Aerial Hyperspectral Data: 360 Spectral Bands of Visualization
Electromagnetic Radiation: The Big Picture

Electro Optical Spectrum (E-O Spectrum)

Shorter Wavelengths
- Gamma Rays: .003nm
- Visible Light: .5 μm
- Infrared: 3 μm

Longer Wavelengths
- Microwaves: 3 cm

Reflective: Solids / Liquids
Emissive: Gases
What is Hyperspectral?

- Also known as Imaging Spectrometry.
- The acquisition of images in hundreds of registered, contiguous spectral bands such that for each picture element of an image it is possible to derive a complete reflectance spectrum.
Other Forms of Remote Sensing

Typical Reflectance Curves

After Richards, 1993
White Pine Spectral Curve & Landsat Band Regions

- Leaf Pigments
- Cell Structure
- Water Content

- TM1 (Blue)
- TM2 (Green)
- TM3 (Red)
- Red Edge
- NIR1
- NIR 3
- Lignin
- Water Absorption
- TM5 (MIR)
- Water Absorption
- TM7 (MIR)
- Cellulose

Wavelength (nm)

% Reflectance

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The hyperspectral data cube has as \((x,y)\) coordinate the longitude and latitude on the ground of an image pixel, and as \(z\) coordinate the hyperspectrum at that particular \((x,y)\) location.
Hyperspectral Applications as a Visualization Tool:
- Fire Risk/Fuels Mapping
- Forest Heath
- Invasive Species Mapping
- Water Quality
- Crop Residue
- Geothermal Exploration

Rooftop classification in CA

A copper mine, waste pond and a variety of agriculture in Chile

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Visualizing the Data

Data Can Be Displayed in a Variety of Ways:

- Google Earth
- GIS Software (ArcGIS, QGIS)
- Image Software (ENVI, ERDAS)
- GPS (Trimble, Garmin)
- Plotted to Hardcopy Maps
- 3D Software
ProSpecTIR VS VNIR-SWIR Instrument

TYPICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th></th>
<th>VNIR 400-970 nm</th>
<th>SWIR 970-2500 nm</th>
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<tbody>
<tr>
<td>SPECTRAL RANGE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 400-2500 nm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPECTRAL RESOLUTION</td>
<td>VNIR 2.9 nm</td>
<td>SWIR 8.5 nm</td>
</tr>
<tr>
<td>(OPTICAL)</td>
<td></td>
<td></td>
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<tr>
<td>SPECTRAL CHANNELS</td>
<td>376 typical operation, 500 at highest resolution</td>
<td></td>
</tr>
<tr>
<td>SPECTRAL BINNING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONFIGURATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VNIR</td>
<td>1x</td>
<td>1x</td>
</tr>
<tr>
<td></td>
<td>2x</td>
<td>2x</td>
</tr>
<tr>
<td></td>
<td>4x</td>
<td>4x</td>
</tr>
<tr>
<td>SWIR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPECTRAL CHANNELS</td>
<td>244</td>
<td>254</td>
</tr>
<tr>
<td></td>
<td>122</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>63</td>
</tr>
<tr>
<td>SPECTRAL SAMPLING (nm)</td>
<td>2.3</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>4.6</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>9.2</td>
<td>23.2</td>
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TERRAIN COVERAGE & FIELDS OF VIEW

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>SPATIAL PIXELS</td>
<td>320</td>
</tr>
<tr>
<td>FOV</td>
<td>24 degrees</td>
</tr>
<tr>
<td>IFOV</td>
<td>1m GSD @ 2500’</td>
</tr>
<tr>
<td></td>
<td>0.075 degrees (1.3mrad)</td>
</tr>
<tr>
<td>SWATH</td>
<td>1km @ 7600’</td>
</tr>
<tr>
<td>0.43 x altitude</td>
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OPERATIONAL CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>VNIR</th>
<th>SI CCD 12 bits</th>
<th>SWIR</th>
<th>MCT 14 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAMERA A/D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SNR</td>
<td>500:1 typical, 750:1 peak</td>
<td>650:1 typical, 1100:1 peak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTEGRATION PERIODS</td>
<td>adjustable at each sensor for optimum exposure levels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMAGE RATE</td>
<td>Up to 100 images/s</td>
<td></td>
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MECHANICAL & POWER

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<tbody>
<tr>
<td>DIMENSIONS</td>
<td>25 x 19 x 16 inches (HWD)</td>
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<tr>
<td>WEIGHT</td>
<td>40kg sensor</td>
</tr>
<tr>
<td></td>
<td>25kg for flight computer, power supplies</td>
</tr>
<tr>
<td>POWER</td>
<td>Instrument - 200W OPERATIONAL, 500W AT COOLDOWN</td>
</tr>
<tr>
<td></td>
<td>Flight Operations Computer - 600W</td>
</tr>
</tbody>
</table>

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After the mission is planned an aircraft is selected and the sensor is installed. In the US, SpecTIR utilizes a Cessna 206 stationed near headquarters in Reno, NV or a Cessna 207 or 310 located outside Philadelphia, PA for work in the Eastern US. We also work closely with a company in TX, which have several aircraft types.

Each mission is carefully planned to integrate the ProSpecTIR system as quickly as possible.
Creating a Flight Plan: A Visualization Tool

TopoFlight is a planning software for:
- DEM integration
- Flightline creation
- Maximizing coverage, while minimizing reflys
- Export to KMZ (Google Earth)
- Export to flight following software (TrackAir)
- Export of Excel to for flight-time management

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Creating flightlines in Topoflight:
- Flightline generation incorporates the topography of the region and the parameters set by the planner/sensor.
- Attributes such as: swathwidth, line length, flight height and flight azimuth can all be edited to fit your parameters.
- Shapefiles, DEMs, GeoTIFFs and other vector and raster data can be added to enhance the flight plan.
Once your flight plan is created, you have a better idea of the size and scope of the mission:

- Flight time
- How many lines the acquisition will require
- Transit time (if there is more than one AOI)
- Cost
- Efficiency
- Safety
By analyzing the hyperspectral data, we are able to generate mineral maps. In the case of Columbus Marsh, we used the mineral maps to guide a field campaign to conduct shallow temperature surveys for geothermal exploration.
These images represent both a vegetation stress layer and species identification, SpecTIR provided the Orange County Fire Authority of California. The stress layer present is based on the water content of the vegetation, where dark blue signifies higher water content and the yellow color represents the least water content in the canopy. In this instance, the lower the water content of the vegetation, the higher the risk of becoming wildfire fuel.

Species Identification
Chlorophyll Concentration
Hood Canal, Washington

Water Turbidity
Hood Canal, Washington

Photo courtesy of Len Subick
Mineral Mapping and Asbestos Detection

Asbestos Detection based on presence of Actinolite

Legend
- Chrysotile
- Actinolite
- Muscovite
- Montmorillonite
- Kaolinite

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Oil and gas exploration is executed by interpreting bare ground or vegetated areas. By analyzing vegetation stress and/or abrupt changes in vegetation species, analysts can identify anomalous plant communities tolerant to disturbed soils indicative of oil/gas seepage.
Questions?

Thank you for your time and feel free to contact us:

Kevin Rock
krock@spectir.com

Other Points of Contact:

• Conrad Wright, Chief Business Development Officer
  – Reno, NV; conrad@spectir.com

Other ground sampling techniques that can be utilized.

Evidence of Mountain Pine Beetle near Lake Tahoe

Emerald Ash Borer survey in NV

Mountain Pine Beetle trap in NV

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