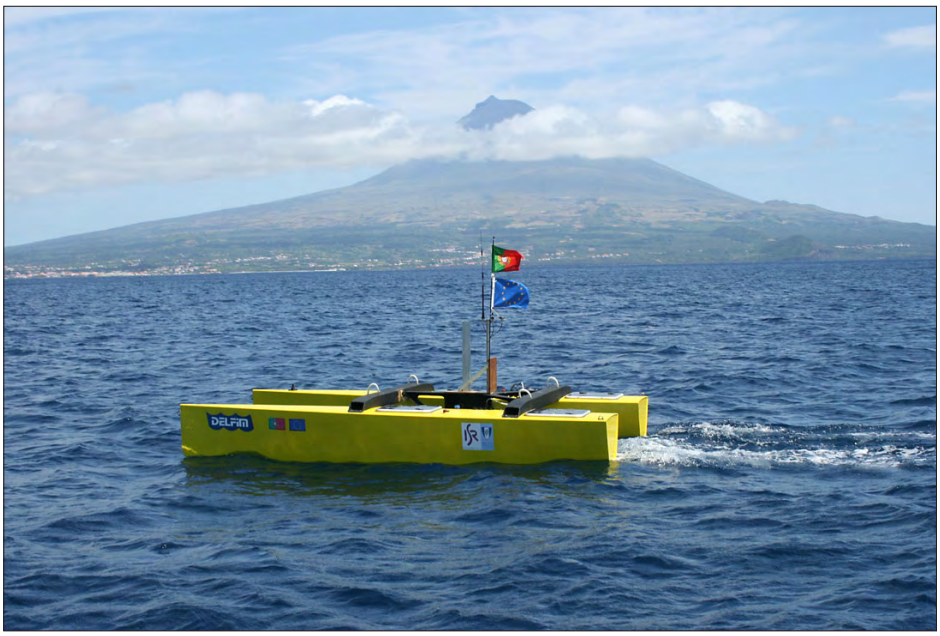
GREX

Newsletter 1 October 2008

Successful sea trials – the Azores mission, Summer 2008

From July 21- Aug. 4, 2008 the GREX partners joined ranks in the Azores to perform a series of tests aimed at transitioning from the "drawing board" to the real world. After two years of intensive work, the main core of the hardware and software (H&S) that were developed for the concerted operation of multiple marine vehicles were finally put together and tested using real and virtual vehicles.



Underlying this R&D development effort was the ultimate goal of developing a number of building blocks (middleware system) to seamlessly integrate vehicles with disparate architectures and capabilities into a team capable of executing advanced cooperative missions at sea. Central to this endeavor was the development of a "magic" GREX computer-box that, along with a set of communication hardware, effectively allows each vehicle operator to join a team without any major alterations of the vehicle´s H&S architecture.

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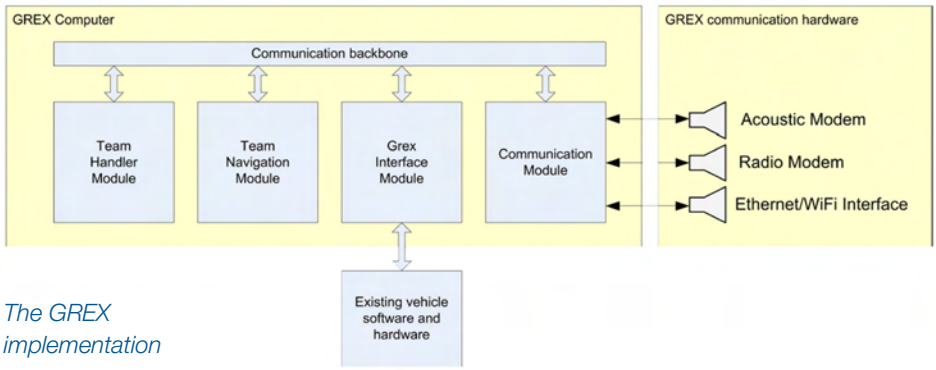
System Integration

With the solution adopted, the system integration is basically focused on two major tasks:

- to develop a software module known as the GREX Interface Module (GIM) that interfaces existing vehicle's individual single vehicle mission plans to the GREX world of multiple-based mission plans, and
- to ensure that an appropriate communication channel is established between its vehicle and the on-board resident copy of the GREX computer.

