Acousto-optical imager for simultaneous reflectance spectrum and shape measurement

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Spectral imaging is widely used for high contrast visualization of various objects, spectral data extraction, pattern recognition and many other tasks. Stereoscopic spectral imaging is the next step of this technique, which additionally allows three-dimensional (3D) mapping of the inspected object. It may be implemented by means of multi-spectral interferometry methods and multi-laser scanning. These techniques, however, do not allow fast 3D data collection in arbitrary spectral bands by means of a passive, compact and no-moving-part instrument. In this study, we describe a novel 3D spectral imaging concept of the small-size embeddable components for tunable spectral filtration of stereoscopic images. This approach is based on a simultaneous diffraction of two imaging light beams on a single acoustic wave in a uniaxial birefringent crystal. Optical scheme consists of front lens, two diaphragms, crossed polarizers, AO crystal with two prisms attached to its faces, and output lenses, which focus filtered light beams onto monochrome image sensors. Developed device is free of moving elements and is fully PC-controlled. It provides arbitrary spectral access, performs high-contrast spectral imaging and enables calculating 3D shape of the inspected object. The described technique may be implemented in form of ultra-compact, robust, fully PC-controlled elements. By calculating the parameters of AO interaction, it is possible to specify a tuning range (up to mid-wave infrared), bandwidth, aperture, spatial resolution and other parameters for the AO tunable filter, which are necessary for a particular application. One can define an arbitrary number of spectral channels (up to a few hundreds), their positions and the sequence order. These capabilities provide a unique basis for the development of advanced data processing methods.