MASTS Workshop Summary

Scientific Requirements for Autonomous and Remotely Operated Underwater Vehicles

A Platforms & Sensors Workshop 24 August 2011

Workshop Abstract

Several institutions in Scotland have underwater vehicles (AUVs, ROVs, Gliders) that could be used across a range of marine science projects when properly equipped with appropriate sensors and systems. A particular opportunity is a hover capable Prototype Autonomous Inspection Vehicle (PAIV) recently acquired by Heriot-Watt following conclusion of trials by industry for a commercial variant.

The workshop aims to identify the requirements of scientists in the MASTS group and elsewhere for using such vehicles. The possibility of developing further Scottish national assets to meet these needs will be considered, alongside options for converting PAIV into a system useable by the scientific community

The workshop will be of interest to scientists facing specific mapping and sampling challenges, as well as engineers engaged in underwater vehicle R&D.

Organisers: David Lane & Murray Roberts (Heriot-Watt University)

Summary of discussion following workshop presentations

1. Tim Boyd, Estelle Dumont, Mark Inall, Toby Sherwin Mark Inall (SAMS)

'AUVs: new technologies in physical oceanographic research'

Outlined limitations of various methods used to gather oceanographic data before focussing on AUVs and the systems operated by the Scottish Association for Marine Science: (1) Remus 600 AUV equipped with up and downward-looking 600 kHz ADCP and forward-looking micro-structure sensing package designed to measure small-scale turbulence in undisturbed water ahead of the vehicle; (2) Seaglider equipped with oxygen, CTD, fluorometer and backscatter sensor. The Seaglider has completed its first mission to Rockall Bank and in the future may replace the need for conventional research vessels to carry out the extended Ellett Line hydrographic survey from western Scotland to Iceland.

- Marine renewable energy operators and regulators need to understand turbulence and flow in great detail. This information is difficult and expensive to acquire and AUVs could have an important role to play in providing data from proposed deployment sites. There was agreement that there could be a gap in the market for a novel AUV designed specifically to operate in high flow settings where renewable energy installations may be installed.
- The turbulence sensor package on the SAMS Remus 600 vehicle will be used to measure within very thin layers of seawater where conventional sampling (CTD etc.) would disturb or even destroy the feature of interest.
- The SAMS Remus 600 is being deployed in the Gulf of Corryvreckan so real experience working in extremely high flow turbulent environments is being gained.
- The need for a benthic survey AUV capable of operating within rough topography at depths where ship-based multibeam becomes too coarse to identify important features (1000-2000 m depth).
- The issue of AUV recovery at sea was highlighted. Typically NERC vessels are reluctant to deploy small boats to help AUV recovery for safety reasons. Might it be possible to adapt fishing techniques (e.g. purse seine netting) to recover AUVs at sea in bad weather conditions from vessels of opportunity, including fishing vessels?
- The National Oceanography Centre in Southampton is currently establishing an Autonomous Underwater Vehicle facility.
- How many AUVs might be operating in the future – 10s, 100s, 1000s? Hard to estimate, but it seems that the role of gliders is set to increase. High volume manufacturing is set to be begin (e.g. by iRobot) and gliders may soon begin to replace operations like the Ellett Line hydrographic survey that have been previously carried out by research vessels.

2. Ursula Witte (University of Aberdeen)

'Instrumentation for research into deep seafloor functioning'

Summarised value of *in situ* biogeochemical flux data derived from autonomous lander platforms, including importance of video-guided deployment. Importance of deep-sea ROV platforms to carry out highly site-specific survey, sampling and experimentation. Outlined a new NERC project that will develop a novel pressurised mega-corer capable of recovering piezophiles for study/culture on board ship.

- Importance of understanding patchiness in the deep sea environments. Value of techniques like near-bed multibeam echosounder survey and video mosaicking to record patchiness and plan science missions.
- Co-ordinated use of AUVs (e.g. the Remus 100 & 600 vehicles) to map and plan missions with a marine science payload vehicle (e.g. an ROV or advanced hover-capable AUV) would be very valuable and effective way of working.
- Possible also to imagine an AUV becoming a mobile lander, moving from site to site carrying out the same experiment across patchy environments.
- Need for highly precise control in ROV position and sampling manipulator.
- Ability of ROV to deploy multiple (cheaper) experimental units rather than one or two (more expensive) autonomous landers.
- Importance of a suitable elevator system to shuttle samples to the surface and bring experimental units to the seabed limiting time lost launching and recovering ROV.