The latter contains several software modules that interact with each other via a communication backbone and provide interface with the vehicle and other GREX computers, distributed on the vehicles of the team. The architecture allows effectively team oriented missions to be designed and implemented in an effortless manner.



The GREX implementation

The GREX Team

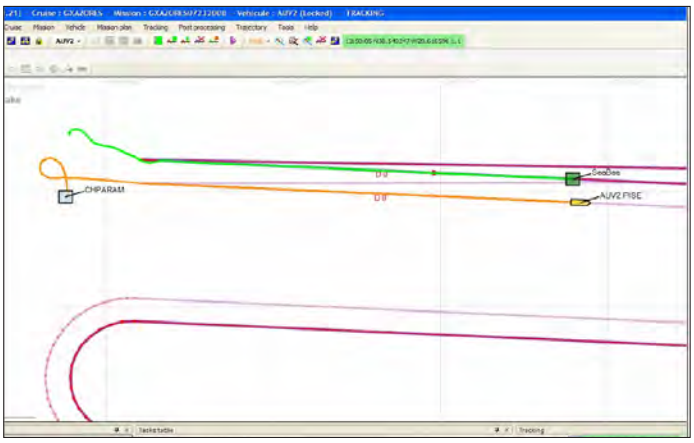
The tests brought together scientists and engineers from the IMAR/DOP (Portugal), ATLAS (Germany), SEEBYTE (United Kingdom), IFREMER (France), IST (Portugal), TUI (Germany) and ORANGE ENERGY (Portugal).

The GREX Team in the Azores

The GREX team in the IMAR laboratory

A visitor, dropping by the IMAR laboratory at the island of Faial, would at times be confronted with the sight of the DELFIMx autonomous surface vehicle in the middle of a warehouse where, sitting along a table, the partners were “fighting cooperatively” with their computers to “tame the code that would instill life” in the different real and virtual vehicles involved in the Summer mission. Whenever systems became ready for trials, a flurry of activity would be initiated to either “roll them down” to sea or to test their integrated behavior in simulation in the lab, via the actual Grex networking system. At the same time, IMAR/DOP would be testing a number of acoustic systems for target tracking while ensuring that all support vessels and respective crews run smoothly and seamlessly.

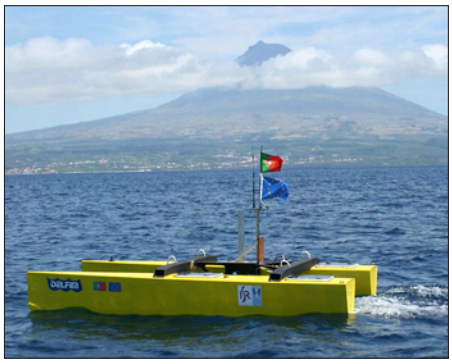
Major Achievements



Two simulated vehicles in “perfect harmony” along a track

- After several days of intensive software integration, the communication module was “on air” using the radio modems installed in the different real and simulated vehicles and providing an infrastructure for multi-vehicle networking. Together with a first set of operational GREX software modules (e.g. “Team Handler” and “GIM”), this allowed for the execution of a “landmark” coordinated path following maneuver involving two simulated AUVs: Ifremer´s Asterx and ATLAS’ SeaBee, both using hardware in the loop. For the first time, the GREX plug-in for SeeByte’s SeeTrack graphical user interface was used for mission planning.

Half way into the Summer trials DELFIMx sprang to life under the control of a GREX computer. The very first GREX mission at sea was performed flawlessly in the Pico Channel near Horta harbor. This test confirmed the resilience of DELFIMx and opened the way for integration with other GREX computers and the execution of cooperative missions at sea.

