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March 2018

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Volume 61 Number 2

March 2018
Volume 61 • Number 2

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RBR


H2O Robotics

# Expanded Underwater Robotics Ready for Oil Spills

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**The unmanned vehicles fleet on "Clara Campoamor" vessel deck - 6 AUV; 1 USV, 1 UAV - in the June 2017 exercise in Cartagena.**

All Photos Courtesy: Javier Gilabert

# (e-URready4OS)

Tracking in-water oil spills before reaching the surface by using new emerging robotic technologies is bridging the gap between existing traditional technologies (modelling and satellites) as decision support system for decision makers. Underwater oil plumes can come from bottom leaks or from surface patches forming subsurface plumes as recently been demonstrated. The distributed intelligence of these devices across the spill combined with hydrodynamic modelling is able to build up a highly accurate and dynamic image of the spill. This cooperating multivehicle robotic technology will allow a cheap, flexible, expandable, precise and rapid decision support system, improving the capacity of responding to these events.

Expanded Underwater Robotics ready for Oil Spills (e-URready4OS) is a European Union co-funded project (Directorate General – European Civil Protection and Humanitarian Aid Operations, DG-ECHO) aimed to join forces to make available a fleet of autonomous underwater vehicles (AUVs), unmanned aerial vehicles (UAVs) and unmanned surface vehicles (USVs) with operational capability to intervene against oil spills using new cooperative multivehicle robotic technologies (http://www.upct.es/urready4os).

This project is a natural extension of the URready4OS previous project in which the concept of a cooperative multivehicle

**Two AUVs and one USV in their parking positions ready to start a mission.**

X8 UAV set to take off.

Five AUVs ready for deployment.

fleet of robotic assets for in water oil detection and monitoring was proved.

Transforming this concept in an operative tool requires the improvement of the already existing system, the expansion of the fleet with new assets and the transfer of know-how to oil spill responders. The main goals and expected results of this project are:

- Expand the already existing URready4OS fleet (from 5 to 12 assets) capable of detecting oil in water.
- Provide training to new teams joining the fleet by performing exercises.
- Improve the current system with new software developments comprising a specific version of Neptus.
- Increasing the capability of the open source freely available MEDSLIK-II model for tracking small scale spills.
- Transfer the know-how to Maritime Safety Agencies (MSA) through short theoretical and practical courses.

Eleven institutions, universities and MSAs, from eight EU countries constitute the partnership: Universidad Politécnica de Cartagena - UPCT (Coordinator); Oceanographic Center - University of Cyprus – OC-UC, Universidade do Porto - UP, University of Zagreb - UZ, Sociedad Española de Salvamento y Seguridad Marítima - SASEMAR, Irish Coast Guard - ICG, The Scottish Association for Marine Science - SAMS, Tallin University of Thechnology - TUT, Universitat de Girona - UG, Universitat de les Illes Balears – UIB and the Norwegian University of Science and Technology – NTNU.

The e-URready4OS system is a fleet of multiple assets with different capabilities and characteristics comprising AUVs (Autonomous Underwater Vehicles), USVs (Unmanned Surface Vehicles) and UAVs (Unmanned Aerial Vehicles) from six different manufacturers coordinated by an open source command and control software (NEPTUS).

The AUVs fleet incorporate three LAUVs, two IVER2, two Sparus and one Remus 600. The Light Autonomous Underwater Vehicle (LAUV) is manufactured by OceanScan MST (a spin-off company from the Underwater Systems and Technology Laboratory – LSTS - University of Porto, http://www.oceanscan-mst.com/) targeted at innovative standalone or networked operations for cost-effective oceanographic, hydrographic and security and surveillance surveys. Based on a modular design, the platform is built to be robust and reliable.


USV deployment with AUV in parking position.


Deployment of the Remus 600 to join the rest of the fleet - 5 AUVs and 1 USV - to begin an unmanned multi-vehicle collaborative mission.

