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DUAL-APERTURE DESIGN FOR MULTISPECTRAL EARTH OBSERVATION PAYLOAD FROM A NANOSATELLITE

Abstract

Iris is an open-source, dual-aperture payload capable of visible-near infrared and short-wave infrared push broom imaging being developed to demonstrate multi-spectral Earth observation from CubeSats. In particular, Iris is capable of generating spectral data pertinent for wildfire science and wildfire risk analysis from space. This payload is scheduled to fly on board Ex-Alta 2, the University of Alberta's second 3U CubeSat and Alberta's contribution to the Canadian Space Agency funded Canadian CubeSat Project. Deployment from the International Space Station is expected in 2022. The complete dual-aperture imaging system comprises two filtered optical lightpaths, two image sensors, support structure, and a supporting electronics and firmware suite, all designed to be modular to integrate within a compact 10 cm cube (1U) chassis at an accessible price point. This makes Iris unique in capability and in potential for advancing open-source Earth observation technology from a nanosatellite platform.

Iris is capable of gathering spectral data at center wavelengths of 865, 490, and 665 nm through one aperture and at a center wavelength of 2100 nm through the other. The bifurcation of the visible-near infrared and short-wave infrared lightpaths was done to increase performance for each system while simultaneously achieving significant cost reduction. Across all bands, design simulations suggest a signal-to-noise ratio of greater than 20 dB, with a spatial resolution of 200 m or better averaged across the field-of-view. This expected performance is comparable to that of other known missions of similar scope, even though Iris performs under much more prohibitive volume constraints. Each optical element is mounted inside a compact aluminum structure, which is outfitted with adjustment mechanisms for fine tune alignment post assembly.

Iris has a custom electronics and firmware suite designed to drive and manage two custom-filtered sensors on a single printed circuit board. The sensors are strategically oriented and integrated alongside an Intel Cyclone V system-on-chip field-programmable gate array, on-board memory, and other supporting electronics such that a secure interface with dual-aperture optical housing can be facilitated and spatially correlated images can be taken. A heuristic image ranking algorithm prioritizes images for downlink alongside data compression functionality, serving to increase scientific value per ground station link time for both sensors.

A full protoflight model of Iris is being manufactured and tested in Summer 2021, followed by comprehensive analysis and performance characterization to verify requirements. Results from the tests and the final design will be presented.