NATO OTAN

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Milestone in NURC's Collaborative Antisubmarine Warfare Programme

NURC's Collaborative Antisubmarine Warfare (CASW) programme conducted the GLINT/NGAS11 sea trial in the Gulf of Taranto in southern Italy from 31 August - 15 September. The purpose of the experiment was two-fold: the GLINT (Generic Littoral Interoperative Network Technology) objective was to demonstrate real-time detection and tracking of targets using autonomous underwater vehicles (AUVs). The NGAS (Next Generation Autonomous Systems) objective was to detect targets using fixed bottom sensors.

One of the OEX Explorer's being recovered by the NRV Alliance.

The GLINT/ NGAS11 trial represents an important milestone for the CASW programme at NURC: it is the first demonstration of active ASW using a multi-static network of underwater vehicles to successfully detect and track underwater targets. In addition to achieving the goals of the GLINT/NGAS11 trial, a large and valuable data set was also collected for post-trial analysis.

The GLINT/ NGAS11 experiments built on the successes of previous sea trials. GLINT enhancements for 2011 included new processing capabilities onboard the AUVs, which allowed fusion of narrow-band and broad-band contacts in NURC's Distributed Multi-Hypothesis Tracker and an improved communications suite, called NEMO, built around new low-frequency EvoLogics modems. The NGAS enhancements included signal processing algorithms and autonomous transmission of passive contact reports through a Seaweb underwater network.

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Solving the Endgame in Mine Countermeasures

A recent test by NURC demonstrated one of the final steps in getting robots to find, identify, and detonate an underwater mine. For the Autonomous Neutralisation Trial (ANT'11) held on Elba Island, 11 - 31 October, the goal was for an autonomous surface vehicle (ASV) to find a mine and then to guide a low-cost, expendable underwater vehicle close enough that it could detonate the mine.

This test was part of NURC's Autonomous Naval Mine Countermeasures programme. The mission is simple: find ways to keep navy personnel out of harm's way during mine neutralisation operations and dispose of the mines quickly and cost-effectively. Although the mission is simple, the challenge is scientifically complex with the solution building on years of acoustics research at the Centre.

The ASV carrying the underwater vehicle to its launch point.

The systems used in the test were based on commercial-off-the-shelf vehicles, helping keep costs down. NURC modified an ASV (4-metre catamaran from SeaRobotics) to include:

- A high-resolution, forward- or side-looking imaging sonar (BlueView P450/P900) on a pan and tilt unit that allows the sonar to keep an object in its field of view
- An onboard processing system that handles automatic real-time sonar imaging and tracking
- Robotics software to control the behaviours of the ASV based on its mission goals and environment

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Date Set for Student AUV Competition

The date for next year's Student Autonomous Underwater Vehicle Challenge Europe (SAUC-E) is set for 6 - 13 July 2012. As it has for the past two years, the event will take place in NURC's harbour, which offers students the challenges of operating their vehicles in a realistic undersea environment. Teams of students from universities all over Europe will compete using vehicles they design and build. Their AUVs will be tested in a series of predefined tasks. Teams are judged not only for their AUVs' ability to complete these tasks, but also for technical merit, craftsmanship, safety of design, and fund-raising efforts. For more information about the competition, visit www.sauc-europe.org.

Sponsor SAUC-E

Want to get college students excited about underwater technology and science?

Then join NURC, ONR GLOBAL and ONR U.S. in sponsoring this year's competition.

Visit www.sauc-europe.org or contact pao@nurc.nato.int

LIDAR Workshop

Light detection and ranging (LIDAR) systems have been used in the past to measure ice thickness, bathymetry of the oceans and atmospheric conditions. LIDAR has also been used in mine detection and has even been considered for underwater submarine communication. However, despite all of these applications, it has not been used to measure temperature and optical properties vertically in the water column. LIDAR systems can review data as deep as three to four optical depths, which means that optical properties can be measured through the thermocline for approximately 70 percent of the world's oceans.

