Hyperspectral imaging from Unmanned Aircraft Systems (UAS): trials and tribulations

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Abstract:
The *TerraLuma* research project in the School of Land and Food at the University of Tasmania, Australia has developed novel tools and algorithms for environmental remote sensing applications and aerial surveys using unmanned aircraft systems (UAS). Up-to-date and accurate spatial data are of crucial importance for sustainable management of our eco- and agro-systems. During the last five years, we have been working on UAS and the integration of specialised earth observation sensors, such as multispectral and hyperspectral sensors, thermal cameras, and laser scanners, to map and monitor different aspects of the environment at ultra-high resolutions on-demand.

The primary advantage of UAS-based remote sensing is the ability to bridge the scale gap between field-based observations and full-scale airborne or satellite observations. The key advantages of UAS for environmental remote sensing are their capacity to: 1) collect ultra-high spatial resolution imagery (1 – 20 cm), 2) acquire data on-demand at critical times, and 3) carry multiple sensors that can collect imagery outside of the human visible range.

This presentation will cover recent developments in small hyperspectral sensors on UAS. In 2013, the *TerraLuma* group was the first to integrate a pushbroom hyperspectral scanner on-board a multi-rotor UAS and flew it in Antarctica to quantify the biophysical and biochemical properties of Antarctic moss beds. This presentation will cover the UAS sensor design and integration challenges, the operational challenges, and the processing workflow for deriving high quality hyperspectral images and derivatives (such as chlorophyll content) from UAS hyperspectral imagery. We will present the results of mapping moss health of Antarctic moss beds at ultra-high resolution (5 cm pixel size). This presentation will also look at recent developments in hyperspectral sensor technology. We will present preliminary trials of a hyperspectral snapshot sensor that can capture 25 spectral bands in a single image. This sensor allows the production of hyperspectral 3D point clouds and allows acquisition of hyperspectral orthomosaics from a relatively small and light UAS. We will provide examples of this new sensor for mapping vegetation properties in native grasslands, alkaloid poppy crops, and vineyards.

Figure 1. HyperUAS system carrying a pushbroom hyperspectral sensor (top); moss health derived from 162 spectral bands in the VNIR spectral range for an Antarctic moss bed.

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