Nereid Under Ice (NUI)

Overview

The Deep Submergence Laboratory at the Woods Hole Oceanographic Institution along with colleagues at Johns Hopkins University and the University of New Hampshire, and supported primarily by a grant from the National Science Foundation, has developed a robotic underwater vehicle that provides the Polar Research Community with a capability to tele-operate, under direct real-time human supervision, a remotely-controlled inspection and survey vehicle, under ice, and unconstrained by the motions of a support vessel. The Nereid Under-Ice (NUI) vehicle enables exploration and detailed examination of biological and physical ice-margin and under-ice environments through the use of high-definition video in addition to a range of acoustic, chemical, and biological sensors tailored to suit the needs of an individual expedition. The goal of the NUI system is to provide scientific access to under-ice and ice-margin environments that is presently impractical or infeasible.

In July 2014, NUI successfully completed it's first under-ice field expedition from aboard the Alfred Wegener Institute's ice-breaker Polarstern. In addition to conducting engineering trials, the vehicle was equipped with various biological sensors for studying near-ice primary productivity (a comprehensive pumped fluorometry system (SUNA nitrate, Eco Triplet FL/BB/CDOM, SBE25+ CTD, FRRF, PAR), hyperspectral radiance and irradiance sensors (RAMSES ACC, ARC), upward-looking still camera and and Imagenex DT100 multibeam, in addition to a Wetlabs Eco doublet Chl/NTU and SBE49 FastCAT CTD, and upward and downward looking RDI 300 kHz ADCP/DVLs. Additional information about the expedition can be found here: http://www.marum.de/en/ARK-XXVIII3.html.

We welcome input from the Polar Science Community on how best to serve your scientific objectives.

Contact: Michael Jakuba, mjakuba@whoi.edu

Project Team

Principal Investigators: Andrew D. Bowen¹, Dana R. Yoerger¹, Christopher German¹, James C. Kinsey¹, Louis L. Whitcomb¹,² Larry Mayer³

Engineering Team: Michael V. Jakuba¹ (lead), Christopher L. Taylor¹ (electrical systems lead), Daniel Gomez-Ibanez¹ (power systems and telemetry lead), Casey Machado¹ (mechanical systems lead), Glenn MacDonald¹ (LARS lead), Stefano Suman¹ (software lead), Andrew Billings¹ (thrusters lead), Keenan Ball¹ (acoustic systems lead), Christopher McFarland² (navigation), and many others.

¹Woods Hole Oceanographic Institution
²Laboratory for Computational Sensing and Dynamics, Johns Hopkins University
³Center for Coastal and Ocean Mapping, University of New Hampshire
Capabilities

- Real-time exploration under direct human control far from influence of host ice breaker
- HD video and real-time visualization of mapping and survey data products
- Respond to features of interest by altering sensing modality and trajectory as desired
- Vertical mobility – access to pressure-ridges, melt-pools, crevasses, general close inspection and mapping.
- Land against underside of ice or on seafloor
- Precision access to under-ice boundary layer
- Access beneath glacial ice tongues and shelves
- Future manipulation, sample retrieval, and instrument emplacement capability

Capabilities cross-comparison with other scientific systems targeted for the under-ice environment. *Nereid Under-Ice* extends the range over which ROV-like inspection and real-time telepresence is possible relative to conventional ROV systems. (*denotes systems under development as of 2013*).

Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Range</th>
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<tbody>
<tr>
<td><strong>Range</strong></td>
<td>40 km @ 1 m/sec plus 20 km reserve (preliminary). Maximum speed in excess of 1.3 m/s. Closed-loop control of heading, depth, ice-relative and geo-referenced position (within 150 m of ice and seafloor, respectively)</td>
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<tr>
<td><strong>Air Weight</strong></td>
<td>1800-2000 kg depending on configuration.</td>
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<tr>
<td><strong>Depth Rating</strong></td>
<td>2000 m</td>
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<tr>
<td><strong>Battery</strong></td>
<td>18 kWhr lithium-ion</td>
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### Time

On board precision atomic clock synchronized to GPS, 1 ppb drift rate/year.

### Navigation

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<tr>
<th>Inertial</th>
<th>Parascientific Nano-Resolution pressure sensor; SBE 49 FastCAT back-up</th>
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### Acoustic

| up/down 300 kHz ADCP/DVLs; Blueview P900 imaging sonar for obstacle avoidance, One-way travel-time acoustic navigational aiding at 10 Hz, 3.5 kHz. |

### Communication

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<tr>
<th>Tether</th>
<th>Fiber-optic communications-only Gb Ethernet, 20 km</th>
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| Acoustic | LF (3.5 kHz) 20-300 bps for ship to vehicle (20 km range); HF (10 kHz) 300 bs, ship-to-vehicle (1-5 km range), vehicle to sensor; vehicle to vehicle |

### Imaging

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<tr>
<th>Acoustic</th>
<th>TBD. Fieldwork in July 2014 will employ an Imagenex DT100.</th>
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| Optical | Real-time color HD-SDI video on internal pan/tilt/zoom (Kongsberg OE12-522); LED lighting (8 DSPL Sphere, dimmable), 3 channels SD, encoded on board. |

### Chemical/Physical Sensors (permanent)

| Seabird FastCAT-49 pumped CTD |

### Biological Sensors (permanent)

| WetLabs FLNTURTID Chl/backscatter fluorometer (0-30 ug/l, 0-10 NTU) |

### Auxiliary payload allowance (bow/spine):

| Native support for 10 auxiliary sensors. ~100 kg wet weight, 500 Whr Energy, 1000 W total (6 high-power channels with Gb Ethernet and/or RS-232, 100 W per channel, 6 low-power channels 3-15 W per channel, RS-232). 4 hardware trigger lines. All channels logged on board and delivered in real-time topside. Other communications protocols on request. |

### Auxiliary payload allowance: spine (upward-looking, protected)

| 240 mm x 450 mm x 500 mm (width, length, depth) |

### Auxiliary payload allowance: nose/chin (forward/down-looking, protected)

| ~0.8 m³ total available volume, reconfigurable. |

### Publications (reverse chronological order)


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