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RESEARCH ACTIVITIES 2010

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CABLES BEHAVIOR AND SIMULATION

INTELLIGENT SENSORS

Head Office

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EDITOR'S NOTE

Dear Readers,

Following our traditional edition line, on this issue our magazine presents the annual summary of the different projects and research developed by SARTI research group, during 2010.

The research projects undertaken by SARTI, in collaboration with other Spanish and international research teams, are linked to the development of instrumentation technology for marine applications, as well as for general industry.

SARTI began its activities in 2000, and this year is the 10th year of our activity. Therefore it is the right time to introduce this issue, the No 10, of our magazine Instrumentation ViewPoint.

We encourage you to collaborate in future issues of this journal, and to attend the next year's congress: INTERNATIONAL WORKSHOP ON MARINE TECHNOLOGY, MARTECH 2011, on September 22 and 23, in Cadiz, Spain.

Best regards from your partner,
PhD Antoni Mànuel
Director of TDC SARTI

The following papers had been published in the indexed magazines during 2009-2010

OBSEA an Expandable Seafloor Observatory
A.Mànuel, M.Nogueras, J.Del Rio. Sea Technology (ISSN 0093-3651)
Vol: 51 Nº7 July 2010

Development of a Synchronization Trigger for the Spanish Oceanographic Ships Based on an Embedded Real-time Java System.
Jordi Sorribas , Joaquin del Río, Shahram Shariat-Panahi, Christoph Dickel, Antoni Mànuel, Enric Trullols.
IEEE Transactions on Instrumentation and Measurement
Vol:58 issue 9 Pp: 3323-3334 September 2009

Design and Test of a High Resolution Acquisition System for Marine Seismology.
Shahram Shariat-Panahi, Francisco Alegria, Antoni Mànuel.
IEEE I&M Magazine Vol:12 Nº2 Pp:8 -15 April 2009 ISSN 1094-6969

IEEE 1057 Jitter Test of ADCs
S. Shariat Panahi, Francisco Alegria, A. Mànuel-Làzaro, Antonio Cruz Serra

IEEE Transactions on Instrumentation and Measurement
Vol: 58 Nº7 Pp: 2234-2244 JULY 2009

Sliding-mode control design applied to parallel-connected modular inverters through FPGA-based implementation
Ramos Lara, Rafael Ramon; Biel Sole, Domingo; Fossas Colet, Enric; Guinjoan Gispert, Francisco.
IET control theory and applications. Any: 2009. Volum: 3. Pàgs: 1611

Performance and impact on the seabed of an existing- and an experimental-otterboard: comparison between model testing and full-scale sea trials.
Prat Farran, Joana d'Arc; Antonijuan Rull, Josefina.
Fisheries research. Any: 2009. Volum: 100. Pàgs: 156

SUMMARY

SUMMARY

PRELIMINARY OBSEA MOORING DESIGN

Alejandro Arbós[2], Marc Nogueras[1], Joaquín del Río[1]
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Abstract. The Obsea Cabled Observatory (www.obsea.es) is going to be expanded with new sea surface sensors such a meteorological station and a video camera. These new sensors are going to be installed in a surface buoy with wireless communication to the Obsea Data Center at SARTI's Laboratories. The mooring design and simulations are presented in this paper, taken into account the marine conditions of the area located in the Vilanova I la Geltrú coast in the Metiterranean Sea. The simulations of the static and dynamic behaviour of the anchored buoy were done with the software OrcaFlex 9.4.

1. Buoy and accessories model

The aim of this work is to present the preliminary followed steps for the mooring design of the buoy. The scheme of the buoy is shown in Figure 1-a It is a 6m length buoy with a diameter of 1m in the centre. It has been modelled in the simulation environment, , as is shown in figure 1-b, and to known the physical properties of the buoy allow Orcaflex a quicker analysis.

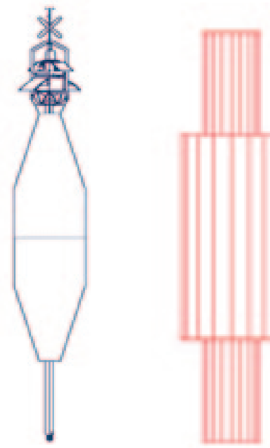

Figure 1. Real buoy schema and its Orcaflex model

The buoy was modelled as 3 cylinders, taking into account the centre of gravity and moment of inertia of the real buoy. The buoy will be anchored at the sea bottom using 3 chains. These chains will be fixed to the buoy through a custom design fixing structure, shown in Figure 2. This element has to be modelled in Orcaflex with a simple structure.

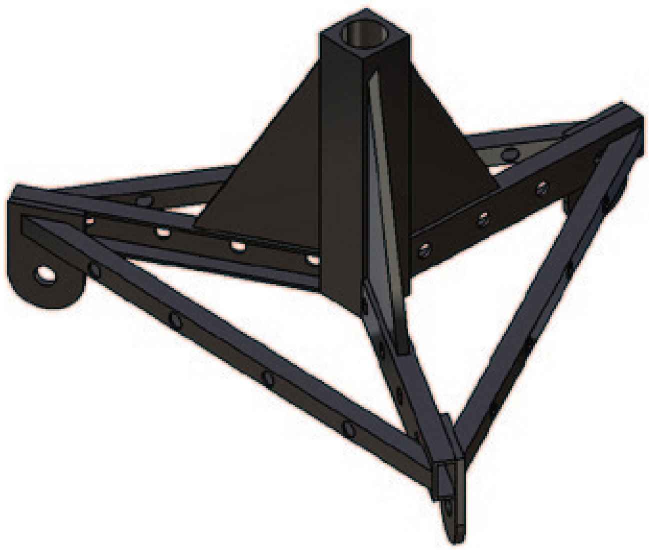

Figure 2. Custom structure to fix chains.

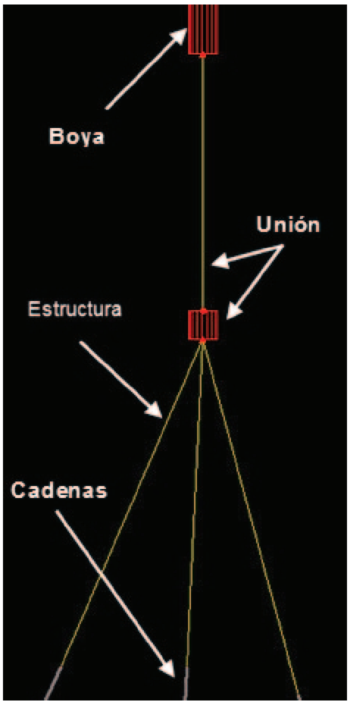

Figure 3. Chain fixing structure model

On the Figure 3 is shown the fixing structure model and how the chains are linked in a 3 leg shape, separated 120º because in this way the chains can keep in this same position.

