System Integration and Performance Validation of a Heavy-Lift UAV SWIR Hyperspectral Platform for Live Fuel Moisture Mapping

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Vegetation live fuel moisture content (FMC) is an important parameter to study wildfire risk and fire spread. Hyperspectral sensors have been used for studying FMC as they record detailed spectral features (e.g. water absorption bands near 970, 1200, 1450 nm) that correlate with plant water content. Use of hyperspectral satellite imagery has been widely practiced to study different soil and vegetation parameters. However, UAVs now provide better advantage of high-spatial resolution, but their data reliability remain insufficiently validated.

This study uses shortwave infrared (SWIR) hyperspectral camera: Resonon's Pika IR-L, with spectral range of 925-1700 nm. Freefly's ALTA X UAV (NDAA-Compliant drone) with its ActiveBlade propellers to reduce vibration makes an ideal carrier for mounting the Pika IR-L for hyperspectral surveys. This work focuses on the novelty of this hyperspectral sensor integration with the ALTA X UAV platform and rigorous validation of the platform stability and data reliability.

The methodology will largely focus on sensor integration, radiometric and inertial calibration and synchronized field data collection. IMU and GNSS flight logs will be analyzed to quantify the platform stability, also studying roll, pitch, yaw and vibration effects. After analyzing the flight stability and data quality, hyperspectral reflectance data will be processed to compute moisture-sensitive spectral indices, which are then compared with field-measured FMC using statistical metrics. If the index-based methods underperform, machine learning approaches will be explored to model the moisture content utilizing full spectral information.

ALTA X/Pika IR-L integration is expected to work as a robust platform for high-resolution SWIR remote sensing. The integration is anticipated to provide high-quality data with minimal vibration-induced distortion. This work contributes by shifting focus from empirical modeling alone to comprehensive system validation, addressing a critical gap in UAV-based hyperspectral research and introducing a novel UAV-sensor integration for future vegetation and wildfire studies.