With this untapped area of investigation, NURC, in conjunction with NRL-Stennis, hosted the LIDAR Observations of Optical and Physical Properties (LOOPP) Workshop. Held in La Spezia, Italy, 15 - 17 November, the LOOPP Workshop brought together international scientists to review past research efforts in using LIDARs to retrieve water column optical properties, to review current status of LIDAR systems and propose possible improvements, and to discuss the future of LIDAR research.
Participants discussed and selected platforms for providing a proof of concept and a schedule for transferring a system from one platform to the next (for example, ship-based to airborne to AUVs).

A follow-on meeting is planned by NRL-Stennis in spring 2012 in Washington D.C. to bring together a larger group of scientists, engineers, and application specialists.

NURC 2012 Program of Work Approved

The NURC Scientific Committee met 17 - 20 October to review progress on the 2011 programme of work and recommend the 2012 programme of work that has been proposed by the Centre. The programme of work specifies the projects that will be funded for the upcoming year and is the roadmap the Centre uses to keep research focused on NATO military needs.

The committee also took this opportunity to meet in joint session with the NATO Science and Technology Reform Implementation Team to discuss status of the reform and integration of NURC into NATO's new Science and Technology Organisation (STO), a transition which will occur 30 June 2012. Topics discussed included NURC's new mandate and charter, transition from Allied Command Transformation (ACT) to the new STO, options and strategies for the Centre's research ship (NRV *Alliance*), future funding models, and the transition of the programme of work from 2012 to 2013.

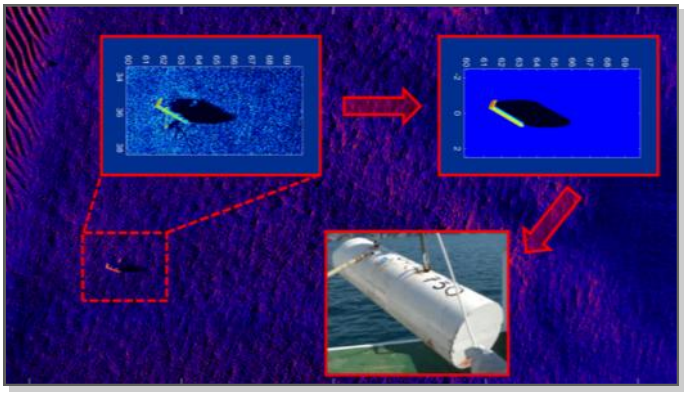
NURC Hosts First Automatic Target Recognition Workshop

High-resolution synthetic aperture sonar (SAS) systems are quickly becoming fundamental tools for modern mine hunting operations. The quality images of the seabed they produce can be analyzed to detect and classify mine-like objects. To ensure the security of naval resources, all mines need to be localized and classified accurately. At the same time, to avoid delays in the minefield clearance operations, harmless objects should not be misclassified as mines. To support human operators in this complex task, and to enable autonomous mine hunting operations, automatic target recognition (ATR) algorithms are currently being developed by NATO nations.

NURC held an ATR workshop 14 and 15 September to advance ATR research within NATO. Seven NATO nations (Belgium, Canada, Germany, Netherlands, Norway, UK and USA) were given a unique opportunity to work collaboratively and to test and combine their ATR algorithms in real-time on common data sets. This was the first multi-national workshop of this type.

Prior to the workshop, NURC had prepared state-of-the-art high-resolution synthetic aperture sonar data collected during previous sea trials. These data were made available to all participants.

The participants first installed and tested their software. This phase enabled demonstrations of the various automated detection and classification algorithms developed at NURC and within the NATO nations. Image processing techniques designed to improve sonar data before detection and classification (such as speckle noise reduction and sand ripple suppression) were also demonstrated. During a second phase, these various algorithms were combined to obtain an initial comparison of ATR algorithm performance on a common data set.



An example of ATR processing: Using high resolution sonar imagery, an unknown object is detected on the sea floor, automatically compared to templates of known mine shapes, and classified as a cylindrical mine shape.

"The ATR workshop was an outstanding event. I loved being able to discuss approaches and algorithms with other participants and to compare results obtained, over a two day period, on a challenging, realistic data set. This workshop should definitely be continued in the future!"