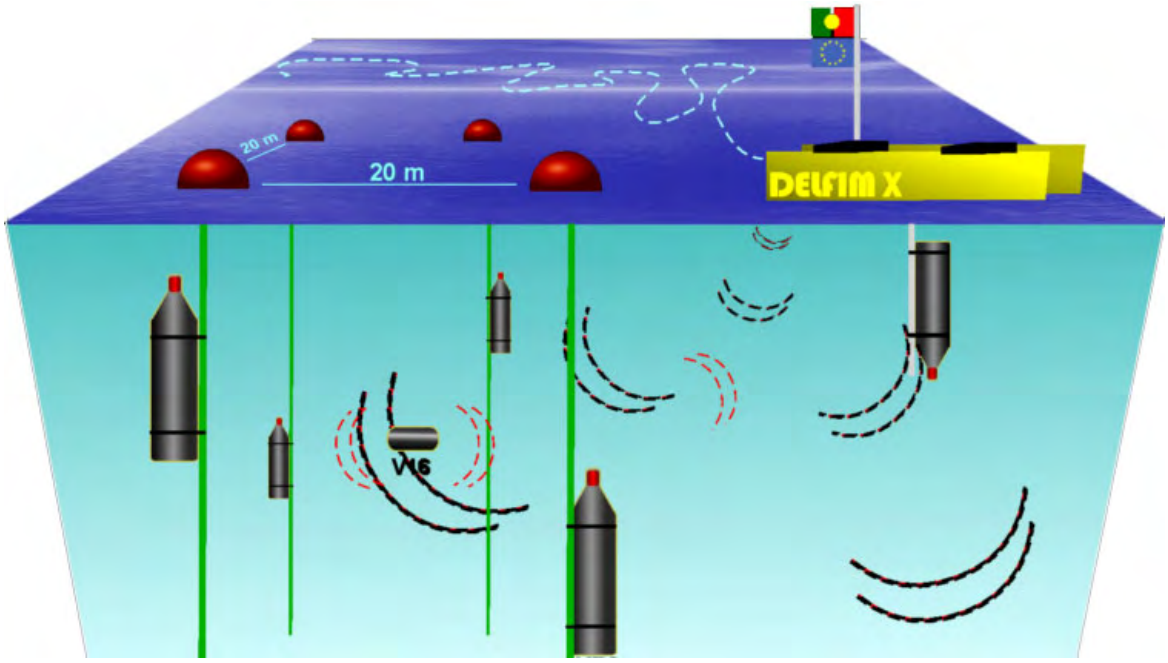


The DELFIMx Catamaran performs a first GREX mission at sea: Going-to and Following a"Lawn-Mowing" Pattern

Later in the Summer trials, still under the control of a GREX computer, DELFIMx performed a coordinated target tracking with the manned Águas Vivas (AV) vessel. In this scenario, the AV was free to roam the sea along unplanned trajectories and to broadcast its GPS positions via radio. In tune with the spirit of GREX missions, a system in charge of reading this information, processing it, and fitting successive line and arc segments was developed. DELFIMx "read" the successive path segments and followed them, thus achieving the first cooperative maneuver with real vehicles in the scope of the project, using the GREX communications module.

DELFIMx and Águas Vivas performing a coordinated target tracking maneuver

Once DELFIMx achieved the first fully successful GREX mission at sea, a self contained VEMCO VR2 listening station was attached to the catamaran in order test if the thrusters' noise interfered with the quality of acoustic signals sent by a dummy tagged fish (pinger). The distance to the pinger and the presence of other vessels in the area was annotated to help interpret the tests results. Additionally, triangulation and range tests were also performed using a moving pinger and a set of four VR2 stations moored at variable depths in square-like configurations. Preliminary results from both the range and acoustic interference tests where encouraging, and additional interference tests using underwater communication acoustic modems are scheduled for November in Sesimbra, Portugal.

