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Robotic Hyperspectral BRDF Measurement System Improvement, Field Measurement and Data Analysis

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Background

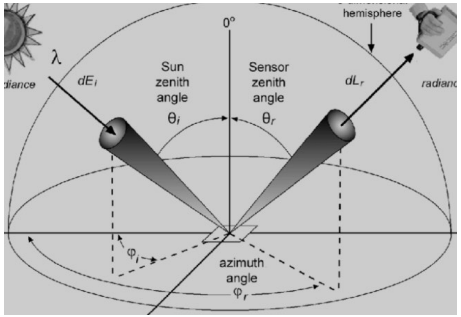
- BRDF is a 4 dimensional function that defines how light is reflected off of a surface
- BRDF retrieval from earth is crucial for calibration and validation of low Earth orbit (LEO) and geostationary (GEO) imaging sensors.
- Ground campaigns to measure BRDFs often utilize traditional systems
- Recently developed portable RHG-BRDF system strives to make BRDF retrieval more efficient

Conventional system

RHG-BRDF measurement system

Objectives

- Set up and calibrate Robotic Hyperspectral Ground BRDF(RHG-BRDF) measurement system
- Perform field measurements of different surfaces using Robotic Hyperspectral Ground BRDF measurement system
- Analyze data and identify sources of error



RHG-BRDF system description and measurement procedure

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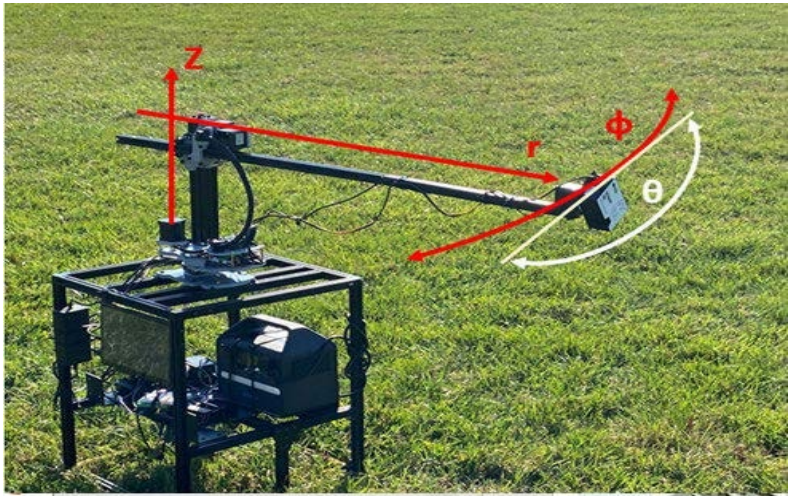
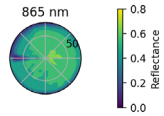
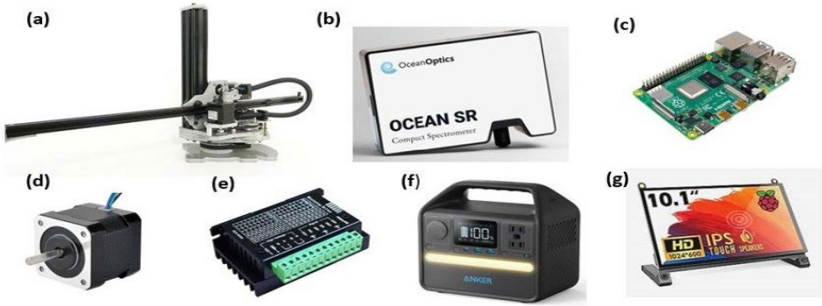


Calibrate system with solar diffuser before measuring reflectance samples → Initiate automated measuring of target surface. Measures surface at 36 azimuth and 17 scan angles. → Retrieve the BRDF values at different wavelengths for each surface



- 4 dimensional system:
- 3 axis robotic arm height(z-axis), radial axis or length(x-axis) plus rotatable spectrometer attached to radial axis.
- Spectrometer: Ocean Insight Hyperspectral spectrometer, capable of collecting light intensity along wavelengths from 343 to 1055 nanometers.
- System is powered by motor and portable battery. Automated by python script