2. Positioning of anchored buoy system

The positioning chain system has a tripod diagram, separating the chains 120º, as shown in Figure 4.

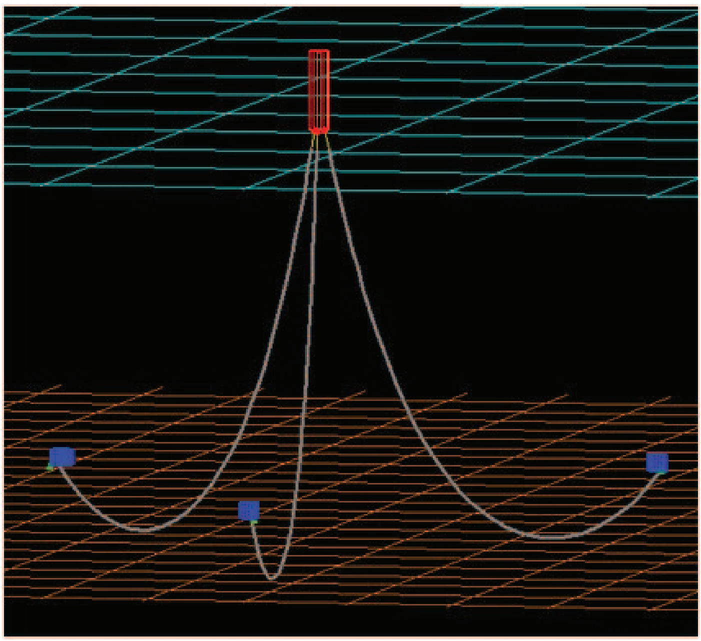

Figure 4. Three-dimensional representation of anchored buoy system with 3 chains

Once the different elements are defined in the Orcaflex simulation environment, a static analysis gives us information about the static position of the chains, and what are the forces at the ends. In this case, we have 20m depth and 50m chains length. Figure 5 shows the static position of the system.

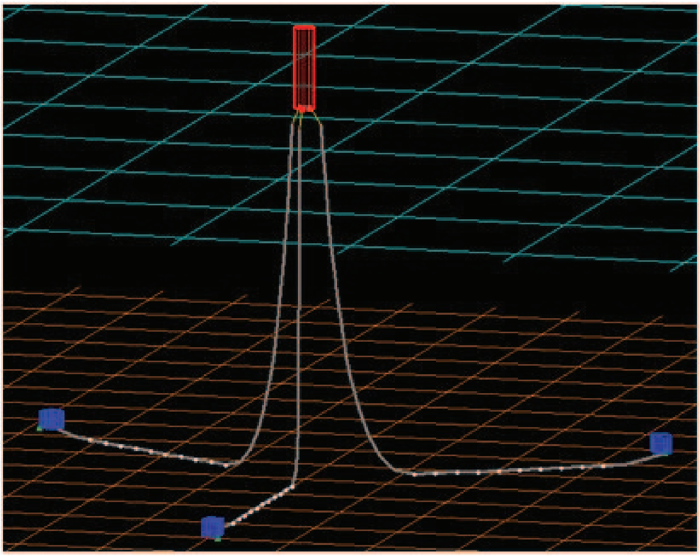

Figure 5. Three-dimensional representation of anchored buoy system with 3 chains with static analysis

After the static analysis, a dynamic analysis takes into account boundary conditions that have been carried out. In order to know what is the best orientation of the chains, and which will be the forces in presence of different wave heights, we took into account the information of "Puertos del Estado" about most common and maximum heights, periodicity, and direction of waves in the area.

Zone	Hs max [m]	Hs min [m]	Hs Average [m]	Tp max [s]	Tp min [s]	Tp average [s]	year
Cantabria (Peñas cape)	10,1	2,8	6,61	18,2	10	12,97	2009
Cantabria (Peñas cape)	7,8	2,6	6,28	16,6	10	12,44	2008
Cantabria (Peñas cape)	12,2	3,6	6,46	16,7	8	11,49	2007
Catalonia (Tarragona)	5	1,5	2,9	10	4,8	6,775	2009
Catalonia (Tarragona)	6,2	1,4	3,06	11	6,3	7,08	2008
Catalonia (Tarragona)	4,1	1,7	2,676	10	6,2	7,4	2007
Galicia (Silleiro cape)	11	3,2	8,06	18,2	9,2	12,776	2009
Galicia (Silleiro cape)	10,9	3	8,08	16,4	8,7	12,60	2008
Galicia (Silleiro cape)	10,4	3,6	6,7	18,7	10,8	12,823	2007
Andalucia (Cádiz gulf)	5,4	1,8	2,99	16,6	4,8	8,33	2009
Andalucia (Cádiz gulf)	5,9	1,9	3,16	11,1	5,9	7,14	2008
Andalucia (Cádiz gulf)	4,3	1,9	2,74	12,5	5,9	7,125	2007

Table 1. Table swell results according to Spanish study zone

Once the simulation elements, their positioning, and environmental parameters or boundary conditions are known, the dynamic simulation can be performed, and in this way, the system behaviour can be shown, according to swell, periods, and average heights, such as data showed on Table 1. Figure 6 shows different images captured during dynamic analysis.
The next step is the analysis of the simulation results in terms of maximum forces that a chain undergoes, and verifies the correct orientation of the mooring in order to minimize chain forces.

