Real-time Hyperspectral and Multispectral Imaging – understanding the options and compromises in performance

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Hyperspectral imaging provides data-rich images containing finely detailed spectra at every pixel which can be used to detect small differences in material properties. Hyperspectral data are required for many applications where there's a need to distinguish between subtle spectral changes such as in early-stage plant disease detection or identification/differentiation of plant species. However, there are also many applications where spectral differences are more distinct and, in those cases, multispectral imaging provides a perfectly adequate solution. For example, regions containing "stressed" plants can be identified using simple vegetative indices such as NDVI.

With the increasing number of spectral imaging technologies, it is important to understand what each new approach offers and where compromises are made, what the limitations are and whether it's the best option for a specific application.

Most hyperspectral imagers rely on the traditional push-broom approach where the camera scans across a surface or the object under investigation moves across the field of view of the camera. The hyperspectral image builds up during the scanning process and the result is an image with high spatial and spectral resolution. Push-broom techniques provide data rich hyperspectral data cubes, but these take time to collect and can produce large and unwieldly datafiles that are processed off-line. This is not a problem for many applications where the object of interest is stationary such as in art and cultural heritage applications. However, for many applications the scene is more dynamic and fast or real-time imaging is important.

This presentation will demonstrate how advances in push-broom imagers can provide fast acquisition imaging required for UAV or process-line applications. It will also describe various advances in hyperspectral and multispectral imaging technologies including some of the newer snapshot approaches using filter-on chip sensors and imaging spectrometers incorporating micro-lens arrays. It will review the advantages of each approach and indicate the compromises in performance often related to the quality of spectral and spatial information.

Finally, a new multispectral camera will be described. This light field (plenoptic) imager produces video-rate 16 waveband imaging. The camera captures and processes spectral data in real-time, from initial gain and offset compensation and spectroradiometric calibration through to image processing and classification. The 16 interchangeable bandpass filters can cover a contiguous range or non-contiguous wavelengths and can be narrow band, broadband or complex in spectral response. The presentation will compare the performance of this camera with other spectral imaging approaches and will include videos using this camera for real-time application in the VIS/NIR and SWIR wavelength ranges.