Deep-sea exploration will soon be an option for most archaeologists

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Benedetto Allotta, coordinator of the ARROWS project, discusses how the team has created underwater exploration vehicles tailored to the needs and expectations of deep-sea archaeologists.

With the ARROWS project, EU-funded researchers are turning deep-sea archaeological exploration from a risky and out-of-reach undertaking to a flexible and affordable solution.

When Plato first came up with the myth of Atlantis, he probably didn't expect that the mysterious island would keep stirring debates and feeding popular imagination for over 2000 years. Yet, Atlantis fantasies say a lot about the mysteries still surrounding Earth's seabeds: Whilst our seas and oceans are packed with inviolate submerged sites and shipwrecks, archaeological and scientific discoveries are still hindered by logistical and financial barriers, and low-cost, flexible solutions are desperately needed.

Aiming to boost research in this field, the EUR 4 million ARROWS (Archaeological Robot systems for the World's Seas) project picks up where military security and offshore oil and gas technologies left off by creating underwater exploration vehicles tailored to the needs and expectations of deep-sea archaeologists. Since the project started in September 2012, the 10-partner strong consortium has developed three new 'Autonomous underwater vehicles' (AUVs), including U-CAT, a highly manoeuvrable robot inspired by turtles and designed to penetrate shipwrecks. These AUVs and their dedicated components boast

tantalising advantages such as reduced size and mission cost, higher versatility, lower weight and more ergonomic designs.

Benedetto Allotta, professor of Robotics at the University of Florence and ARROWS project coordinator, details the main selling points of the AUV technologies developed by the project team, explains the demonstration process with active participation of archaeologists and discusses the future commercialisation of ARROWS' brand new AUVs.

What are the main objectives of ARROWS?

ARROWS aims to adapt and develop low-cost cooperating AUV technologies to significantly reduce the cost of archaeological operations, covering the full spectrum of archaeological campaigns. The ARROWS methodology involves identifying archaeologists' requirements in all phases of an archaeological campaign and proposing/demonstrating suitable technological solutions.

What was the role played by archaeologists in ARROWS?

On the one hand, archaeologists played a role of specification, with a view to identifying the requirements for the technologies to be developed. The requirements for the AUVs to be used in archaeology have been defined by the Archaeological Advisory Group, a board including European archaeologists from and beyond the ARROWS consortium.

On the other hand, archaeologists supported us in the choice of significant demonstration sites/scenarios.

Did you face any problems during the project and if

so, how did you solve them?

Due to the absence of GPS underwater, one of the main problems in the use of AUVs for underwater archaeology is to correctly geo-reference images and sonograms taken from underwater sites. Accuracy requirements expressed by the archaeologists are in the range of one metre, which is a very challenging achievement. Another problem to be addressed and solved underwater in order to have a team of cooperating heterogeneous vehicles is communication. This has to be addressed by means of modem acoustic technology, which is much slower and less reliable with respect to airborne radio communication.

What are the main strengths of the U-CAT compared to other underwater robots?

The U-CAT has been designed by our Estonian colleagues with the ambition being to develop a robot capable of entering modern (metal) wrecks. The main strengths of the U-CAT lie in: its small size which enables it to go through small passages inside the wreck; its round shape with no protruding parts to minimise the risk of getting stuck; its low weight and ergonomic design to be operable from a small boat; and very good manoeuvrability to efficiently move in the rooms and corridors of the shipwreck. Moreover, the cost of the U-CAT is low enough to make it affordable to archaeologists and to reduce the economic risk in case of vehicle loss. The U-CAT is user friendly, requiring special training in robotics to be operated, and its possible use in Remote Operation (ROV mode) furthers extends the range of potential applications.

Other technologies have been developed under the project. Can you tell us more about these?

Two more vehicles have been developed within the framework of

ARROWS: The first one is 'Marine robotic tool for archaeology' (MARTA), a moderate-cost AUV designed by the University of Florence which features a modular electromechanical structure. Modular means that the vehicle can quickly—in a matter of minutes—be dismantled and assembled again with different sensor payload configurations (either sonar or optical payload). Battery packs can be replaced very rapidly as well. The vehicle is torpedo-shaped with a smaller diameter (177 mm) than existing, best-selling vehicles and has rather rich navigation sensor equipment in order to cope effectively with the requirements of accurate geo-referencing. The sensor payload includes two digital cameras and a forward-looking discovery sonar. However, other payload modules can easily be designed and deployed.

The other AUV is the A-Sized vehicle designed by Edgelab SRL, an Italian SME based in La Spezia. Edgelab's vehicle is torpedo-shaped as well, with a diameter even smaller than that of MARTA (150 mm). Edgelab's approach consists in developing a really cheap, 'sexy' and easily deployable vehicle albeit with reduced performance. The vehicle weight is in the range of 15 kg, making its logistics really simple. This vehicle represents a very interesting low-cost opportunity not only for archaeologists but also for scientists.

In addition to the vehicles themselves, components for AUVs have also been developed by other SMEs in the consortium. In particular, a soft cleaning tool, to be mounted on an existing, bigger AUV (the Typhoon vehicle developed by the University of Florence) has been jointly developed by NESNE (Turkey) and AMT (Spain) and will be tested in Sicily.

Making your technologies affordable is one of the main project goals. How did you achieve this?

We decided to address the problem of expensive vehicles through custom designs of innovative vehicles, including a minimum set of expensive navigation sensors. The A-Sized is an extreme interpretation of this concept, resulting in a really low-cost vehicle with reduced performance but major advantages in terms of logistics and deployability. The MARTA vehicle is more a compromise between cost requirements, geo-referencing accuracy, and ease of use, with the advantage of a modular electromechanical structure allowing different vehicle and payload configurations.

You conducted tests in the Mediterranean and Baltic seas. Are you happy with the results?

Designing and building three new vehicles from scratch wasn't an easy task. The underlying but very important tasks of enabling communication and cooperation between a heterogeneous team of vehicles wasn't easy either.

So far, tests have been performed in Tuscany, Israel, Croatia and the Baltic. Preliminary results are encouraging. The final demos are now in preparation, and a campaign in the Egadi Archipelago (Sicily) is planned for 26 May to 6 June. More tests will be performed in Estonia in the second half of July. We are very optimistic about the success of the final ARROWS demos.

When do you expect your technologies to be commercialised?

We expect that at least some of the technologies and vehicles developed within the framework of ARROWS will be commercialised within the next three years.

More information: For further information, please visit ARROWS: www.arrowsproject.eu/

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