The IVER2 AUV is a well known small man-portable AUV manufactured by Ocean Server Technology, Inc (http://www.ocean-server.com/). With a proven track record over thousands of missions, it is ideal for imaging and environmental surveys, including research, development, and OEM based applications. The IVER2 design allows to integrate new sensors and capabilities. Sparus II AUV is a multipurpose lightweight hovering vehicle with mission-specific payload area manufactured by IQUA (a spin-off company from the University of Girona, http://iquarobotics.com/). The payload area can be customized by the end-user and with an open software architecture, based on ROS, for mission programming. Remus is manufactures by Hydroid (https://www.km.kongsberg.com/hydroid), a wholly owned subsidiary of Kongsberg Maritime leading manufacturer of advanced, innovative Autonomous Underwater Vehicles and marine robots for deep sea survey and mapping worldwide.

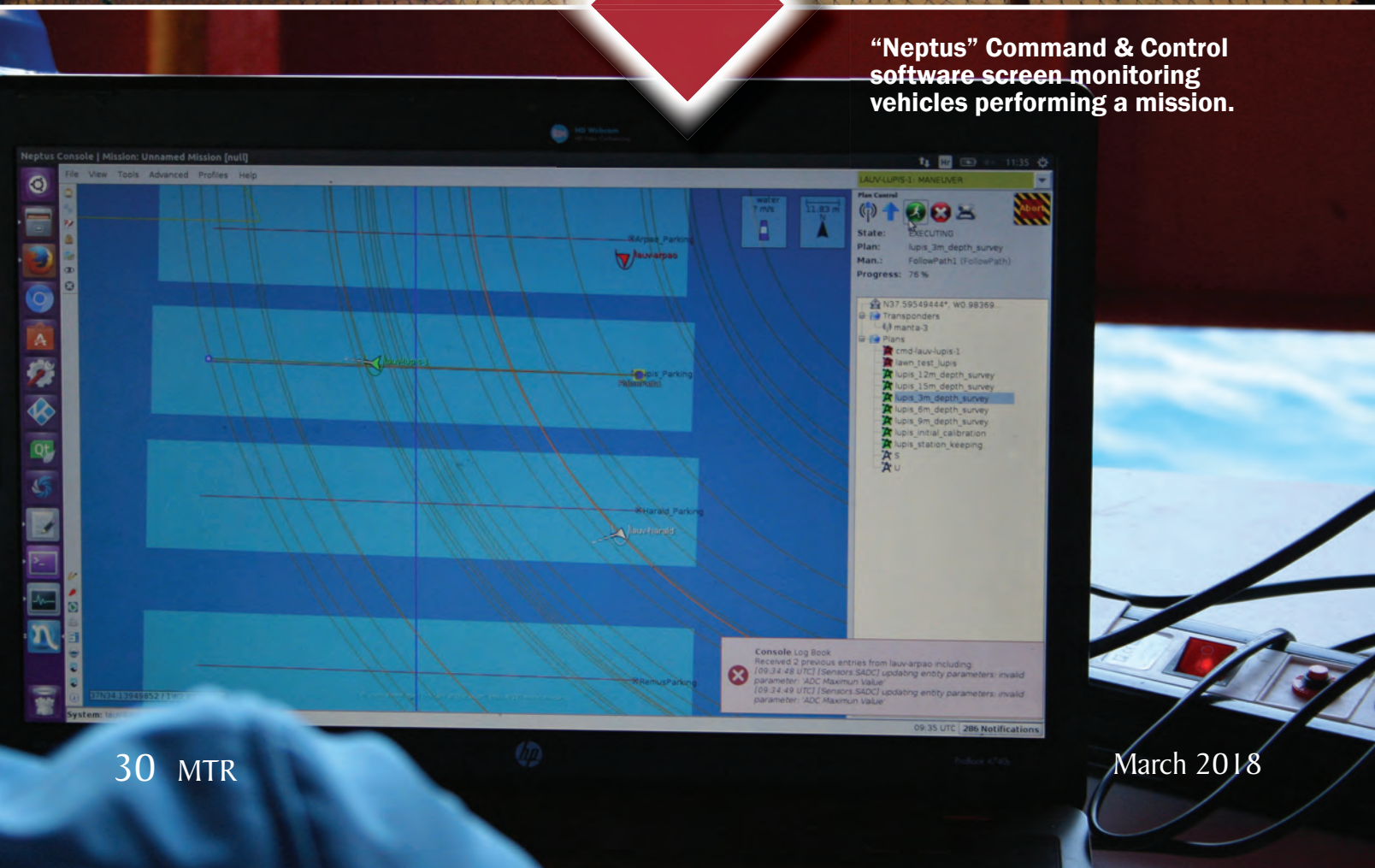
The surface component of the system is an Unmanned Surface Vehicle (USV), an autonomous overactuated surface platform (PlaDyPos) with 4 thrusters. This configuration enables motion in the horizontal plane under any orientation. The platform has been developed at the University of Zagreb Faculty of Electrical Engineering and Computing, Laboratory for Underwater Systems and Technologies (LABUST) for tracking of underwater objects communication router between the surface and the underwater navigation aid.

