NEAR-INFRARED HYPERSPECTRAL IMAGING WITH DMD-BASED PROGRAMMABLE FILTERING OF A SUPERCONTINUUM LASER OUTPUT: METHOD AND APPLICATIONS

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CONFERENCE ABSTRACT

Near-infrared hyperspectral imaging has been demonstrated to be a valuable process analytical tool for various fields of applications in modern industries. Typical applications are waste sorting or quality and safety inspection of foods and pharmaceuticals. As it is a non-destructive technique combining chemical with spatial information, near-infrared hyperspectral imaging is also particularly suitable for the localization and classification of surface contaminations.

To date, industrial implementations of hyperspectral imaging in the near-infrared region between 900 nm and 1800 nm are mainly based on push-broom scanners requiring spatial motion of either the object or the scanner system. For this reason, scenarios are typically those in which objects or materials are transported on a linear stage or conveyor belt anyways. Other approaches like spectral scanning or snapshot imaging, which do not require spatial motion, have successfully been demonstrated for the visible range mainly under laboratory conditions. In the near-infrared, technological challenges, e.g. limited resolution of near-infrared two-dimensional detector arrays, availability of variable filter devices having high spectral coverage, small bandwidth and fast tuning speed or the availability of high radiance light sources, prevent industrial and commercial break-through so far.

In our work we investigated another technological approach and present a near-infrared hyperspectral imaging system based on spectrally composed illumination. Our setup allows extremely versatile applications from narrow single-band spectral scanning to combined scenery illumination. This variety of illumination modes is facilitated by dispersion- and DMD-based programmable filtering of a supercontinuum laser source as the basic input. As the spectral selectivity is determined by the source side, the detection pathway is implemented by an InGaAs camera system integrating over the full broadband range. We benchmarked our technology against a commercial push-broom scanning system (Specim FX17e) and calibrated our spectral capabilities using a state-of-the-art FTIR benchtop system (Bruker Vertex 80v). Given the narrow-band scanning, classical data evaluation algorithms (e.g. PLS-regression or -classification, SVM, neural networks) are used to derive models for the scene, while the spectral scenery illumination directly leads to a lateral image contrast correlated with the material distribution and physicochemical properties.

In our contribution, we present the system, its spectral characteristics, and capabilities as well as a first industrial application study on the classification of plastics.