DESIGN AND ANALYSIS OF THEIA: A MINIATURISED SCIENTIFIC-GRADE MULTISPECTRAL IMAGER

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Various studies have indicated that remote sensing applications in agriculture[1], land coverage change monitoring[2] and vegetation phenology[3] would benefit from higher temporal frequency radiometrically accurate imaging. Hence, we are designing the radiometrically calibrated scientific-grade miniaturised multispectral Earth Observation Imager (EOI) Theia. Usually, when nanosatellites fly cameras, they are only meant for aesthetic images without considering the radiometric quality of the data. With Theia, we are developing an EOI with a 5% radiometric accuracy throughout its three year lifetime. Moreover, multiple Theias observing the same region from various points of view could give remote sensing scientists data on the angular distribution of a target's reflectance.

The radiometric accuracy is achieved via system- and component-level characterisation and pre-and post-launch calibration. The imager uses an on-board calibration module for post-launch calibration that makes capturing dark and flat frames possible. The calibration module consists of a diffuser and an aluminium shutter that can be moved in front of the optical path. The EOI separates two spectral bands using a dichroic mirror, bandpass filters and two sCMOS sensors. Straylight is suppressed with three baffles inside the imager and a black coating.

Furthermore, this is accomplished while fitting inside 1U, complying with the CubeSat standard, and weighing less than 600 g. The prototype imager has been designed to capture frames in the red and near-infrared spectrum to calculate the Normalised Difference Vegetation Index. The imager is meant as a companion piece to larger remote sensing satellites, such as Sentinel-2. Theia's design is now complete, assembly and testing are in progress, and the launch is planned for 2022 on-board the 12U GOMX-5 CubeSat. The imager is designed in cooperation with the European Space Agency.

References

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