The air components are two SKYWALKER X8 (low-cost Components Off-The-Shelf) Unmanned Aerial Vehicle, modified at the LSTS, which allows for quickly deployable surveillance missions. It's a hand launchable vehicle perfected for low altitude reconnaissance scenarios with live video feed used here as communication relay for AUVs when out of range.

Any new open asset can be added to the fleet just tuning communications and integration in the Command and Control Neptus software. Neptus is a Distributed Command and Control Infrastructure for the operation of all types of unmanned vehicles developed at the LSTS (University of Porto, https://lsts.fe.up.pt/toolchain/neptus). It supports the different phases of a typical mission life cycle: planning, simulation, execution and post-mission analysis and can be adapted by operators to fit mission-specific requirements and extended by developers through a comprehensive plug-in framework.

After the deployment of the vehicles in the water, a series of interactions between agents and operators take place. The positions of vehicles and recorded information by the AUVs

X8 UAV taking off from deck.
The net is prepared for landing.




"Neptus" Command & Control software screen monitoring vehicles performing a mission.

are transmitted, either by air or underwater to the operators. AUVs can transmit this information directly to the ship (or land base station) underwater via acoustic modem. They can also transmit the data to the USV underwater by the same system. The USV sends afterwards the information by air, via Wi-Fi, either to the ship, if in the Wi-Fi range, or to the UAV. The UAV, can contact the USV aerial signal by low altitude flying over the surface vehicle. However, the AUVs can also store the information to be transmitted by air – via Wi-Fi – either to the USV, the UAV or the ship (if within the range) when onn the surface. The different types of communication and distance ranges provide the system with an extraordinary flexibility to design the operations.

Three training exercises have been performed. The first in 2014 in Split, with support of the Croatian Navy with three AUV, one USV and two UAVs operated under the same communication system. The second exercise was carried out on board of the SASEMAR (Spanish Maritime Safety Agency) vessel "Clara Campoamor", multipurpose ocean going tugs and has 80 meters long, off Cartagena (SE Spain) in the Mediterranean Sea in 2015. The same team put into practice different strategies to locate and monitor a Rhodamine WT spill below 15 meters. In 2017 the third exercise took place on board of the same vessel and site with three new AUVs. Missions for six AUVs (different manufactures), one USV (PlaDyPos) and one UAVs (X8) were all designed by the chief pilot and uploaded to the vehicles. Several mission were designed to locate, characterize and monitor its direction, size and volume.

