INTEGRATED PROJECT "MONITORING OF THE ENVIRONMENT"

KEYWORDS: SENSORS (OPTICS, LASER, TERAHERTZ, ACOUSTICS, THERMAL, ...); SYSTEMS; EMBEDDED ELECTRONICS; SIGNAL PROCESSING; SMART SYSTEMS; ROBOTICS; INTEGRATION / MULTIMODAL MEASUREMENTS; MULTISENSOR SYSTEMS; SENSOR NETWORKS/VEHICLES NETWORKS; VISION; MINIATURISATION; SENSOR FOR VECTOR; IOT; IOEVERYTHING; UNITED MODELS; MODULARITY.

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MAJOR RESEARCH UNITS INVOLVED: IES, LIRMM, L2C

PHD FUNDED 2015-2017: 3

MAN-MONTHS POST-DOC FUNDED 2015-2017: 36

EXAMPLES OF CROSS COOPERATION: IFREMER; UMR ITAP: INFORMATION-TECHNOLOGIES-ANALYSE ENVIRONNEMENTALE-PROCEDES AGRICOLES; UMR MARBEC: MARINE BIODIVERSITY EXPLOITATION AND CONSERVATION; UMR HYDROSCIENCES MONTPELLIER; RESEARCH ACTIONS WITH LABEX CEMEB

EXAMPLES OF INTERNATIONAL COOPERATION: STANFORD UNIVERSITY (USA), UNIVERSITY OF BUENOS AIRES (ARGENTINE), UNIVERSITY OF BOLOGNA (ITALY), UNIVERSITY OF BELGRADE (SERBIA)

HIGHLIGHT: 2 PATENTS RELATED TO SENSOR DEVELOPMENTS, 2 PROJECTS CURRENTLY VALORISED BY THE SATT AXLR COMPANY (TATITAG, CUBESAT-IOT)

Objectives

The IP Observation of the Environment has initially been designed to link, in the framework of the NUMEV Community, research actions dealing with the design of sensors and their deployment with the goal to collect and analyze environmental data.

Indeed, in the last two years, research activities centered on sensors and instrumented UAVs dedicated to the monitoring of environmental issues have been widely supported by NUMEV.

Contributions

Currently, the integrated project is structured in two parts: The first one is focused on the development and implementation of new sensors in specific environmental situations. The second one concerns the deployment and the moving of these sensors.

New sensors for monitoring environment: since the beginning of the project, several actions have been initiated, addressing the development of new sensors for environmental measurements. The selected projects on sensors deal in particular with fields related to the development of sensors and devices to detect pollutants, to quantify the impact of agricultural products on the environment (in situ measurement of particle dispersion by a photonic sensor), to study biotopes (contributions of wood material to the activity and health of bee colonies), or to develop robotics dedicated to the collection of underwater biological samples (Figure 1).

A recent advance concerns in-vivo sensors to identified environment parameters. Another project, PhD cofunded with IFREMER, is running concerning in situ recording of fish physiological status information. For the first time, it will be possible to evaluate the physio-

logical state of the fish in its natural environment, for example by measuring the spatial and temporal variations of its fat content, which is representative of the environment. Several external factors can thus be measured/deduced. For that Specifics Embedded Tags on Mediterranean tunas has been developed and used on real environment[1,2]. This started with NUMEV in 2014 is now part of IFREMER Flagship POPSTAR[3].

A second example is a project aiming to the development of a laser sensor technology, dedicated to the control of vortex beams to create high performance bio-sensors[4,5]. It has been supported through the funding of a post-doctoral position. The objective was to control the physical properties of a semiconductor laser cavity, based on III-V semiconductor VCSEL and photonic crystals nanotechnologies, to build a compact coherent laser source with a stable and controllable orbital angular momentum, termed Optical Vortex. This laser, via the exchange of angular momentum, is able to interact with matter to allow the deployment of new novel technologies in mechanical control (optical tweezers) and measurements (velocimetry Doppler) at the level of single molecules of biological relevance.

A company, named INNOPTICS, currently works on the sensor integration to allow industrial applications such as velocimetry measurements dedicated to droplet control at the output of spreading nozzles to limit pest risk.

This IP has been also strongly structured around research projects dealing with the deployment of sensors to study our environment. The "Monitoring Environment" IP also enabled the creation of a momentum in Montpellier in the field of underwater exploration. A project developing an adapted UUV with a specific manipulator arm of the latest generation to collect fragile biological samples[6] on the deep seabed has been also recently granted with IFREMER and a cooperation with Stanford is ongoing concerning this activity.

The highlight of this dynamic appeared in 2016 with the emergence and the funding of the ALEYIN Flagship Project. It aims to the design of an autonomous system (underwater robotics, figure 2) for the exploration of karst environments[7]. Through the understanding of the resurgences, the estimation of the state of the water resources, and the development of a precise cartography, its major challenge concerns the development of a decision-making tool for the public authorities. This project brings together 4 laboratories with the scientific ambition to create a global center of expertise in karst exploration. ALEYIN's initial budget is € 250,000, financed by NUMEV's flagship projects.

