SMALLSAT HYPERSPECTRAL IMAGE QUALITY: THE CSIMBA MISSION

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Recently, very small hyperspectral instruments and missions are being developed and launched, able to collect full spectral images and demonstrate capabilities which until recently were only possible with much larger instruments and platforms. Initial results from such missions show that they manage to achieve some ambitious goals. Still, challenges like platform stability, data downlink limitations and lower image quality hinder the adoption of their data for many applications.

With the CSIMBA mission we focus on improving image quality to a level where it is sufficient to enable demanding applications relying on precise narrowband spectral information. The mission will use a 12U CubeSat platform, and operate from a 500km altitude to provides a 80 km swath and 20 m GSD. The CSIMBA instrument is based on a compact hyperspectral push-frame imager consisting of a 12Mpixel CMOS detector with thin film interference filters combined with a compact wide swath TMA telescope. It covers a 470nm to 900nm spectral range with 5nm spectral resolution. Additional imaging areas on the same chip allow to perform panchromatic acquisitions and combine those with hyperspectral ones.

The system is equipped with powerful read out electronics and onboard computing capabilities supporting advanced acquisition and processing. High frame rates support digital time delay integration (TDI) with up to 12 stages, which allows a major increase in SNR. To facilitate good exposure over heterogenous scenes, high dynamic range imaging has been implemented. To improve image quality for very low signals, e.g. when imaging water bodies, a dedicated mode using longer integration times and aiming at lower spatial resolution has also defined. Specialized modes explore the combined use of the panchromatic and hyperspectral imaging, where computational imaging techniques will be used to increase spatial detail.

We will present results of a detailed performance analysis of the instrument, based on an imaging model including the spectral characteristics of the imager, various noise sources and simulating different imaging modes. We apply this on a representative set of radiance spectra, created from typical reflectance spectra, and converted to TOA radiance using atmospheric modelling and realistic irradiance. Results for nominal hyperspectral imaging including 12TDI stages are shown in the figure below. The SNR shows a strong wavelength dependence on the wavelength, which impacts the suitability of the data for some applications depending on the importance of specific wavelengths.