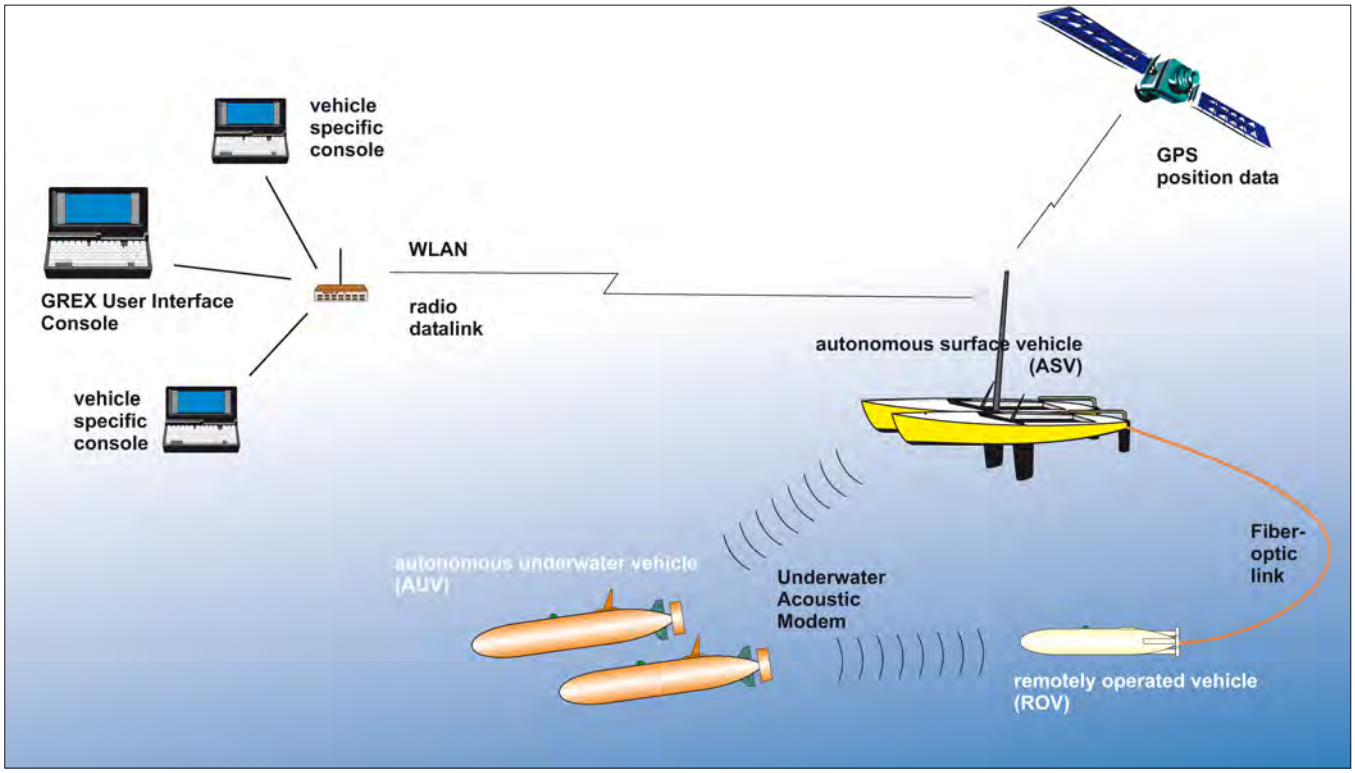


VEMCO emitter and receivers: The experimental set-up in the Azores

General Project Information

Introduction

Today, due to the limitations of state-of-the-art embedded systems, underwater researchvehicles are limited in both their autonomy and capabilities. It would be a leap ahead, if a researcher could use a multiple vehicle approach, whereby each vehicle plays the role of a sophisticated node (with sensor, processing, and communication capabilities) in a possibly large network – this means combining the properties of different systems in a team. “Grex” - the Latin word for a herd or flock – intimates the focus of the project: to create a conceptual framework and middleware to coordinate a flock of heterogeneous robotic vehicles in order to achieve a well defined practical goal in an optimized manner.



GREX System Overview

Objectives

The main goal of the project is to achieve a first level of distributed “intelligence” through dependable embedded systems that are interconnected and cooperate towards the coordinated execution of tasks. Thus the project will witness the development of theoretical methods and practical tools for multiple vehicle cooperation, bridging the gap between concept and practice. The technology developed must be on one hand sufficiently generic in order to interface pre-existing heterogeneous systems. On the other hand it must be sufficiently robust to cover problems caused by faulty communications.

Practically, developments will cover methods for effective programming of multiple systems, coordinated mission control and navigation, formal methods for validation and testing of the programming language, and the use of perception and communication techniques to enable ad hoc formation of information- and sensor-networks. Aseries of field trials will be carried out to assess the efficacy of the methods developed. They conclude and demonstrate the success of the GREX project.

Expected Results

The main innovation key points will be composed of:

- a User-Interface with underlying middleware to plan and distribute a coordinated mission for heterogeneous systems,
- an open communication middleware for inter-module and interprocess communication,
- a communication middleware, which enables heterogeneous vehicles to communicate with each other by LAN, WLAN, radio, and underwater acoustic communication,
- a widely generic control system for coordinated control of multiple objects in uncertain environments.

The GREX project has been started on 1st June 2006 and will be funded by the EU IST (Information Society Technologies) programme (IST-No. 035223) under the 6th Framework Programme.

Further information on the GREX project is available under www.grex-project.eu.

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