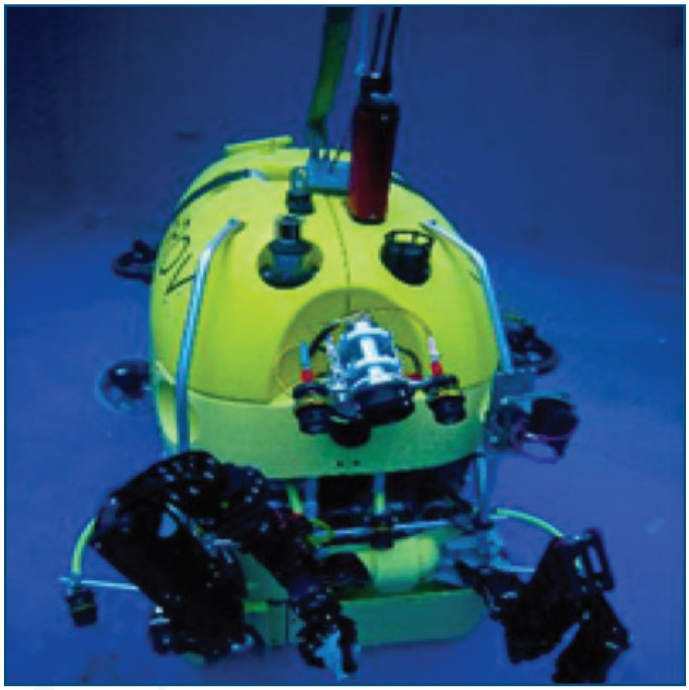

Fig 1: UUV with manipulator arm to collect biological samples

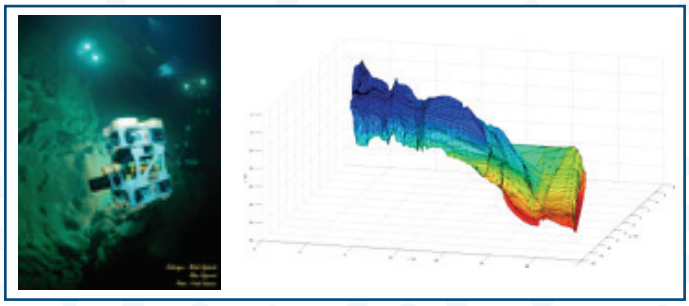

Fig 2: a. Underwater robotic exploration;
b. Cartography of a karst structure.

The vectorization of sensors is also addressed through the contribution of the development of satellite-based radiocommunication systems[8] (Robusta-3A, Figure 3) or the analysis of functional data at geographical positions. For this reason, the LabEx is proud to contribute to the Space Center of the University of Montpellier and two nanosatellites were launched in 2017 (one from India and another one from Russia) with the ultimate goal to use nanosatellite to observe no accessible biodiversity zone.

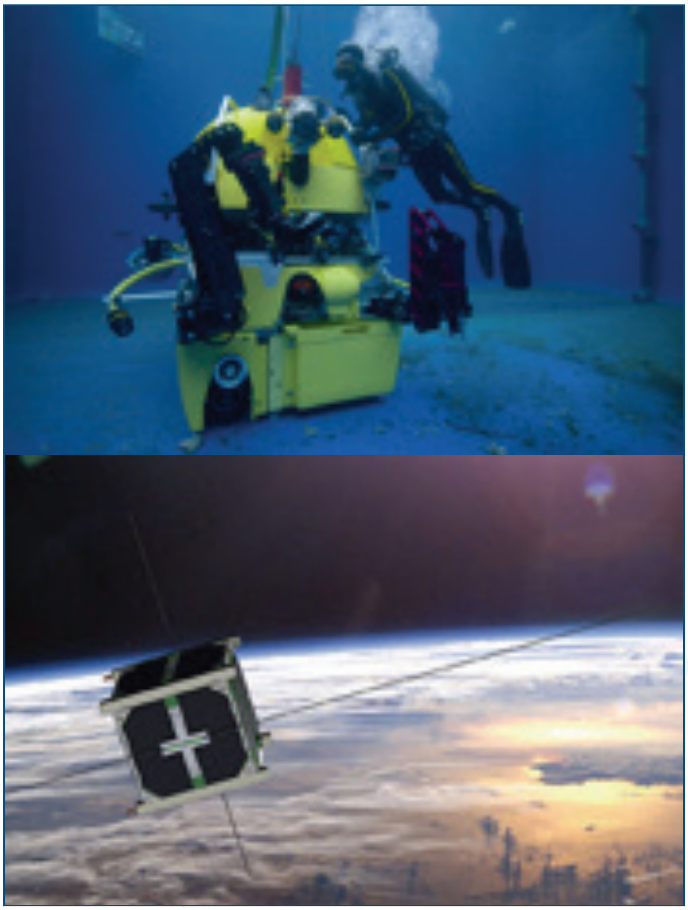

Fig 3: Robusta-3A Nanosatellite project

The structuring character of the IP is clearly visible through the number of partners involved in the different projects. Within the NUMEV community, this IP has been able to LMGC and IES, LIRMM and IES or L2C and IES forces on specific multidisciplinary research projects. In addition, external collaborators to MIPS, scientific references of the environment community, are multiple. In particular, IFREMER, IRD, INRA, IRSTEA can be noted.

The IP has also contributed the diffusion of the knowledge in the Environment or Living fields through the funding of scientific events as the International Conference "Biomedical and Photonics" organized at Montpellier (La Grande-Motte) or "Biologging workshop" common with the LabEx CEMEB in 2016. In terms of training, the IP participated with the axis Modeling in the funding of stays in Montpellier of a Tunisian doctoral student on a topic dealing with the mathematical analysis of a model of anaerobic digestion and contributed to the funding of training periods for Master students. This IP also initiated Hackathon students like contest, especially Hydrocontest[9], an international student contest dealing with embedded sensors on race ship.

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