# Submarine robots learn teamwork

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New technology developed by European researchers will allow autonomous underwater vehicles to work together as a team. It increases the scope of submarine applications for autonomous vehicles. Even better, the technology can be retrofitted.

One could reasonably argue that the ocean floor is composed primarily of surprise. Surprise is the most common finding when scientists investigate some unexplored portion of the sea bed. And the ocean is 90 percent unexplored.

We know more about the surface of the moon than we do of the watery depths. The most advanced alien life form so far encountered by humanity - a species using chemosynthesis, an entirely new metabolic process to create energy, cells and life - was found by Professor Colleen Cavanaugh at a hydrothermal vent in the ocean deep just 30 years ago.

Studying the deep ocean floor like this is cumbersome, expensive and dangerous. The majority of exploration efforts have to employ an autonomous unmanned vehicle (AUV), which works without control cables.

But many AUVs are specialised, they cannot travel far alone and they can only provide a narrow range of data. Moreover, there are few AUVs and the unexplored kilometres of ocean are many.

## Underwater robots?

The work of one European project, however, has the potential to dramatically increase the range and functionality of the world's AUV fleet. The GREX project sought to develop appropriate networking technologies and software to have coordinated missions with heterogeneous AUVs acting as a team.

There are many advantages. For a start, multiple AUVs can map a larger area in one sweep, performing a sort of synchronised swimming thanks to some very clever software developed by GREX.

What is more, the formation benefits from the sum of its sensing equipment, making the AUVs potentially much more versatile and capable of getting both a greater variety of data at a higher granularity in one pass.

GREX's results have the potential to extend the range of underwater exploration. Coordinated AUVs can daisy-chain the control signal from one to the other, so they can stretch out, bouncing the control signal from the mother ship to the networked submarines, over many kilometres.

"Underwater communication between vehicles is a very difficult area,"

explains Michael Jarowinsky of MC Marketing Consulting, a partner of the GREX project. “You have no link, so these vehicles are totally autonomous.”

Until now, there have been only solo AUVs out there.

## Tough technical challenges

Coordinating multiple AUVs requires sophisticated software. Seawater is a difficult medium for linking up submarine robots and bandwidth is very limited, which affects the quality and range of the signal - measured in the hundreds of metres.

“So we did not work with individual vehicles, we sought to create a ‘GREX’ box that incorporates communications… tied into the vehicle controls. This can be simply added to existing vehicles, dramatically increasing their functionality,” notes Jarowinsky.

There is high demand for this kind of functionality and the number of potential applications is enormous, from studying hydrothermal vents and their rich, alien ecosystems to making new discoveries in biology, geology, magnetism and any number of other studies.

“We focused on scientific applications in the GREX project. We were interested in fish data for fisheries research, a very important area. We aimed at marine mapping and also the study of hydrothermal vents,” Jarowinsky reveals.

“Scientific applications are an important area for submarine exploration and it requires adaptable software that can be applied to many different tasks. It was useful to prove the technology.”

The sophistication of the GREX technology is amply demonstrated by

the hydrothermal vent application. Methane escaping from the vent creates a plume that degrades slowly, and a formation of submarines can 'track' concentrations to follow the plume to its source.

This requires the AUVs to move almost as a single, distributed vehicle, honing in on the highest concentrations of methane. It is analogous to the slow and graceful yaw of a space shuttle as it docks with the International Space Station.

However, Jarowinsky points out that there are many other potential commercial applications that were not studied by the GREX project.

## Commercial applications

The oil industry uses remotely operated unmanned vehicles controlled by cable (ROVs), which require a supply ship, for the inspection of offshore pipelines. It costs tens of thousands of euros a day to rent the supply ship. Longer-range AUVs equipped with a GREX box could provide huge savings. There are many other, long-term applications, such as ocean mining.

In the meantime, GREX has created a platform for the coordination of AUVs. This platform has been successfully tested in a serious of sea trails. The research results will be disseminated and exploited in three phases. The first, short-term, phase is publishing the research results and informing the submarine exploration community.

In the second phase, SeeByte, one of the project's partners, plans to market the control software and graphical user interface for managing AUV schools. And in three or four years the project coordinator, ATLAS Elektronik, aims to start offering a complete system, including the GREX box, software and installation and training.

“The marine exploration community is very conservative, and they have to know that a system works, that it is reliable. It takes time to completely prove a technology like this,” stresses Joerg Kalwa from ATLAS Elektronik.

GREX was a research project, but the partners will develop a further proposal for a commercial project to take the results from GREX and apply them to commercial problems, perhaps also looking at fundamental technical constraints of the marine environment, like modem technology.

**More information:** GREX project - www.grex-project.eu/

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