To determine spill direction from a known origin, the open source freely available model code MEDSLIK-II community model was used (http://medslikii.bo.ingv.it/). Within the perimeter traced by the model each AUV carried out coordinated missions in concentric circles at different depths thus intercepting the spill in its displacement direction. Once the spill origin is identified an imaginary line is traced along the plume and AUVs are programmed to perpendicularly cross this line in equidistant transects. Finally, missions were performed in straight lines crossing diagonally the plume from many different angles. Fluorometric sensors enabled the concentration measurements, while the diagonal transects provided the map of the spill extension.

New plug-ins for the command and control software NEPTUS were developed and installed in each vehicle allowing a better integration of the fleet. NEPTUS is able to design mission for any manufacturers vehicles, show their trajectories and recorded data in real-time as well as visualize maps of oil trajectories predicted by numerical models. On the other hand, the coordination of an expanded fleet working simultaneously


Photo courtesy of Sonya Legg, Princeton University

**Geoquip Marine Operations AG**
**Booth #: Q400**

**GNOM ROV WORLD**
**Booth #: N201**

than ever while enhancing the BathyCorrometer's reliability even further.

## Business France, France

**Booth #: J200, K200, K300**

Business France is the national agency supporting the international development of the French economy. They are organizing The France Pavilion in partnership with Pôle Mer Bretagne Atlantique and Pôle Mer Méditerranée, which will host 21 exhibitors at Oceanology International 2018. See them on stands J200, K200 and K300.

## CHC Navigation, China

**Booth #: A109**

If you missed out on Oceanology International China 2017, fear not, as CHC is bringing its most popular products from that show to Oceanology International in London. CHC manufactures competitive, affordable and reliable GPS and GNSS receivers and provides complete positioning solutions for surveying, construction, GIS and marine applications in more than 100 countries.

## Copenhagen Subsea A/S, Denmark

**Booth #: J201**

Copenhagen Subsea A/S will introduce its largest thruster yet, the Version Extra Large (VXL) thruster, which fits well with ROVs, AUVs, and Manned Submersible Vehicles. Its whole product range will be launched at the show with a new and extended depth range. Allan Nygård Bertelsen, Managing Director of Copenhagen Subsea, Denmark, said: "We are returning to Oceanology International 2018 as the 2016 event in London was a great place to meet potential customers. It was also a perfect exhibition for us to be able to showcase our products to the correct markets."

**Gesellschaft für Wirtschafts- und Technologieförderung Rostock mbH,**
**Booth #: C150**

## DECO Geophysical Software Co., Russia

**Booth #: R300**

Returning exhibitors, DECO Geophysical Software Co, will offer its RadExPro seismic software, for advanced processing of high-resolution and ultra-high-resolution marine seismic data. RadExPro seismic software is of potential interest for any company or research institution acquiring and processing HR/UHR marine seismic data for geotechnical, engineering, geological or environmental purposes. Live demonstrations are available at their booth on request and they are offering a special show promotion of 10% off regular software prices.

## develogic GmbH, Germany

**Booth #: G201**

develogic GmbH, which develops and manufactures turnkey system solutions for subsea data collection and transmission for marine monitoring applications, will present its new AIS Drifter Buoy and ECB PopUp.

## DeepOcean, Norway

**Booth #: G651**

DeepOcean's ADUS Manager, Mark Lawrence will speak at the Subsea imaging metrology conference about DeepOcean's vision on the development for innovative approaches to manage, manipulate and visualise large point cloud data sets.

## DeepWater Buoyancy, USA

**Booth #: C353**

It is this exhibitors debut at Oceanology International 2018. DeepWater Buoyancy will be introducing visitors to the show its Pop-Up Buoy Recovery System (PUB) which it has added to its line of subsea buoyancy products and the StableMoor, which is specifically engineered for high current applications, designed to reduce drag and increase mooring stability in extreme flow regimes. David Capotosto, DeepWater Buoyancy Director of Business Development, said: "This is an excellent show. "