Autonomous Underwater Vehicle for Mapping and Sensing the Continental Margin

The National Undersea Research Center at the University of North Carolina at Wilmington (NURC/UNCW) is currently preparing to enter into partnerships to acquire and operate an Autonomous Underwater Vehicle (AUV) for scientific research. An AUV is an untethered, undersea robot. Power, intelligence and sensing/sampling sub-systems are self-contained. This is achieved through software control and communication from the AUV to the survey vessel via an acoustic link.

Rise of AUVs in Ocean Applications

ROV and AUV development and business are growing, driven by prospects in industry sectors, ranging from offshore oil and gas production to submarine cables and ocean minerals. The total commercial subsea industry market will have an annual value exceeding $20 billion in 2003. The largest sector is subsea oil and gas production. Following the oil price recovery, The World Subsea Report forecasts that ROV/AUV sales of equipment and services to the subsea oil and gas production market will double from their 1998 levels to nearly $12 billion in 2003, giving a total market of $44 billion over the five-year period. The next decade will see AUVs entering commercial operations in five major applications: seabed survey, oceanographic data gathering, pipeline touchdown monitoring, floating production system support operations (the hybrid AUV/ROV), and military applications (fn 1).

The AUV is an autonomous underwater sensor carrier that takes high-resolution sensors down to where they belong-- just above the seabed. AUVs use on-board artificial intelligence to complete survey tasks with little or no human supervision. AUVs excel at providing high-resolution acoustic images ideal for search and identification surveys, underwater surveillance, marine construction applications, bathymetric survey, and *fisheries research*. Groundbreaking technology in inertial navigation, fuel cells and electronics miniaturization allow a large portion of an AUVs internal volume and power to be available for mission sensors, and an effective and efficient tool for seamless seafloor coverage. Operators can easily reconfigure software to meet the needs of a wide range of missions. Sophisticated acoustic modems provide reliable two-way digital communication for real-time quality control of the sensor data.

Since AUVs are tetherless, they have economic benefits for mapping, compared to towed/tethered systems. The elimination of survey line-turns makes a deepwater AUV operation four times more efficient than a towed system. More importantly, data quality is improved because an AUV can follow the bottom, provide higher resolution, and less data "holidays" (gaps) that result from changes in topography. The small size of AUVs and also results in cost savings by providing faster surveys (e.g., no run-in and run-out, high deep-water cruising speed, turning radius of meters versus kilometers for towed systems), and lower deployment costs (fly-away capability from vessels of opportunity).

NURP AUV

In 2002-03, NOAA's National Undersea Research Program will support a grant to the University of Mississippi and University of Southern Mississippi for establishment of a National Institute of Undersea Science and Technology (NIUST). NIUST's proposal to NOAA, now being reviewed, includes $750,000 to purchase a 3000 m AUV. The NIUST principal investigator responsible for this NIUST objective, Dr. V. Asper, has asked

[1] Westwood, J. 2000. What the Future Holds for ROVs and AUVs. Underwater Magazine, May/June 2000. On-line at http://www.diveweb.com/uw/archives/arch/mayjune00.03.shtml.

NURC/UNCW to operate the vehicle. USM and NURC/UNCW will work with other partners, including NIUST, the Navy Hydrographic Office, other NURP regional centers and other NOAA programs, to select, equip and test an optimal AUV for deep continental margin (300-3000 m) mapping and sensing. These objectives will minimally require sensors for multi-beam bathymetry, side scan sonar, CTD (conductivity/ salinity, temperature, depth), and ports for additional optional sensors.

Commercial AUVs are now available with integrated side-scan sonar, sub-bottom profilers, synthetic aperture sonar, multi-beam echo-sounders, and CTD sensors. Specifications and capabilities of an available AUV include:

Survey Speed	3-4 Knots
Minimum Speed	1 Knot
Turn Radius	<10 meters
Maximum Design Depth	4800 meters
Maximum Operation Depth	3000 meters
Operational Cycle	24 hours
Survey Endurance	20 hours (at 3 Knots)
Recharge/Download	2 hours
Descent/Ascent (3000 meters)	1 / 1 hours
Primary Payload Sensors	Side Scan Sonar, Sub-Bottom Profiler, Swath Bathymetry
Primary Navigation Sensors	Inertial Navigation System
Secondary Navigation Sensors	USBL and LBL Acoustic
Battery Technology Upgrade Path	Silver Zinc /
Core at 3 Knots	200 W (Max)
Payload	135W (Min)
Power Module Replacement	1 hour (Max)
Power Module Recharge	30 hours (Max), Automated
Data Transfer	Acoustic Modem, RF Modem & Ethernet
Vehicle Data Storage (Min)	Space for 48 hours
Survey Data Storage Sensors	Integral to Payload
Mechanical Layout	Modular
Line Keeping	+/- 2 meters
Altitude Keeping, flat terrain	+/- 1 meter

Bluefin Robotics AUV deployed from vessel of oportunity

Partnership to Support AUV Operations

Currently, the cost of deep (>300 m) AUV technology makes it difficult for individual institutions to purchase, operate and maintain an accessible, well-equipped system. The NURP AUV will be owned by USM and its primary mission to will be to address NOAA mission objectives. The unit will be maintained and operated by NURC/UNCW. As presented in the NIUST proposal, at least two months in the first year will be dedicated to survey work in the Gulf of Mexico and in service to other NURP regional centers.

At this time we seek partners to help acquire and sustain AUV operations. The funds now set aside to purchase the vehicle are minimal for purchase of the desired system, however, final costs must be determined after a competitive bid process. Partners will have access to the unit at no lease cost (only direct costs for shipping and supplies). Users outside of the partnership may also have access through peer-reviewed proposals to the NURP regional centers, or via a reasonable day rate to be determined.

Other sources used in this summary include http://www.bluefinrobotics.com and http://www.kongsberg-simrad.com/