Optech

measurement at the speed of light
Adding Hyperspectral Capability to CHARTS

SHOALS 1000 TH

Grady Tuell
Goals

- 3D Benthic Habitat Mapping

- Use of Spectrally-derived depths for densification and quality control

- Shoreline Delineation and Characterization

- Characterization of the water column
Tasks

• Procure an Imaging Spectrometer

• Integrate with SHOALS

• Develop Exploitation Capabilities
Ongoing Integrations of Optech and ITRES Technology

JALBTCX

EAUK

ICC

Naka Nihon

Acquater
**Data Collection**

Address different imaging modalities for each sensor

**Geometric**

Establish accurate projections between object space and image space for each sensor

**Electronic**

Synchronization to common navigation

**Data Exploitation**

Develop and implement information extraction algorithms in fusion paradigm

**Roadmap**
Electronic Integration

- **GPS (10^0 Hz)**
- **IMU (10^2 Hz)**
- **Spectrometer (10^2 Hz)**
- **Laser (~10^3 Hz)**
Data Collection
Address different imaging modalities for each sensor

Geometric
Establish accurate projections between object space and image space for each sensor

Electronic
synchronization to common navigation

Data Exploitation
Develop and implement information extraction algorithms in fusion paradigm
Geometric Integration

Calibration
Boresighting
DDIGR

\[[X_1, Y_1, Z_1, K_1, \Phi_1, \Omega_1]\]

\[[X_3, Y_3, Z_3, K_3, \Phi_3, \Omega_3]\]

\[[X_2, Y_2, Z_2, K_2, \Phi_2, \Omega_2]\]

\[X, Y, Z\]
Data Collection
Address different imaging modalities for each sensor

Geometric
Establish accurate projections between object space and image space for each sensor

Electronic
synchronization to common navigation

Data Exploitation
Develop and implement information extraction algorithms in fusion paradigm
**Atmospheric correction**

**Depth correction**

\[
L_{\text{surface}} = L_{\text{bottom}} e^{-2k_\lambda d} + L_{\text{water}}
\]
Constrained Parameter Estimation

\[ L_{\lambda}^{\text{surface}} = (L_{\lambda}^{\text{bottom}} - L_{\lambda}^{\text{deep}}) e^{-2k_{\lambda}d} + L_{\lambda}^{\text{deep}} \]

\[ d_{\lambda} = -\frac{1}{2k_{\lambda}} \ln \left[ \frac{L_{\lambda}^{\text{surface}} - L_{\lambda}^{\text{deep}}}{L_{\lambda}^{\text{bottom}} - L_{\lambda}^{\text{deep}}} \right] \]
Exploitation

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<tr>
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<th>PIXEL</th>
<th>FEATURE</th>
<th>DECISION</th>
<th>INFORMATION</th>
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<tr>
<td>$L_\lambda$</td>
<td>$D, \rho$</td>
<td>$I_{xyzt}$</td>
<td>Classification</td>
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<td>Visualization</td>
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<td>Constrained algorithms</td>
<td>Pixel-by-pixel classification</td>
<td>Computation of spectral depths</td>
<td>Image Drapes, Sharpened Images (Brovey Transform)</td>
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Pseudoreflectance Image
Bathymetric Laser Equation

\[ P_r = \frac{(m)P_T \eta \rho F_P A_r \cos^2 \theta}{\pi (n_w H + D)^2} e^{-2n(s, \omega_0, \theta)kD \sec \phi} \]
Bottom Peak Signal

PMT Waveform

Photoelectrons/ns

Bottom Peak Signal
Ft. Lauderdale Results

Pseudoreflectance

Depth
Pseudoreflectance Draped on Depth
Pseudoreflectance Draped on Depth Model

- Un-colonized pavement
- Seagrass
- Sand
- Macro-algae
- Colonized pavement