ANERIS: Development of an intelligent oceanographic probe with high resolution autonomous sampling and collecting capabilities.

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Abstract – ANERIS is a multidisciplinary project focused on the design and development of a innovative sampling and collecting sonde. As main innovation, this probe will be able to obtain microstructure profiles and spectrometric data simultaneously with very high resolution (hyperspectral). Furthermore, probe's structure has been design to minimize limitations of current sea water collecting systems. By providing autonomy and intelligence to the system samples will be collected according to specific scientific criteria. Large amount of information will be obtained, making possible to characterize water column as a whole but with small scale detail.

Keywords – ANERIS, innovation, autonomous, hyperspectral, CMIMA-CSIC.

1. INTRODUCTION AND MOTIVATIONS

Sea water collecting devices have been evolving but they still have limitations. One of the main limitations is the uncertainty of collecting water samples at a desired depth because of the existing delay between decision and water sample collection. Other limitations stem from the movement produced by the oceanographic ships and wiring systems. Turbulence and mixing effects produced by oceanographic ships and collecting bottles itself, that break water column thin structure and disable water samples for low-scale studies, are also problems that have not been solved yet.

ANERIS, acronym of *Analysis and development of an intelligent oceanographic probe with autonomous sampling and collecting capabilities*, is a multidisciplinary project that started at the end of 2008. ANERIS project is focused on the design and development of a new sampling and collecting oceanographic probe able to minimize limitations of current devices. As a multidisciplinary project, four research groups from the Spanish institution CSIC (Consejo Superior de Investigaciones Científicas) work in collaboration for this project. The covered areas are: Oceanographic Instrumentation (Marine Technology Unit, UTM), Marine Biology (Marine Sciences Institute, ICM), Automatic Control Systems (Industrial Automatics Institute, IAI) and Artificial Intelligence (Artificial Intelligence Investigation Institute, IIIA).

2. MAIN CHARACTERISTICS

ANERIS probe is designed to minimize actual collecting devices limitations by providing autonomy and intelligence to the system. This instrument incorporates an intelligence system that enables to adapt its performance depending on the environment. The probe will be capable to decide where to collect the water samples, taking into account all measurements acquired during the descent and ascent trajectories. As a result we are going to obtain a large amount of high resolution data in relation to the water column crossed by our device, which will be used subsequently to study small scale phenomena.

One of the benefits of device's autonomy is that undesired effects produced by nearby ships and wires will not be present. The navigation system will stabilize the speed, avoiding the main part of turbulences and mixing not produced by natural causes.

Other important parts of the probe are: (1) the very high resolution system, which is composed by environmental and optical sensors (e.g. fluorescence sensors and high spectral resolution sensors), (2) the new sea water collecting system, which consists of a new type of sampling bottles. Each bottle will be constructed so as to collect water samples in a segmented manner. The spatial resolution of the sampling system will be improved, since the structure of the bottle will be segmented in different small compartments.

2.1 Sensors system

One of the most important parts of the sonde is the sensors system (Fig. 1) composed by microstructure and optical sensors that measure temperature, pressure, conductivity, fluorescence and hyperspectral irradiances [1].

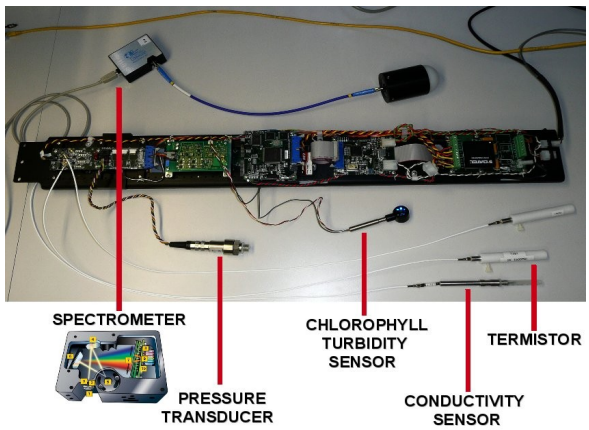

Fig 1. Sensors system and related control hardware view.