3. Monty Priede (University of Aberdeen)

Reviewed Aberdeen University Oceanlab's increased research interest in topographically complex deep-water environments including ISIS-ROV surveys at the mid-Atlantic Ridge. Outlined requirements for future underwater vehicles including survey and sampling within rough terrain and pelagic environments alongside value of a standardised sensor pack. There is a case for a research ROV capacity in Scotland to complement ISIS, rated perhaps to 1500 m.

- Conventional AUVs were not capable of working within rough topography for Mediterranean neutrino detector surveys highlighting need for an AUV capable of benthic mapping above structurally complex seabeds.
- Benthic ROV surveys need a suitable randomised design and are very time consuming at sea. A suitable AUV capable of gathering this information without a human pilot and attendant ship would be a major innovation.
- A pelagic AUV capable of hovering and working within this poorly known but vast ocean space would be very valuable. Important questions remain unanswered in the pelagic realm because the platforms don't exist to work there. Europe lacks expertise in this area.
- There could be a useful role for a standardised sensor package that could be fitted to any platform, from CTD array to benthic landers and underwat er vehicles.

4. David Lane (Heriot-Watt University)

Outlined Heriot-Watt University Ocean Systems Laboratory's *modus operandi* from purely academic engineering research through to commercial work and the development of spin-out companies (e.g. Seebyte). Particular expertise in autonomous systems engineering, sensor design and modelling and sensor processing. Summarised current fleet of underwater vehicles including a Remus 100 AUV equipped with benthic sidescan sonar, Prototype Autonomous Intervention Vehicle (PAIV) and a series of other research AUVs including the Nessie vehicles developed to compete in the AUV Challenge Workshop funded by the MOD and EPSRC. Ownership of PAIV has been transferred from Subsea7 to Heriot-Watt University and this could provide the basis of a MASTS community AUV/ROV rated to 1000 m.

- PAIV has completed tanks trials with Subsea7 and field trials in Loch Earn. It could have anything between a 1 and 3 day endurance depending on mission plan, thruster use etc.
- Subsea7 are now taking concepts developed with PAIV to produce a new series of autonomous intervention vehicles. This development will commercialise the technology and represents an 8-figure investment targeting the oil and gas sector.
- The approach developed with PAIV fits many of the needs identified during the workshop, especially those related to the need for vehicles capable of autonomous survey in structurally complex environments like mid-ocean ridges, offshore banks and deep coral habitats.

5. Murray Roberts (Heriot-Watt University)

'ROV, ROTV, AUV, AIV…Alphabet soup or a dish ready to serve? The case for a Scottish shelf/slope ROV'

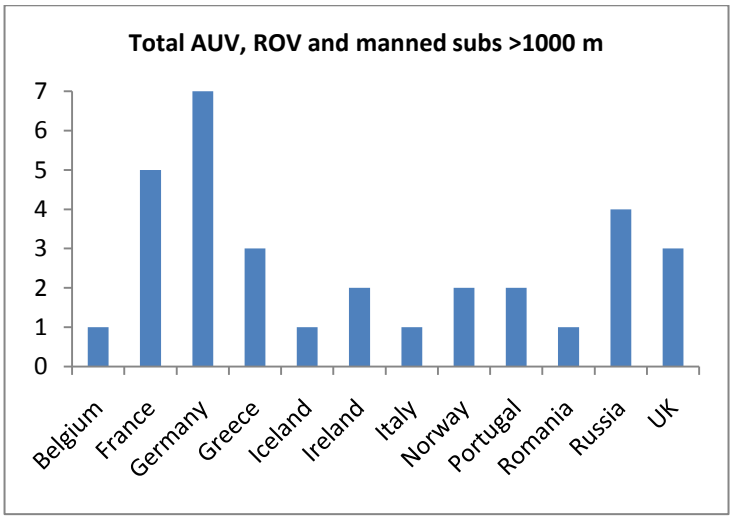
Summarised importance of ROVs and manned submersibles for working within structurally complex cold-water coral habitats. Presented the numbers of European research ROVs, AUVs and manned submersibles capable of operating at greater than 1000 m (see Appendix 1). Then summarised the capabilities the UK ISIS vehicle and the risks to UK science of relying on only one 6000 m ROV. Concluded by outlining the value of shelf/slope vehicle to MASTS community in terms of habitat mapping, engineering, blue-skies research and marine protected area monitoring.

