1. Core research themes and interests

The Underwater Systems and Technologies Laboratory (LSTS) from Porto University has been designing, building and operating unmanned underwater, surface and air vehicle systems for innovative applications with strong societal impact since it was established in 1997. The main research theme concerns how to design and deploy heterogeneous networked vehicle systems in a systematic manner and within an appropriate scientific framework. We are interested in systems composed of physical (vehicles, sensors, communication devices, computers and human operators) and computational entities (software components) which evolve, interact and communicate in an environment which can be affected by, and affect, these evolutions, interactions and communications. Computational entities are bound to physical entities, but this binding can change over time. Computational entities can be created, deleted and composed under location and linking constraints. New types of control actions (e.g. the creation of controllers on the fly, dynamic binding, passing communication channels or migration of controllers between physical entities) allow unprecedented behaviors that can only be described at new levels of abstraction (e.g. persistent operations in spite of physical limitations such as fuel constraints).

We are working on models of systems with evolving structure and communications and developing control techniques for these systems. Our research is targeted at applications in oceanography, biology and defense-related activities requiring the persistent operation of coordinated heterogeneous vehicles.

2. Current maturity of our technology (is it pure research/in simulation/deployed)

In the last 15 years we have successfully fielded unmanned air, ground, surface and underwater vehicles in innovative operations in Europe and in the United States of America. These include some world firsts, such as the underwater rendezvous between the Aries and Isurus AUVs, respectively from the Naval Postgraduate School and Porto University, which took place in 2006 in Monterey, California.

The LSTS fleet includes two remotely operated submarines (rated for 200m and equipped with video cameras and side-scan sonar), two autonomous underwater vehicles (1.8m long, equipped with side-scan sonar, acoustic modem and ADCP), six Light autonomous underwater vehicles (1.5m long, equipped with CTD, side-scan sonar and acoustic modem), one autonomous surface vehicle, six autonomous air vehicles (wingspans 1.8–3.6m) and gateway buoys (wireless and underwater communications). Our fleet has seen action at least twice a month since 2007.

We use the Neptus/IMC/ Dune/DFO software tool set, developed at the LSTS, to support the implementation of our planning, command and control framework. Neptus is a distributed command, control, communications and intelligence framework for operations with networked vehicles, systems, and human operators. IMC is a communications protocol that defines a common control message set understood by heterogeneous nodes (vehicles, consoles or sensors) in networked environments. Seaware is an interface for publish-subscribe messaging, deployed on top of the Real-Time Innovations DDS tool. DUNE is the system for vehicle on-board software. It is used to write generic embedded software at the heart of the vehicle, e.g. code for control, navigation, or to access sensors and actuators. DFO (Data Flow Objects) is a coordination language for the specification of supervision control software, deployed on top of DUNE. It is used for supervision of mission execution, vehicle state, and embedding maneuver controllers.

3. List of projects our group has worked on within the last 3 years and who has funded it

Currently, we LSTS is leading several national and EU projects concerning the development of networked vehicle systems. The LSTS is developing modeling and control techniques for networked vehicle systems under the Netv and Persist projects funded by the Portuguese Foundation for Science and Technology. The LSTS is tasked, under the Seacon project funded by the Portuguese Ministry of Defense, to deliver three units of an advanced version of the award-winning Light AUV to the Portuguese Navy. The LSTS is leading, in cooperation with the Portuguese Air Force Academy, the Pitvant unmanned air vehicles program funded by the Portuguese Ministry of Defense. The LSTS is cooperating with the Portuguese Task Group for the Extension of the Continental Shelf in the operation of the Deep Sea Remotely Operated Vehicle Luso. The LSTS is developing tools and technologies for ocean observation under the Raia project funded by the EU Programa de Cooperação Transfronteriza Espanha-Portugal. Under the Control for Coordination project, funded by the EU FP7, the LSTS is developing coordination & control strategies to be demonstrated with ocean-going vehicles in 2011. The LSTS is leading, in cooperation with the Portuguese Navy and Air Force, the NECSAVE initiative from the European Defense Agency which is scheduled to start in the first semester of 2011. The LSTS is an associate member of the CONET European Network of Excellence.

4. Web page and publications relevant to this meeting

www.fe.up.pt/~lsts/