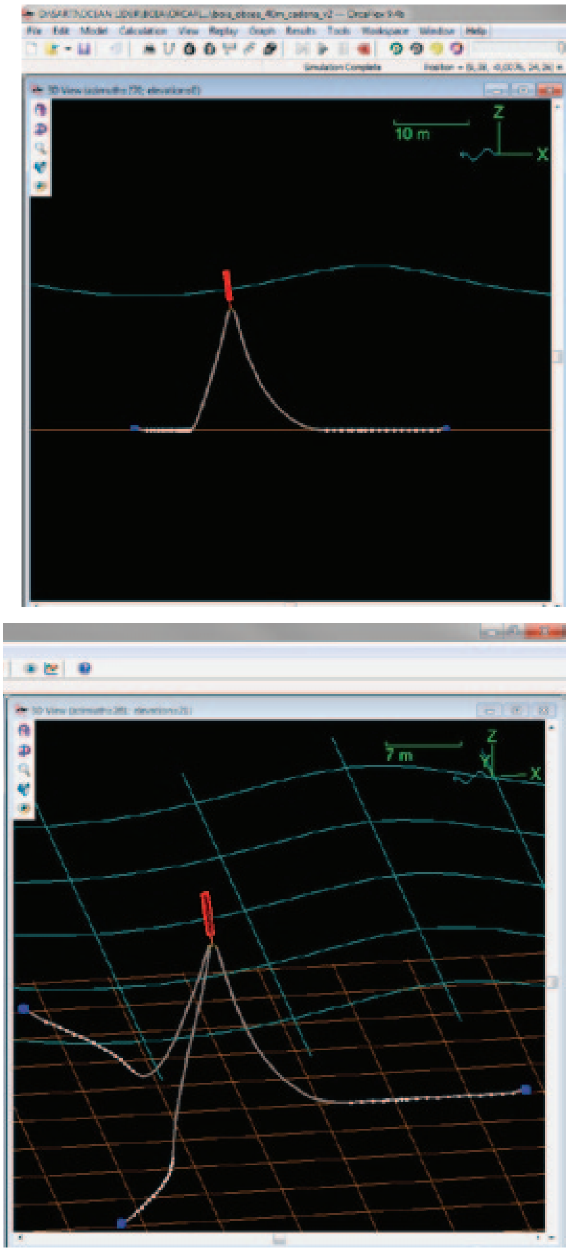

Figure 6. Three-dimensional representation of anchored buoy system with 3 chains with dynamic simulation

7. Conclusion

A static and dynamic simulation of the Obsea mooring design has been presented. First approach to the use of Orcaflex software has been done in order to evaluate its functionality. At this time a depth evaluation of the results has to be done in order to verify the correct design. These results will be published soon.

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[2]Ferdinand P. Beer and E. Russell Johnston, Jr (1984). Vector Mechanics for Engineers, fourth ed.. McGrawHill. P. 911. ISBN 0-07-004389-2

PRELIMINARY STUDY OF MOORED POWER CABLES

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4-Prysmian Cables and Systems.

Abstract. New green energy sources deployed at sea, in mobile platforms, will use power cables in order to transport the energy generated at sea surface to the bottom. Theses power cables will be exposed to the dynamic behaviour of the platform movements, due to waves, currents and wind. A preliminary study of the static behaviour of these cables in function of parameters like mass, bending stiffness, length, water density or seabed friction is presented in this article. Simulations are been done with Orcaflex 9.4 environment. Three different cables have been simulated to observe their deformation and forces.

1. Introduction

Simulation of the static and dynamic behaviour of the cables due to marine conditions has to be done before the actual cable became manufactured, in order to identify critical parameters, like forces or curves that the cable will suffer. Parameters that will be studied and shown on this paper, at different graphs, will be: tension on superior-end (End A), maximum curvature radius, X coordinate of seabed contact, and per cent of cable with seabed contact.

2. Cable and Environment Parameters Definition

Static simulation has been done for different environmental densities in order to be able to compare results. For the subsequent static studies, 2 environments: have been defined: sea water and air with densities shown at Table 1. Two different frictions values were defined, for low and high friction (Table 2), and two cable lengths (Table 3). Finally three bending stiffness were defined as are shown in Table 4. At this paper, only the Sea Water environment results are shown.

Environment	Density	Units
Sea water	1025	kg/m^3
Air	1,3	

Table 1. Environment data study table

Friction	Value
Low	0,005
High	0,25

Table 2. Seabed friction data table

Cable type	Length [m]
Cable 1	25
Cable 2	40

Table 3. Table of cable type data

Cable study	Diameter [m]	Bending stiffness [kN·m^2]	Mass·Length [kg·m]
1	0,1	0,1	22
2	0,1	0,7	22
3	0,1	7	22

Table 4. Analysed cables properties Table

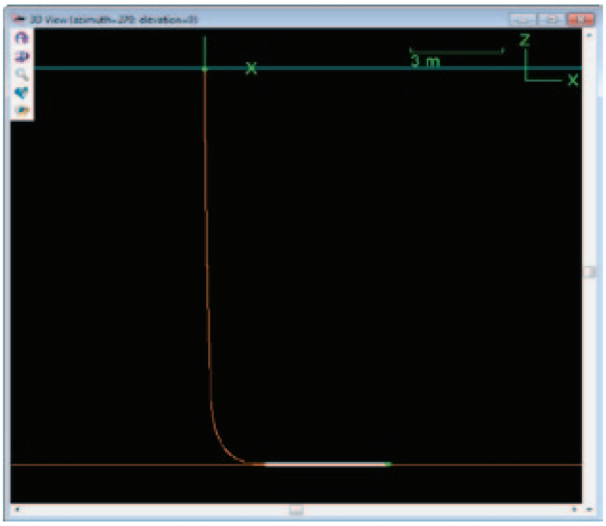

Figure 1. Hang down cable

In order to evaluate the relation between different parameters a static simulation has been done with OrcaFlex software. A hang down cable was defined, as shown in Figure 1.

3. Static Simulation Results

Different parameters were studied and its relations with other parameters. The upper cable part is defined as the point "EndA", and the lower part of the cable, which has contact with the seabed, is defined as point "EndB". Forces at EndA are a key point, and it is very important to know how theses forces change in relation with the cable length, cable bending stiffness, and seabed friction. These results are shown in Figure 2, where it can be seeing the incidence of cable friction with the seabed, and also the cable bending stiffness. For this simulation, point EndA is fixed at sea surface, and point EndB is free, and can be move in function of cable movements. In this first graph, it can is possible to see the tension that the first end cables suffers, for each different cable, and having different seabed friction between cable and seabed.

It can be seeing how EndA cable tension changes for taken into account cable length and its seabed friction. For EndB free, we can see that tensions are quite constant in function of bending stiffness.