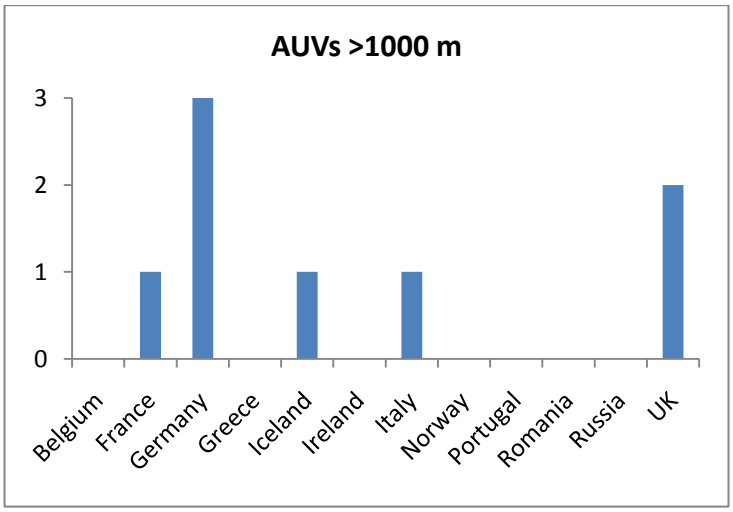
- PAIV provides an existing platform that could be adapted to operate in ROV mode. It would be possible to develop a hybrid AUV/ROV but perhaps would be more sensible to build the case for a 1500-2000 m rated ROV alongside PAIV.
- Marine Science Scotland have on-going need to conduct fishery surveys within areas closed to trawling. AUVs could play an important role here but would need long endurance to cover sufficient areas.
- There remains very little known about how fish behave in schools. Might a future small-scale AUV be able to insert itself into schooling fish like mackerel to observe and measure? It was noted that there have been several projects to build swimming AUVs based upon fish locomotion and with miniaturisation and further development perhaps this approach might become possible.
- What potential might there be in novel batteries using nuclear technology to improve AUV endurance?

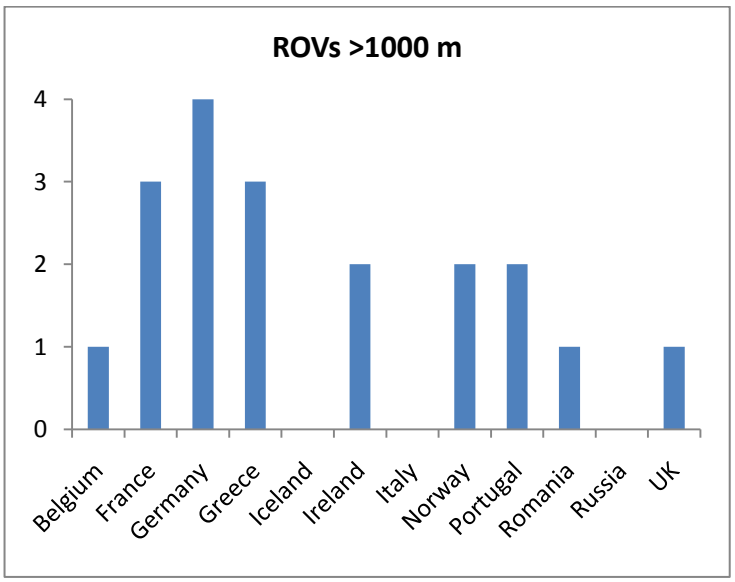
Next steps

Produce a short one-page document outlining the vision of a MASTS community AUV/ROV rated to 1000-2000 m. This should note Scotland's importance and international expertise in commercial subsea vehicles. The vision should also include the importance of marine science and technology in training Scottish graduates to work in this sector.

Appendix 1: Numbers of AUVs, ROVs and manned submersibles rated to more than 1000 m depth recorded in the Euroceans database (http://www.uvinfobase.eurocean.org)







Appendix 2: Meeting Participants

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