Remote Environmental Intelligence at Areté Associates

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and the Environmental Intelligence Group

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Outline

• Areté Associates
• Phenomenology, Algorithms, and Software
• Core Competencies
• Imaging Sensor Systems
• Remote Hydrodynamic Characterization
  – Ocean, Rivers and Tidal Flats
• Data Products from Time-Series Imagery
  – Currents, Bathymetry and Sediment Transport
Areté Associates Facilities and Capabilities

### Longmont, CO
- Optical Systems Research
  - Laser Solutions

### Santa Rosa, CA
- ISR & Control Systems
  - Stabilization and control systems

### Northridge, CA
- Signal & Information Processing
  - Radar Signal Processing
  - ISR&T Image Processing
  - Discrimination Algorithms
  - High Fidelity Simulation
  - Biological Defense Solutions

### Tucson, AZ
- Optical Engineering
  - Streak Tube Imaging LIDAR (STIL)
  - Micro-photonics/MEMS
  - Optical Sensor Systems
  - Low Rate E/O Sensor Production
  - Infra-Red Countermeasures
  - UAV ISR systems

### Chantilly, VA
- Intelligence & Homeland Security Programs
  - Ground Station Processing Solutions

### Arlington, VA
- Sensor Applications
  - Physical Oceanography
  - Marine Sensors
  - Field Experiments
  - EO/Radar/LIDAR Remote Sensing
- National Security Assessments
  - Ground Processing Systems
  - Strategic War Gaming

### Niceville, FL
- Multispectral Data Exploitation
  - Ground Processing Systems
Phenomenology, Algorithms & Software

- Physics and Math-based studies and modeling
- Exploitation of our understanding to derive methods for extracting useful information or detection
- Implementation of algorithms in product form providing important technology solutions and support
Core Competencies

• Current and Bathymetry Extraction
  • Littoral environmental characteristics such as currents and depths are determined from time series of visible or infra-red imagery.

• Recent program efforts include:
  • RiverEye
  • Tactical Littoral Sensing
  • Tactical UAV (T-UAV)
Core Competencies

- Sensor Physics
  - Ocean, sky, cloud, and plume simulation
  - Simulated water scenes in movies (AES)
    - Titanic
    - Waterworld

Areté Environmental Software
Core Competencies

• Intelligence, Surveillance, Reconnaissance (ISR) Algorithm Suite
  • Automated high fidelity geo-registration, mapping, 3D scene reconstruction, and moving target indication
  • Allows for data products at a known GPS location

Skagit Bay, WA
Imaging Sensor Systems

Airborne Remote Optical Spotlight System-MultiSpectral Polarimeter

AROSS-MSP

3 polarizations

150°
30°
90°

NIR  R  G  B
4 colors

Twin Otter

AROSS-LF & AROSS-IR

Azimuth motor
Elevation motor
LF camera window
IR camera window

3-camera sensor module

NIR
Red
Green
Blue

90°
30°
150°

0  5  10  15  20  25
Percent (%)

350  550  750  950
Wavelength (nm)

AROSS-LF & AROSS-IR
Current Estimation Using Time-Series Imagery

- Two distinct signatures can be used to estimate surface currents using optical imagery of rivers and estuaries
  - Advection of sediment/turbulence features
  - Doppler shift of surface gravity wave dispersion surface
Theoretical 3-D Spectral Model

\[ \omega = \left[ g \kappa \tanh(\kappa h) \right]^{1/2} + \kappa \cdot U \]

Original retrieval algorithm for \( h \) and \( U \) is based on fitting this wave dispersion surface to the 3-D spectrum.
Advective Current Retrieval

Our advective retrieval algorithm for $U$ is based on fitting a planar surface to this feature in the 3-D spectrum...thus a 2nd means to estimate the surface currents (when waves absent)
Example Currents for Oregon Inlet

- ebb
  - Jet-ski ADCP, 1.5 m depth bin
- flood
  - Bottom ADCP, 1.1 m depth bin
Example for Haverstraw Bay
Accuracy of Current Retrievals

300+ data points with *in situ* ADCP “truth”

Cumulative Distribution Function

93% ≤ 20 cm/s

65% ≤ 10 cm/s

Probability Distribution Function
Example for Cape Fear River

Current Vectors on Image

Nautical Chart Overlay

~ 2 km
Data Collections at Cape Fear

- 30 frame average to remove surface wave signature
- Foam streak separating two water masses visible during Flood tides
- Evidence of an axial front which forms only during Flood tides

[Image of Cape Fear with labeled Axial Front, Salt Water, and Fresh Water]
ADCP Transect Line

ADCP Stream Velocity: 11/05/09 "FOAM STREAKS"

- Surface
- 4.3m Depth

Surface foam line
Subsurface jet
The goal of the Office of Naval Research Tidal Flat Dynamics Departmental Research Initiative (DRI) is to develop an understanding of, and ability to predict, the morphologic and sedimentologic evolution of tidal flats in high-tide-range settings.
Skagit Bay Tidal Flat at Low Tide

- Top of tidal flats showing river channels and exposed bottom
- Multispectral Polarimetric imagery provides measure of water content and sediment transport
Skagit Bay Tidal Flat at High Tide

AROSS-MSP Imagery

- Foam streak and sediment boundary at tidal front
- Color channels give estimate of depth of sediment in the water column, with filamentary structures absorbing in NIR
Summary

• AROSS Imaging Sensor Systems provide time-series imagery to investigate Phenomenology and Algorithms with large area coverage and multispectral polarimetric capabilities

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Areté Summer Internship Program

Areté Associates, an employee owned company (ESOP), is an advanced science and engineering company contributing to national security objectives. We are a nationally recognized R&D firm known for quality and innovative solutions, specializing in remote sensing applications including electro-optics and radar. Areté seeks individuals to perform challenging technical work in the areas of sensor design and analysis, phenomenology, detection algorithms, atmospherics, oceanography, and related software development.

We are currently seeking outstanding applicants for our Summer Internship Program in our Arlington, VA office.

Ideal candidates will have the following qualifications:
Junior, senior, first or second year graduate student
Major in physics, math, engineering, computer science, or related field
Programming experience preferred in C, C++, IDL, Matlab, or Fortran

10 week paid internship program: June 6 – August 12, 2011 / 40 hour workweek

Work in areas of remote sensing, signal processing, physics-based modeling, and data analysis

Application deadline: February 15, 2011

Applications accepted online - www.arete.com - U.S. Citizenship Required
An application consists of a resume, an unofficial transcript, and a completed application form.

Points of contact:
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U.S. citizenship, drug test, & security interview required to meet position eligibility
Environmental Intelligence Field Team

- Team of talented scientists, engineers, flight operators, analysts, ground crew and system specialists