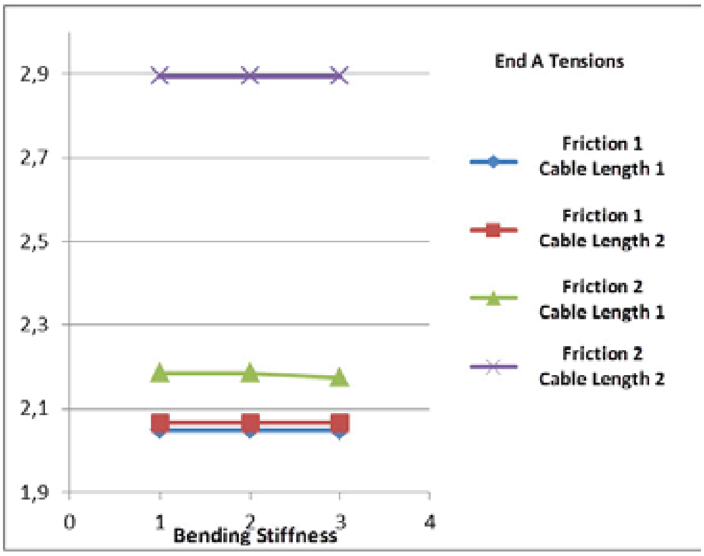

Figure 2. Cable Tensions at EndA in kN

At Ffigure 2, the X coordinate contact point with the seabed is shown. At this case, the bending stiffness parameter is quite important in order to define the cable curvature and the seabed contact point.

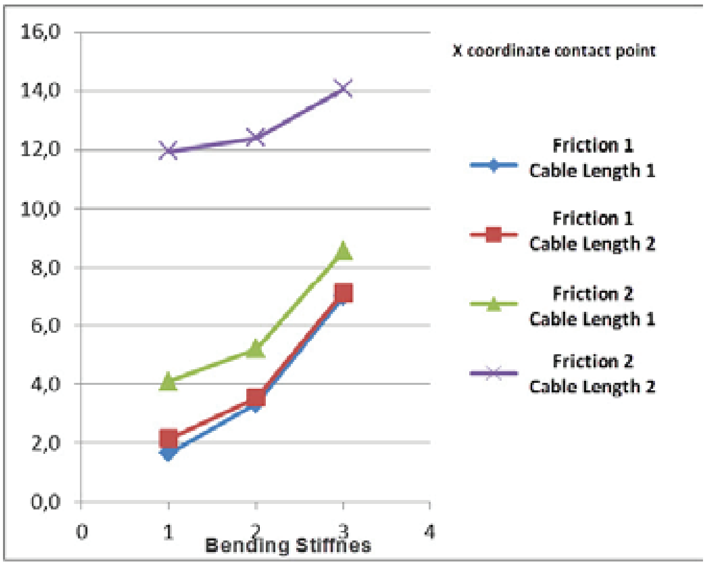

Figure 3. X-coordinate with seabed contact

Another important parameter is the cable curvature and to know how it changes. Figure 4 shows the curvature radius of each cable and as the same way as the before cases, it has to be considered how important is the bending stiffness, the seabed friction and the cable length.
As can be seen, for the bending stiffness lower values, the curvature radius is higher. From this graph can also explain the fact that a higher curvature, the curvature radius is lower and this fact also happens is the relation is changed.
In order to conclude the preliminary results, percentage of cable that has a seabed contact is shown in figure 5. In the same way of previous cases, it shows the difference between the studied frictions, bending stiffness and the cable length.

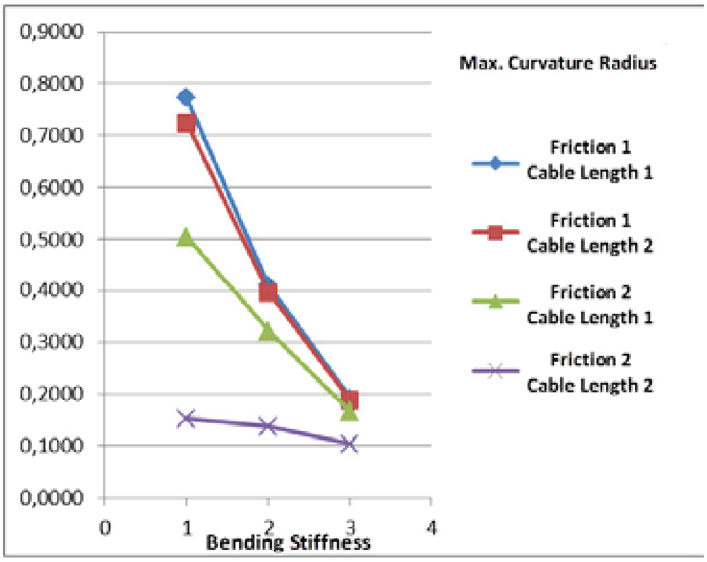

Figure 4. Maximum curvature radius graph

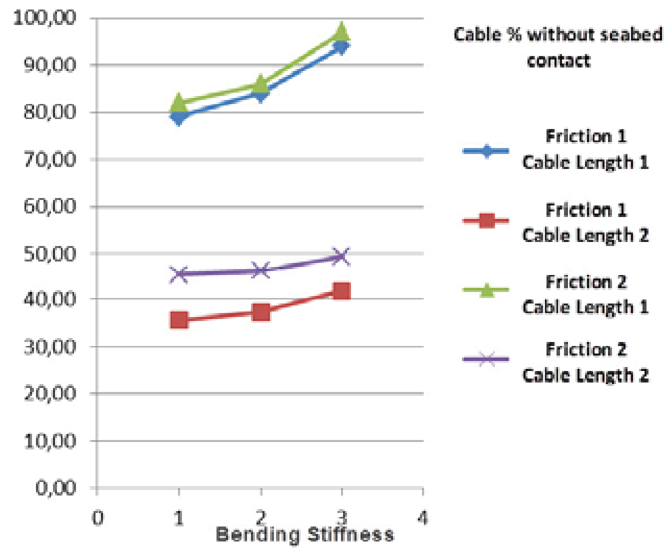

Figure 5. Cable percentage without seabed contact

4. Conclusions

After the preliminary simulations, some conclusions about power cable parameters and its relations are presented for this specific test situation with EndB point free.
EndA forces are function of seabed frictions and for this reason have to be considered. About cable curvature radius, the maximum value is always produced with higher bending stiffness. The seabed contact point for the static situation varies with different seabed frictions and cable length.
These results give us valuable information in order to define the next simulation phase, where EndB point will be fixed to seabed and the decision about where will be the EndB point position fixed.

