

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. The probe design pretend to minimize actual sea water collecting devices limitations by providing autonomy and intelligence to the system.

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

I. 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, platforms 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 sonde 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, IA) and Artificial Intelligence (Artificial Intelligence Investigation Institute, IIA).

II. MAIN CHARACTERISTICS

ANERIS probe is designed pretending to minimize actual sea water collecting devices limitations by providing autonomy to the system. This instrument will incorporate an intelligence system to be able to adapt and modify its performance depending on the environment. It will be used as well to predict the points in the water column that are most significant, following a predefined biological criteria, where the water samples will be collected.

The sampling process will be made up of three stages (Fig. 1): environment exploration, sampling points estimation and water samples collection. During the first stage, when the profiling system will go down, it will collect environmental data from different types of sensors (temperature, pressure, conductivity, fluorescence and hyperspectral irradiances [1]), in order to characterize sea water column. Therefore, during the second stage, the system will process the stored data and decide some provisional interesting points where to collect. During the last stage, when the profiling system will go up, the intelligence system will take part. The sonde will be able to decide where to collect the water samples, taking into account the previous processing stages and the measurements acquired during the ascent.

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

Other important parts of the sonde are: (1) the sensors system, which is composed by environmental sensors and optical sensors, such as fluorescence sensors and high spectral resolution sensors (hyperspectral), (2) the new collecting system, which consist 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

ANERIS optical system is intended to provide information related to water column composition. This type of sensors offer the possibility to better distinguish

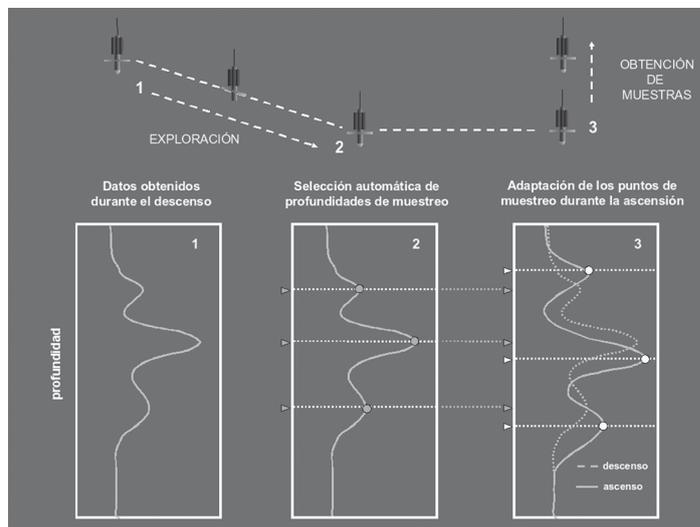


Fig. 1. Schema of the performance of the ANERIS probe.

different groups of phytoplankton, which are characterized by an specific pigment composition and therefore by an specific optical signature. We are working specially with high spectral resolution miniaturized spectrometers (i.e. Ocean Optics USB4000, MP [2]), and fluorescence sensors. Its reduced dimension make them suitable to be integrated in underwater probes. This kind of sensors, like all the other included sensors, will be governed by a PC104 embedded PC, that will control all acquiring, processing and storing data processes.

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 mode. Therefore, the intelligent module will be able to predict optimum collecting depths enough time in advance and compensate possible delays between detection and collection.

2.2. 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 without modifying the conditions of the water column, by collecting high resolution samples.

Collecting bottles will consist in a system of segmented bottles. They will closed using the artificial intelligence system with an appropriate speed so as not to 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.

III. CONCLUSIONS

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

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ROBUST AND ACCURATE MONITORING OF GUADALQUIVIR ESTUARY WATERS: A HIGH-RESOLUTION AND LOW-MAINTENANCE SYSTEM FOR WATER QUALITY AND HYDRODYNAMICS.

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Abstract – Since January 2008, The Guadalquivir Estuary has been equipped with a large amount of instrumentation performing an intensive collection of meteorological, hydrodynamic, hydrological and water-quality parameters. An important effort has been made in setting up a telemetry network to register most of those variables in near real time. All this instrumentation generates more than 70000 data per day. The final purpose of this deployment, and the circulation model being developed in parallel, is to generate a powerful tool for the integral analysis and management of the Estuary.

