optimal classification results. In the virtual laboratory ⑥, a virtual 3D environment, the results can be displayed on 3D models. Further analysis is also possible there using the geometry data not available in the original 2D image sequences. Current areas of research are spectral unmixing and elimination of background noise.



Sensors

Hyperspectral full-frame video camera from Cubert GmbH

- Wavelength interval 450 – 950 nm
- Simultaneous capture of the spectra
- Radiometric resolution of 14 bit
- Monochromatic sensor with 1 MPixel resolution

Airborne system: hyperspectral pushbroom linescanner AISA Eagle II

Processing software SpectralFinder

Spectral Finder

- **Easy-to-use** – Only one reference signature needed.
- **Intuitive** – The software visualizes material differences in the ongoing video.
- **Quick** – Online evaluation of the hyperspectral camera's videos.