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THE HYPSO RGB CAMERAS AND RGB-HYPERSPECTRAL SUPER-RESOLUTION

Abstract

The HYPSO-1 (HYPerspetral Smallsat for Ocean observation) 6U CubeSat, which was launched in January 2022, houses two imaging payloads which are mostly made of cost-effective Commercial-off-the-Shelf (COTS) components. The satellite includes a COTS onboard processing unit (OPU) with field programmable gate array (FPGA) for camera control and data processing. The main imaging payload is a push-broom hyperspectral camera designed for ocean color remote sensing, and the secondary payload is a snapshot Red-Green-Blue (RGB) camera to aid in georeferencing of the hyperspectral data. The images from the HYPSO-1 RGB camera suffer from optical issues that heavily degrade image quality due to errors made during the instrument design and testing phases. The aim of this work is to redesign the HYPSO-1 RGB camera for the successor CubeSat HYPSO-2 to enable the use of RGB-hyperspectral super-resolution methods.

We present the cause of the image quality issues of the HYPSO-1 RGB camera and the process from design to application of a high spatial resolution RGB snapshot camera for HYPSO-2. More specifically, this work includes 1) Optical design of the RGB camera with a trade-off between motion blur and light throughput 2) changes to on-board camera control software to integrate the new camera into the operation of HYPSO-2, 3) imaging scheduling methods to align the coverage of the RGB and hyperspectral cameras for HYPSO-2, while considering their differing instantaneous field of views, and 4) a hyperspectral super-resolution pre-study applied to HYPSO-2 images.

The optical redesign of the RGB camera achieves 26m Ground Sampling Distance (GSD) at nadir from a 500 km altitude, which is 2.5 times smaller than the GSD of the hyperspectral camera. The performance of the optical redesign is verified by ground tests and on-orbit imagery. New timelapse and timed image sequence camera control modes were implemented to align RGB and hyperspectral coverage. The super-resolution pre-study shows improves the resolution of the hyperspectral data.