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ADAPTATION OF THE APPLICATION WASPAR TO NEW LINUX DISTRIBUTIONS

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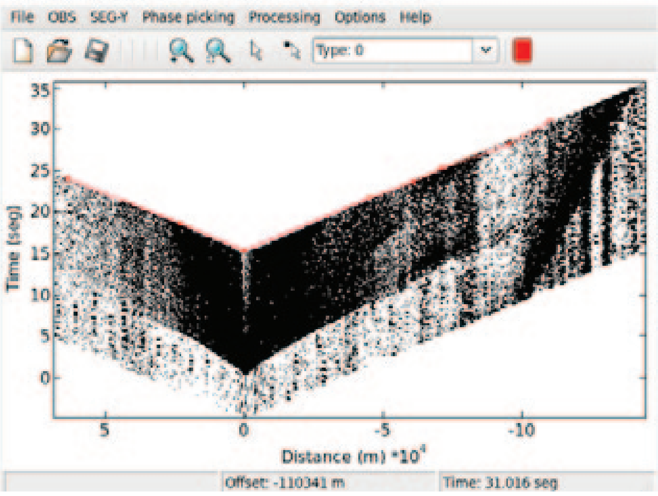
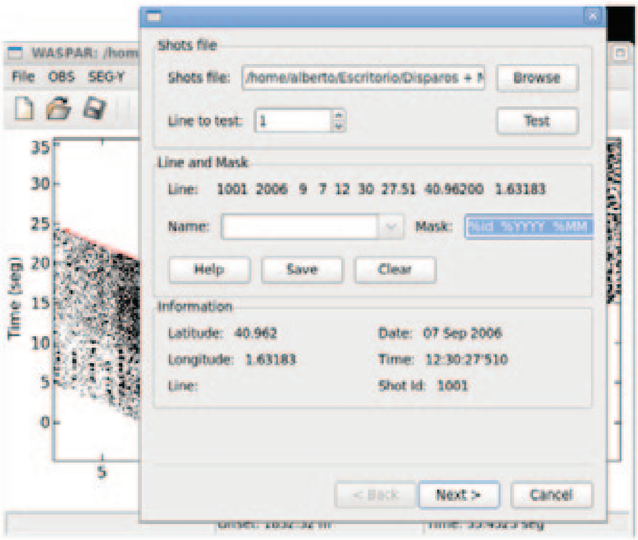
Abstract In this paper we present the process of adaptation of WASPAR, a free software tool that processes and displays wide-angle seismic data. It originally worked in an early version of Fedora, so the intention was to make it compatible with more Linux distributions, such as new versions of Fedora or Ubuntu. Further adaptations have been planned, so it can also be used in a Windows environment.

Introduction
WASPAR (Wide-Angle reflection-refraction Seismic data Processing and Representation), is a software that processes and displays wide-angle seismic data.[1]. It was designed to read different raw data formats, construct record sections, process them using existing and newly developed algorithms, pick seismic phases and generate graphic files using a single interface. It was also designed in a modular way using a plug-in architecture to manage raw data access and processing functionalities.



The WASPAR application was released in 2006, and was designed to work on an early distribution of Fedora, one of many Linux distributions. After this years, though, it ended up showing some problems with some of the most recent and popular distributions, so it was decided to begin a process of adaptation, in order to make it available for most of the users without having to work with another operative system.

Adaptation of the software
The first priority of this project was to make the program fully functional again on the latest distribution of Fedora, currently Fedora 13. This was achieved by revising the source code and modifying part of its content. The main issue was related with some of the graphic libraries used, being that most of them were now obsolete. Because of this, they had to be replaced with their latest versions, and the software had to be adapted to them.



At the same time, the idea was to make the software work on probably the most popular Linux distribution nowadays, Ubuntu. During this process, some problems appeared, mostly due to its different architecture (Fedora is based in Red Hat, while Ubuntu is based in Debian). Because of this, some of the libraries used in this version where different, and so where some parts of the source code that had to be modified. Finally, both processes were finished, and now the application works properly in both systems.

Conclusions and future additions
The process of adaptation has not ended yet, and the functionalities of the software have to be tested in some more platforms, including Windows. Also, there are new features that could be added in the form of new plug-ins, such as data repositioning or new processing filters.

References
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WEB BASED APPLICATION FOR THE SELECTION OF CABLE TRAYS

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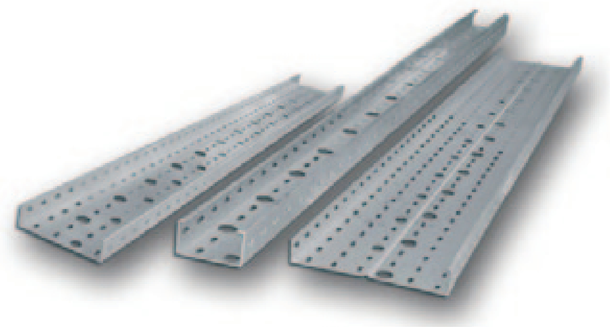
Abstract. In this paper, we present an application that helps the designers and engineers decide which cable tray is the one they need for their projects. It considers both their section and weight, and from that data it offers the trays that are able to support them. It can select also among some models of bulkheads. The application has been developed in a web environment, using the ASP language in combination with a MySQL database.

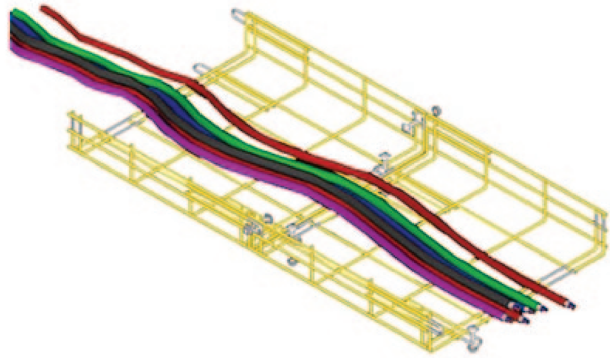
Introduction
The intention in the development of this application was to make easier for the engineers and commercials to find which model of cable trays they needed for their installation projects. Sometimes, this question can lead to a series of calculations that can take a large amount of time. So, the idea was to implement a website app that could do the hard work for them.