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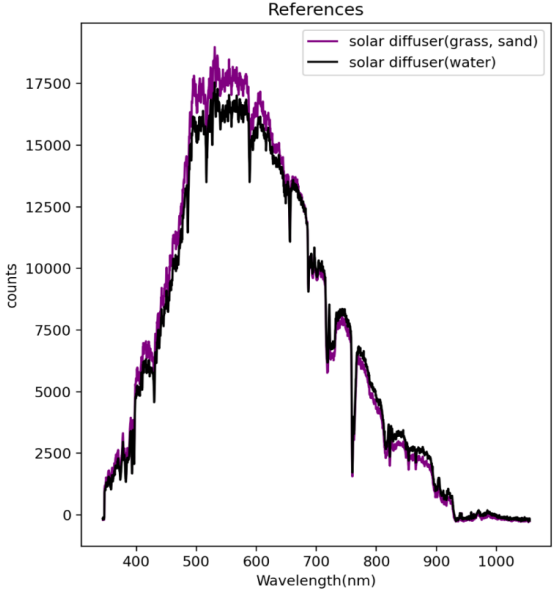
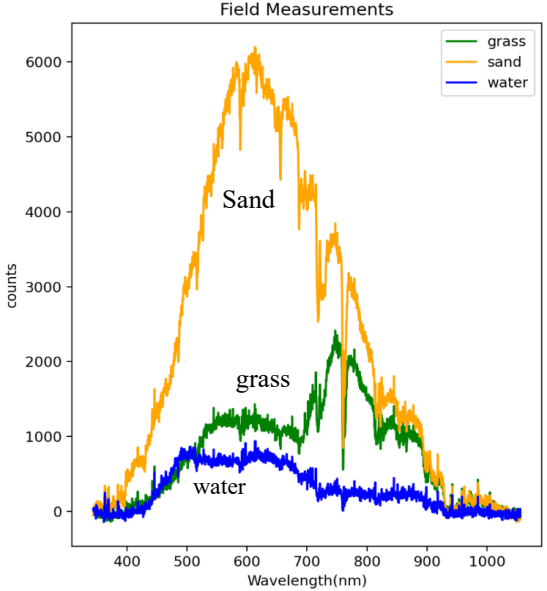
Field Data collection of three surfaces using RHG-BRDF measurement system





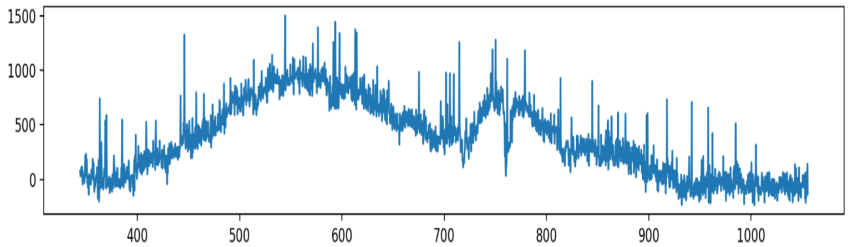
Raw measurements from the RHG-BRDF System

Grass sand water

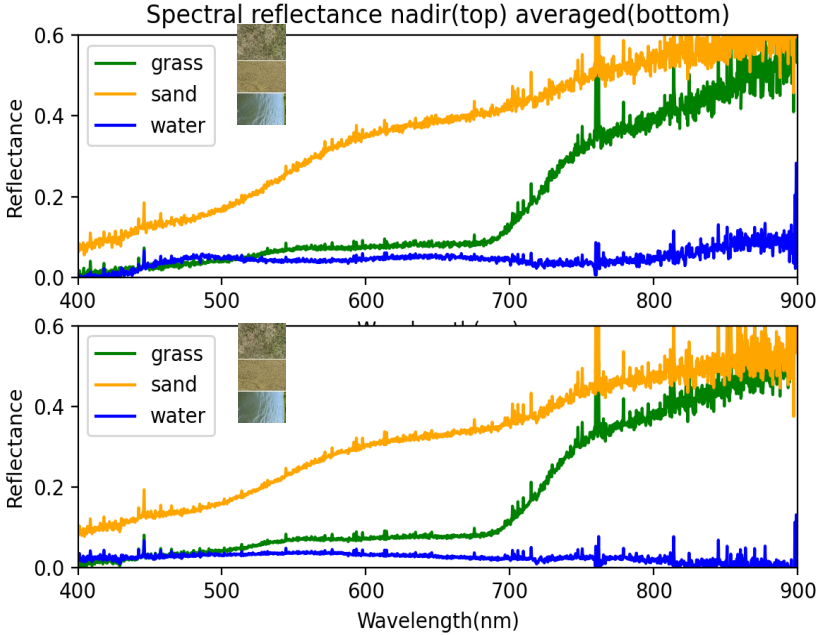
Target surfaces measured: Partially yellow grass, sand from baseball pitch and lake water.