All of these sensors, which main characteristics are shown in Table 1, have been chosen because of their high resolution and fast response.

SENSOR	MODEL	MAIN CHARACTERISTICS
CONDUCTIVITY SENSOR	SEB-7	• Accuracy: 0.005 S/m (typically) • Low noise: 2 x10^{-7} (S/m) / ($Hz^{1/2}$)
CHLOROPHYLL TURBIDITY SENSOR	FTD-3	• Excitation Wavelength: 400 – 480 nm • Emission Wavelength: 640 – 720 nm • Range (fluorescence): 0 – 200 ppb • Range(turbidity): 0 – 200 ppm • Pressure rating: 1000 m • Temperature range: 0 – 30 °C
FAST TERMISTOR	FP07-38	• Range: -2 – 32 °C • Resolution: 0.0001 °C • Response: 7ms • Nominal resistance(at 25 °C): 200 kΩ
PIEZORESISTIVE PRESSURE TRANSDUCER	PA-11	• Range: 0 – 20 bar • Linearity: < 0.5 %FSO (excitation I=1 mA) • Long Term Stability typ. < 0,25 mV
FIBER OPTIC SPECTROMETER	USB4000	• Detector range: 200-1100 nm • A/D resolution: 16 bit • Sensitivity: 130 photons/count at 400 nm; 60 photons/count at 600 nm

Table 1. Sensors main characteristics.

ANERIS optical system is intended to provide information related to water column composition. This type of sensors offers the possibility to better distinguish different groups of phytoplankton, which are characterized by an specific pigment composition and therefore by an specific optical signature. Environmental sensors also provide significant information to better distinguish and characterize water column structure.

We are working specially with very high spectral resolution miniaturized spectrometers (i.e. Ocean Optics USB4000, MP [2]), and fluorescence sensors. Its reduced dimension makes them suitable to be integrated in underwater probes.

Our goal with this system is to obtain a device able to acquire environmental data every few centimeters in the water column. We hope it will work fast enough to make possible a real time data acquisition during the ascent trajectory. Therefore, the intelligent module will be able to predict optimum collecting depths enough time in advance and compensate possible delays between detection and collection. In addition, we are going to obtain water samples according to specific scientific criteria and all the information related to the entire water column.

2.2. Control system

Sensors system is basic in the characterization of water composition and makes essential the development of a control system to manage the issue of how acquisition, pre-processing and storage of information is done. For this purpose, a control system has been designed as a multi-client server using TCP/IP communication. In that way, there is a main node that controls flows of data and orders.

Not all nodes have to make the same processes or have to make them in the same way. For this reason, all nodes have a static addresses to be better distinguished by the main node. Hardware topology is very simple (i.e. a star configuration) but flexible enough to enable addition of nodes in the future.

All control hardware will be implemented using PC/104 boards (embedded PC). Main characteristics of this kind of devices are their small size, low consumption and flexibility. Addition of new features is as simple as staking new boards.

2.3. Collecting bottles system

Standard collecting procedures using Niskin bottles have the drawback that the whole water column obtained becomes mixed. The aim of the new collecting system is to obtain samples by minimizing the modification of the conditions of the water column, by collecting high resolution samples.

Collecting bottles will consist in a system of segmented bottles. They will be closed using the artificial intelligence system with an appropriate speed so as to not create artificial turbulence. Thereby the bottle will be sealed with a tightness system and in the land bottles will be emptied using a nozzle system.

System design will take into account ocean currents speed, turbulence created by the probe or the sealing and the integrity of materials used to avoid sample contamination.

3. CONCLUSIONS

ANERIS project has recently started and is just at the first stages of development. At present, UTM staff is working on the probe sensors and all the control elements (software and hardware). Furthermore, we are working on processing techniques based on model-based simulated data to train and validate the performance of the probe [3, 4]. On the other hand, UTM and ICM staff are collaborating on the design of the new collecting bottles, in order to study the best system to recollect samples without mixing the water structure.

Up to now there is not any instrument with high resolution sampling and collecting capabilities, even much less performed automatically based on the detection parameters. Therefore, this will be a modern and useful instrument for future oceanographic campaigns.

4. REFENCES

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