Website and database design
In order to control the access to the system, we have designed an SQL database, which has been installed over a MySQL server. This database will hold the data about the different users, so anyone who wants to use the application will have to log into the system.



Moreover, the fact of having a database lets the users keep a history of their last calculations, so they are able to revise them any time as needed. Finally, the database will be responsible, also, for the information about cables, cable trays and bulkhead models. It can be updated anytime, so the program will be permanently updated.

Features and implementation
The application is based in a series of forms that collect the inputs from the user. Based on those inputs, the program loads the section and weight data from the database, and looks for the cable trays that support the total volume and weight.



Besides from the basic calculations, the system has some particular features:

- Users are able to create their own cables, introducing their particular data (name, material, weight, section…). Those cables are stored in the database, so they can use them in all their later calculations like the rest of regular cables. This feature will help users not to feel dependent of the specific cables stored in the database.

- At the end of the calculation, at the results page, users are offered two documents. The first is the main datasheet of the tray, where they can find their main characteristics. The second, though, it's a dynamically generated excel table, with the selected tray and a list of related products that can be helpful in their installation. These products are also stored in the database.

Conclusions
The final application has been successfully tested with real users, and can still be improved in order to obtain more specific results. Also, the database can be permanently updated in order to offer the latest tray models and related products.

ADAPTATION OF THE APPLICATION QUALIFO TO COMMUNICATE WITH THE PHOTON KINETICS 8000 OTDR

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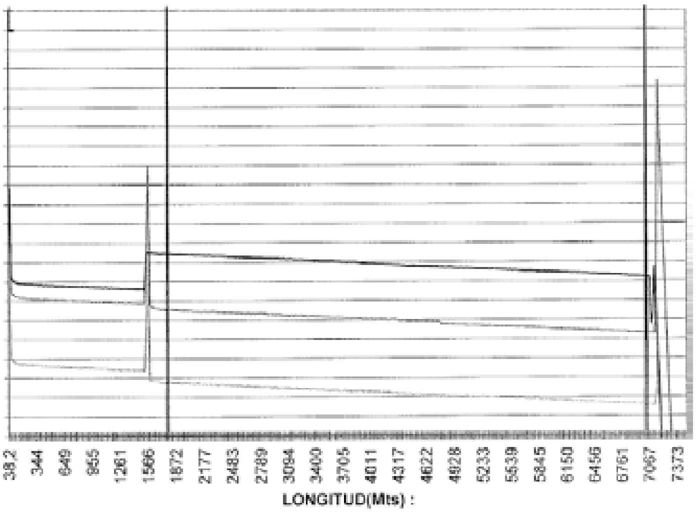
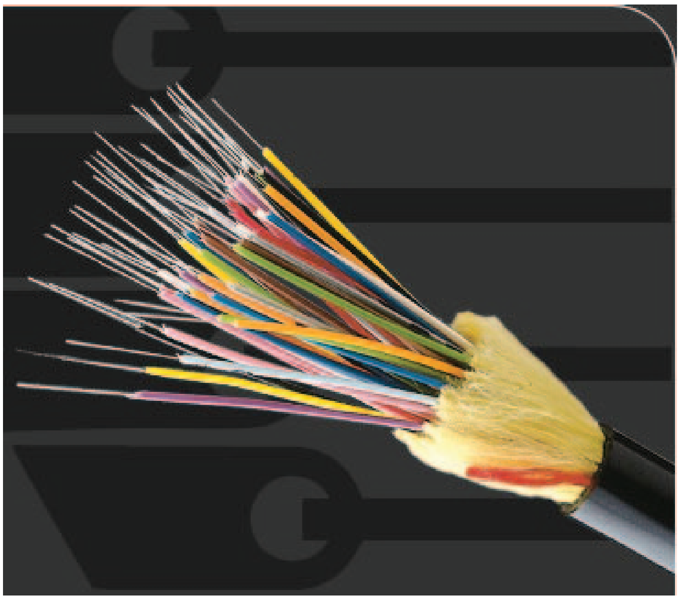
Abstract In this paper we present the adaptation of QUALIFO, a software designed to assure and control the quality of optic fiber cables, to a new OTDR model, concretely the Photon Kinetics 8000. While the communication with the rest of OTDRs is done through a National Instruments GPIB interface, this new model requires to be programmed with a Visual Basic script, and it is connected to QUALIFO via a simple local area network.

Introduction
The software QUALIFO acquires data from fibers with the help of different models of OTDR (Optical Time Domain Reflectometer), such as the Anritsu 9060, but they weren't able to acquire data from different measurement windows at the same time. This made the measuring time to increase, and so the whole process became less efficient.



To solve this situation, it was decided to acquire a new OTDR capable to measure the fibers in different windows at the same time. In this case, the chosen equipment was the Photon Kinetics 8000. This model adds this functionality, but it also needs to be programmed in a different way. While the previous models communicated with the software through a GPIB port, this one is connected with an Ethernet cable, and so we need to establish a new local area network in order to have access to the measured data. It also needs a Visual Basic script to program the measured parameters.

Programming the script and acquiring the measured data
First of all, we designed a Visual Basic script that defines the measuring parameters and orders the OTDR to perform a series of measurements. This was possible thanks to the OTDR own Visual Basic API, which contained most of its more useful parameters and functionalities. The results of the measurements are stored in a text file at the OTDR, which the QUALIFO software is able to read through the local area network.
The second issue needed to solve was to make the QUALIFO to order the execution of the designed script, because the program and the OTDR are located at different computers. The solution was to use the Microsoft application 'PsExec', that allows to execute processes in a remote system of the network. Thanks to it, synchronization between the QUALIFO and the OTDR was possible, ordering the execution of the script and waiting for the result to be written in the text file to obtain it.



Conclusions and future additions
For the moment, only the Photon Kinetics 8000 has been attached to the system, but thanks to this process of adaptation, more similar equipments will be able to integrate with the system to improve further more its efficiency.