Keywords – real-time telemetry, water-quality, hydrology, hydrodynamics, meteorology.

I. INTRODUCTION

The results described in this document have been obtained under the framework of a contract between Autoridad Portuaria de Sevilla (A.P.S.), the institution in charge of Sevilla harbour, and Consejo Superior de Investigaciones Científicas (C.S.I.C.).

The main objective of the research conducted, led by Instituto de Ciencias Marinas de Andalucía (I.C.M.A.N.), is to diagnose and forecast the consequences of human actions on the dynamics of the Guadalquivir River estuary. In order to reach that goal, it has raised the necessity of generating a comprehensive collection of hydrodynamic and hydrological data since this database is an essential tool to validate the model that explains the global behaviour of the estuary. With the aim at promptly fulfilling this task, the Department of Ecology and Coastal Management of I.C.M.A.N.-C.S.I.C. has carried out the deployment of a telemetry network able to perform intensive real-time data collection of hydrological, hydrodynamic and meteorological variables. Furthermore, some other oceanographic instrumentation has been moored in the area of study: a thermistor chain and Acoustic Doppler Current Profiler (A.D.C.P.) with a tide-wave module, a single-point current meter and six temperature-pressure sensors for tide-regime characterisation (fig. 1).

II. MOORED INSTRUMENTATION

Thermistor Chain and Seafloor CTD

The thermistor chain registers sea temperature at 16 depths every 1 minute. The spatial resolution of the chain is 1 meter. The top thermistor is equipped with a pressure sensor monitoring the verticality of the chain. Attached to the concrete block, a moored CTD (RBR) monitors salinity, temperature and sea level every 10 minutes. This chain is located in the continental shelf, nearby The Guadalquivir River mouth.

A.D.C.P and Wave Module

This A.D.C.P. (AWAC-AST) performs 20-cell current vertical profiles and sea-level measurements every 10 minutes. The spatial resolution of the profiles is 1 meter. The Wave Module sample frequency is 2 Hz, the integration period is 60 seconds

and it registers wave information every 10 minutes. Wave measurement is carried out every hour.

Tide gauge network

This network consists of 7 tide gauges deployed at the locations shown in figure 2. They have been configured to take sea-level measurements every 10 minutes.

III. REAL-TIME TELEMETRY NETWORK

Previous to the deployment of this network, the Department of Ecology and Coastal Management of I.C.M.A.N. – C.S.I.C. has carried out the design and construction of two prototypes able to perform intensive real-time telemetry of hydrological (temperature, salinity, dissolved oxygen, turbidity and chlorophyll fluorescence) and hydrodynamic (water column velocity profiles) variables. The technology developed for those prototypes has been used to equip the navigation buoys of the estuary, transforming them into environmental monitoring stations [1]. Figure 2 shows a sketch of the telemetry network deployed at the Guadalquivir Estuary.

Meteorology

This station, installed at the mouth of the estuary, is operative since April 2008 and supplies the network with the following real-time data: wind module and direction, 2π solar radiation, air temperature, relative humidity and atmospheric pressure. All these variables are sampled at 1 Hz and the actual integration period is 10 minutes.

Hydrodynamics

The Water Dynamics (WD) nodes of the network have been installed at the locations shown in figure 2. Every node is equipped with an ADCP (Nortek Aquaprop, 1 MHz) providing 21-cell 3-D velocity profiles of the water column every 15 minutes. The upper 6 cells are monitored in real time as well as some other quality parameters: instrument pitch, roll and head pressure.

Water Quality

The Water Quality (WQ) nodes of the network have been installed at the locations shown in figure 2. Every node is equipped with a CTD (Seabird SBE16plus with three external sensors: a SBE43, for dissolved oxygen, and two Turner Design Cyclops, for turbidity and fluorescence) and a 4-pump module able to provide 4-depth vertical profiles of temperature, salinity, dissolved oxygen, turbidity and chlorophyll fluorescence every 30 minutes.

IV. I.T. INFRASTRUCTURE

In order to remotely control the nodes and store all the data generated by them, a data management and control server has been set up (figure 2). This server is behind a firewall to prevent the loss of sensitive information and it periodically publishes the scientific information gathered by the network into an external FTP server. The data retrieved from the moorings at maintenance are also published into that FTP server.