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High Speed VNIR/SWIR Hyperspectral Imager for Quantifying Terrestrial Ecosystems

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Physical Sciences Inc. (PSI) is developing a high-speed visible/near infrared, shortwave infrared (VNIR/SWIR) hyperspectral imaging (HSI) sensor for airborne, dynamic, spatially-resolved vegetation trait measurements to support advanced terrestrial modeling. This technology aligns with DoE's requirements for broad spectral range hyperspectroscopic instrumentation in a compact form factor suitable for deployment on a small, rotary wing unmanned aircraft system (UAS). The VNIR/SWIR-HSI sensor employs a digital micromirror device as an agile, programmable entrance slit into VNIR (500-1000 nm) and SWIR (1200-2500 nm) grating spectrometer channels, each with two-dimensional focal plane arrays. The sensor acquires 360 spectral bands over a 30º field of view (FOV) in 2.5 s. The architecture enables staring mode hyperspectral imaging and does not require constant aircraft motion to acquire the data cube, making it compatible with a hovering, rotary wing UAS. The data product is a stream of high quality, calibrated, orthorectified spectral reflectivity cubes which are stitched together for subsequent analysis over a wide area. The capability includes spectral matching algorithms based on a linear discriminant analysis for vegetation species mapping.

The design and build of the VNIR/SWIR HSI sensor is presented with emphasis on laboratory and rooftop/tower testing of local vegetation. Performance including spectral resolution and accuracy across the full spectral range and noise equivalent reflectivity across the FOV is reported. The 14.5 lb sensor package is presently being integrated to a Free Fly Alta8 UAS for flight testing, the preliminary results from which are included. Future upgrade plans are discussed.