FEATURES AND CAPABILITIES OF THE OBSEA

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www.obsea.es; www.cdsarti.org

Abstract
Needs for higher resolution, volume of information and longer data series are becoming increasingly important in oceanographic observation. In some applications traditional observation systems, such as autonomous oceanographic buoys and measurements taken from oceanographic ships, present serious disadvantages regarding costs, volume and delay of data or batteries autonomy. The new cabled underwater observatories can be modular, flexible and adapted to different uses and specifications to satisfy the requirements of the scientific community. The OBSEA project (www.obsea.es) is a collaborative task, between the CSIC (Consejo Superior de Investigaciones Científicas) and the UPC (Universitat Politècnica de Catalunya), to design and develop a seafloor observatory situated in front of the "Vilanova i la Geltrú" (Spain) coast into the marine reserve "Colls Miralpeix". OBSEA is a multiparameter laboratory for oceanographic studies integrated in the coastal zone and a test site for marine equipments included in the European Seafloor Observation Network (ESONET).

Introduction
The OBSEA infrastructure consists of two main installations: the Shore and the Subsea Station. The Subsea Station has all the oceanographic instruments and related electronics for its power supply, communications and control. The management servers, in charge of status monitoring and data collection, are located in the Shore Station. These data servers at Shore continually store the information and provide the interface with the world, giving controlled access to the scientific community.
The main objective of the OBSEA project is to provide a test-bed for the development of oceanographic instrumentation and at the same time have a shallow water observatory providing valuable information to the scientific community. This observatory provides real time data for marine observations keeping a database with historic values. All the instruments are transparently accessible to the users through a TCP/IP connection.
In the first stage the OBSEA observatory is equipped with three instruments: An underwater camera providing real time images from the seafloor, useful for scientific research and monitoring of marine organisms and at the same time, valid for security surveillance. A broadband hydrophone to monitor acoustic emissions from a wide variety of subsea phenomena perfect for condition metering, background noise recording and general marine research. The third installed instrument is a mooring CTD that measures temperature, conductivity and pressure, providing important information on long term salinity and thermal variations as well as tide evolution. Furthermore the OBSEA is not limited to these three sensors as it has free ports that can be used to connect any type of oceanographic instrument. In fact for several months an Acoustic Doppler Current Profiler has been installed in OBSEA for climate studies in Colls Miralpeix integrated coastal zone.

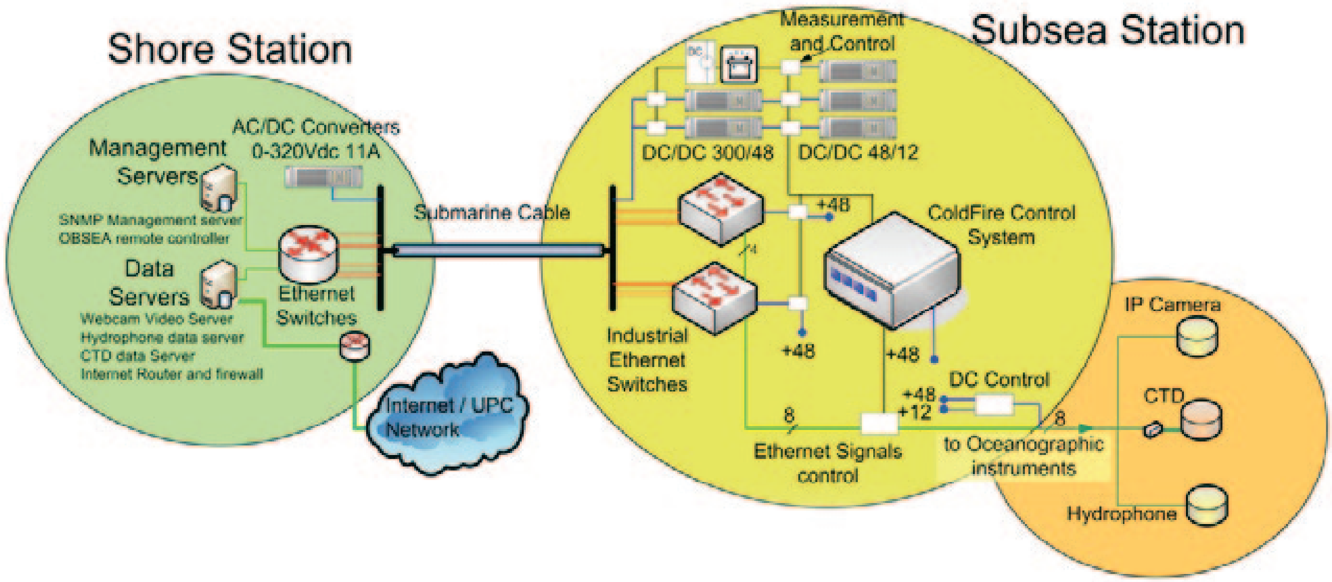

Figure: 1 Diagram of the OBSEA network

Conclusion and results

With OBSEA, a real time observation of multiple parameters in the marine environment is achieved. The main advantage of having a cabled observatory is to provide continuous power to the scientific instruments and to have a high bandwidth communication link.

The OBSEA station is a relatively low cost observatory (700k€), yet very capable that enables investigation and development of marine technology. The received data of the observatory is being stored for future studies and real time transmitted to the interested customers that have investigation projects related to sea observation and climate change. At the moment, there is an agreement for data sharing with the Catalonian Meteorological Institute for climate studies and some research projects have been done in parallel using the OBSEA infrastructure such as Boron measurements for water desalination studies. Noise monitoring has become one of the objectives of ESONET network, to investigate the noise level produced around European coastlines and its impact on the environment, especially in cetaceans. The OBSEA broadband hydrophone is used in the LIDO (Listening to the Deep Ocean Environment) ESONET project.

On the other hand, species identification, biomass estimation and associated behavioural rhythms is acquiring increasing importance for fishery management and biodiversity estimation in continental margin and deep-sea areas. In the past two decades, the number of submarine video-stations has progressively along with socio-economic interest ocean exploration. In this context, expandable Subsea Stations at different depths such as SARTI-UPC's western Mediterranean OBSEA were installed to measure several marine parameters, including videos. Accordingly, the Marine Sciences Institute (ICM) of the Spanish Research Council (CSIC) has elaborated a novel morphometry-based protocol for automated video-image analysis of data from OBSEA camera. This approach accomplishes species identification with Fourier Descriptors and Standard K-Nearest Neighbours analyses on their outlines, and performs animal movement tracking (by frame subtraction), both in the demersal and in the pelagic realm.