Dr. John A. Fawcett, Scientist, DRDC Atlantic, Canada

"The workshop on ATR … was a success. The participating nations demonstrated their ATR software and approaches on a common data set provided by NURC, something that gave valuable insight in the actual performance of the different ATR approaches."

Dr. Roy E. Hansen, Principal Scientist and AUV R&D Program Team Leader, FFI, Norway

"I found the ATR workshop on a common target data set extremely useful. I am integrating ideas shared at the workshop into improvements to ongoing projects."

Dr. John Dubberley, Research Physicist, Naval Research Laboratory, USA

By bringing international ATR practitioners together, the workshop created a unique opportunity for information exchange. At the end of the workshop, processed data were exchanged between the participating NATO nations demonstrating that the ATR workshop was a great platform to foster collaboration. Furthermore, through discussions between participants, it became clear that since the field of ATR is maturing rapidly, there is now a need for the creation of a standardized test bed to compare and evaluate the performance of ATR algorithms for mine warfare applications.

Given the positive feedback from the participants, NURC hopes to organise a second workshop in 2012 to enable ATR performance comparison and standardisation.

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CASW Milestone

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Both the NRV *Alliance* and CRV *Leonardo* took part in the experiment. The *Alliance* towed a sonar source and the CRV Leonardo towed an echo repeater that created an artificial target. A fixed transmitter—NURC's DEMUS—was also used. Each of the two Ocean Explorer (OEX) AUVs used in the experiment towed a receiving array developed by the Centre and carried a real-time signal processing suite, which was used to generate the clutter maps of the test site. The clutter maps showed the presence of high bottom clutter, caused by a fossil shoreline approximately 1 km from shore where the water depth was approximately 20 m.

In addition to a high clutter region, the test site was challenging because of the rapid drop-off of the bathymetry and the proximity of the shoreline. To help in planning, a high-resolution bathymetric survey of the site was conducted by NURC's Environmental Knowledge and Operational Effectiveness (EKOE) programme during the REP11A cruise prior to GLINT/NGAS11.

The following image is part of a screenshot of the real-time data that was being processed onboard the AUVs and then transmitted back to the *Alliance*. The image shows tracks of the target as it moves through the water.

The tracks "trk1_oex_groucho_1634" and "trk1_oex_harpo_276" are close to the known position of the CRV Leonardo, which is moving toward "ER end".

This sea trial involved multinational collaboration, with participation by the Italian Navy; Defence Research and Development Canada; Technical Centre for Ships and Naval Weapons, Maritime Technology and Research (Germany); Norwegian Defense Research Establishment; Defence Science and Technology Laboratory (United Kingdom); Naval Post-Graduate School (United States); and Space and Naval Warfare Center–Pacific (United States).

Mine Countermeasures Endgame

(Continued from page 1)

- An acoustic modem for communication with the unmanned underwater vehicle
- Differential GPS, attitude sensors, compass, and yaw rate sensor
- Two electric trolling motors and a release mechanism for the underwater vehicle

A photo taken from the underwater vehicle shows the close proximity to the target.

For the underwater vehicle, NURC modified an ROV (Video RayPro 4) to include a pressure vessel with electronics that allowed for untethered operations, a WLAN, a GPS tracker, an acoustic modem, an acoustic command interface between vehicles, and control and navigation algorithms (provided by University of Zagreb).

The Elba test showed that the ASV could use its sonar system and onboard processing to find a previously located mine and then continuously communicate the precise location of the mine to the underwater vehicle, which manoeuvred into position. Continuous communication with the underwater vehicle is necessary because it eliminates the need for expensive positioning equipment onboard a vehicle that will be destroyed when the mine is detonated. The ASV was also able to adopt behaviours, such as circling the mine and staying a specific distance from the underwater vehicle or the mine, using its control software.

In addition to demonstrating collaboration between autonomous vehicles, this test might have been the first time that autonomous, real-time mine detection was successfully performed from an autonomous surface vehicle. Real-time detection of mines has great potential for use on AUVs, which is the next step in this project. Future plans also include making the control software more robust and integrating a three hydrophone acoustic tracking system onto the ASV. The hydrophones will serve as "ears" for the ASV, much like the current sonar system serves as its "eyes."