Calculation of reflectance from measurement data

$$\text{Reflected} = \frac{\text{Sample - background}}{\text{Reference -background}}$$



Background intensity from dark measurement



Spectral reflectance of grass, sand and water at nadir position(scanner pointing at ground) (Top), and averaged over all angles measured (bottom)

Analysis of reflectance values across all angles measured at VIIRS M1-M7 bands

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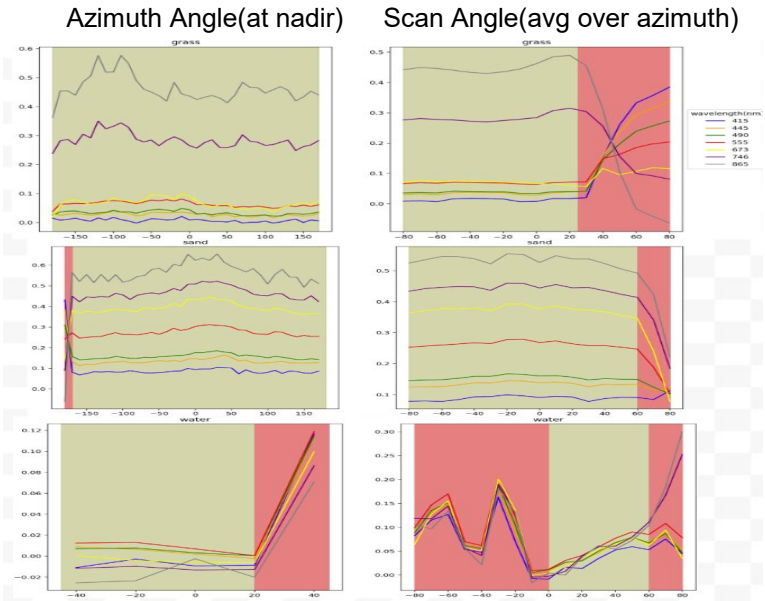
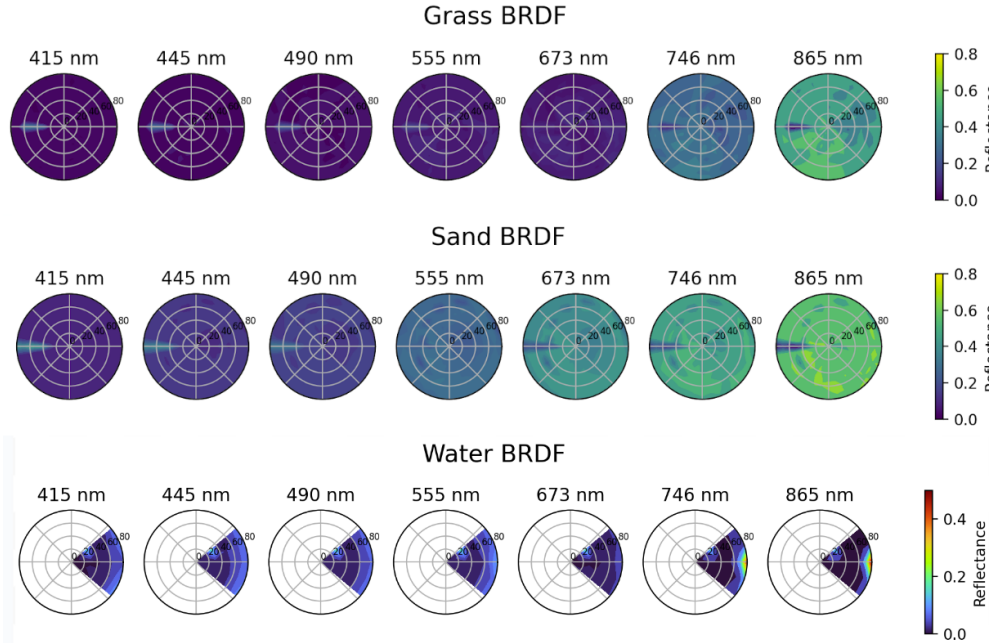


Reflectance vs Angular dependencies for grass(top), sand(middle), and water(bottom) at azimuth and zenith angles. Red areas indicate inaccurate measurements



Derived BRDFs for grass, sand and water at VIIRS M1-M7 bands. Azimuth angles for grass and sand are complete while water is measured from -40 to 40 degrees. Zenith scans are from 0 to 80 for simplicity.