Parallel Hyperspectral Integrated Computational Imaging

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ABSTRACT

Modern hyperspectral imaging is able to collect extraordinary amounts of information at amazing speed. Data threaten to cause a bottleneck in genetic research, drug discovery and development, and other areas. Reducing these data from physical fields to high-level, useful information is difficult. Integrated computational imaging (ICI) is a process in which image information is encoded as it is sensed to produce information better suited for high-speed digital processors. Both spatial and spectral features of samples can be encoded in parallel in ICI. When spectral images are simultaneously obtained and encoded at many different wavelengths, the process is called hyperspectral integrated computational imaging (HICI). Lenslet arrays and masks are ideal for encoding spatial features of an image. Complex molecular absorption filters can be used as mathematical factors in spectral encoding to create a factor-analytic optical calibration in a high-throughput spectrometer. In this system, the molecules in the filter effectively compute the principal-axis calibration function by weighting the signals received at each wavelength over a broad wavelength range. One or two molecular filters are sufficient to produce a detector voltage that is proportional to an analyte concentration in the image field. Because a single detector voltage can reveal analyte concentration, HICI is able to calculate chemical images orders of magnitude more rapidly than conventional chemometric approaches. HICI can contribute to three areas of research in image informatics: (1) database design and metadata structures for multidimensional images, (2) automated object tracking and event recognition in videos, and (3) interactive analysis and query by content of videos.

Keywords: lenslet arrays, molecular computing, multiplex bandpass filter