Figure: 2 Installation of the OBSEA in the Vilanova i la Geltrú Coast

Acknowledgements

The project OBSEA is funded by the Spanish Ministry of Education and Science (MEC) with the project "Interoperabilidad en redes de sensores marinos y ambientales" CTM2008-04517/MAR. The authors acknowledge the support of all of the members of the research team J.J Dañobeitia Marine Technology Unit (UTM-CSIC) Director, J. Sorribas (UTM-CSIC), J.Agguzi (ICM-CSIC), J. Cadena, C. Artero, P. Santamaria, N. Carreras, D. Toma, S. Shariat-Panahi. Subsea pictures have given by Ramon Margalef (STECMA).

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The SARTI Team

POWER CONSUMPTION EVALUATION FOR AN AWAC AND A GSM MODEM INSTALLED ON THE SARTI BUOY

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Abstract. This paper describes a procedure for measuring the combined electrical power consumption of an AWAC and a GSM modem. The purpose is to calculate the number of batteries and power required to provide and autonomy of 45 days. Experimental results show consumption in the order of 1 W/hr, and from this value adequate batteries are selected.

Introduction

The AWAC (Acoustic Wave and Current profiles) [1] is a sophisticate instrument that provides information about the currents profile and the direction of the waves in a single unit. It can measure the speed and flow direction of the currents, from the bottom to the surface in different layers, as well as long waves height, storm surges, wind waves and transient waves generated by local maritime traffic.

The research group SARTI is installing an AWAC next to the OBSEA underwater laboratory [2], offshore the coasts of Vilanova i la Geltrú (Spain), with the purpose to provide to the scientists real-time information of local currents and waves conditions.

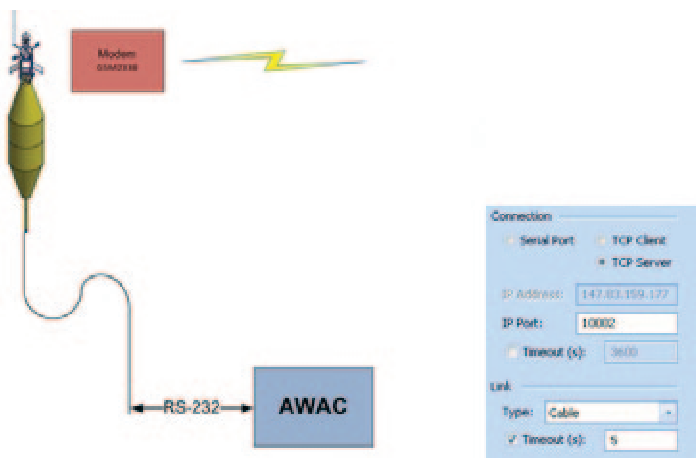
The AWAC will be powered with a pack of batteries installed in a water-tight aluminium cylinder, and the data generated will be sent to a data-center on the coast by a GSM modem installed in a buoy.

The challenge addressed in this paper is to calculate the power consumption of the AWAC and the GSM modem, and determine the dimensions and power of the batteries required to provide autonomy of 45 days, before changing the batteries.

2. System description

The system can be divided in two parts: first the AWAC and the batteries; and second, the GSM modem and the buoy. The AWAC and the batteries are located directly on the seabed, at a depth of 20m.

On the other hand, the GSM modem, a GSM2338 modem [3], is located at the top of the SARTI buoy, in the surface. The connection between the AWAC and the modem is done through a 60m cable using the RS-232 protocol, as shown in Figure 1. On the other hand, the GSM modem is configured as a client and sends the data to an IP address, through the port 10002, Figure 1. For real-time wave measurements, the SeaState [4] software was used, configured as a server listening to the port 10002. On Figure 2, it is possible to observe the AWAC submarine connector pin-out, and the modem connector, respectively.



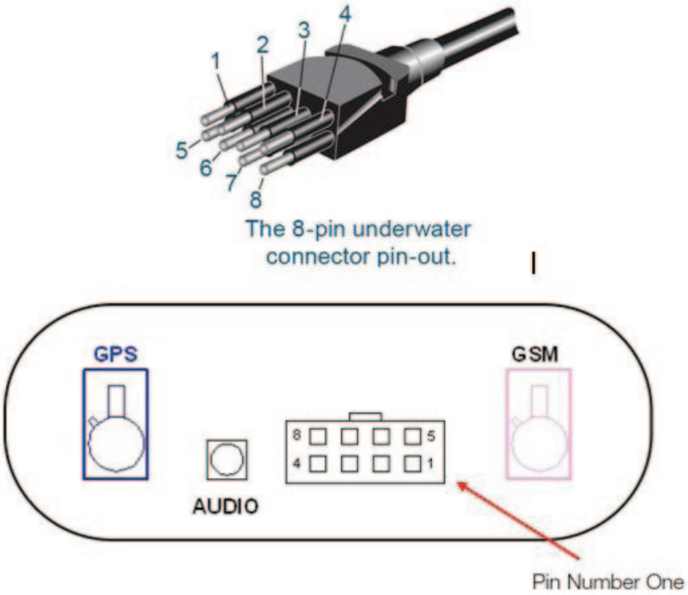


Figure 2. AWAC connector. Modem GSM2338 connector.

Test and Results

Different tests were conducted in order to determine the combined power consumption of the AWAC and the modem.

Test 1: Direct connection between the modem and the AWAC. The GSM modem configured as a client, and the AWAC configured as a server. As a result, this configuration did not work. So, the Test 2 was developed and tried.

Test 2: An intermediate program in LabView was added. The program receives the data sent by the modem to the IP xxx.xxx.xxx, to port 10002, and redirects it to port 10003 (SeaState settings as a client).

To verify the operation of the program a "middle software" monitors the data sent and received by the modem to the port 10002. On the other hand, also the data sent and received by the AWAC to modem is monitored (with a serial protocol analyzer). In this way, it was possible to ensure that the data sent by SeaState to the modem is the same as that generated by the AWAC.

On a first try, when the data was analyzed, it was observed that the data received and sent to the modem was not the same. The modem was not sending 6 of the 786 bytes required to read the instrument configuration. The problem was that the modem had enabled the use of the backspace key (0x08 in hexadecimal), which deletes the previous byte.

After changing the configuration of the modem, and verifying the correct transmission of data, the consumption test was setup.

(left) Figure 1. Modem connections between AWAC and GSM2338. AWAC configuration in SeaState.

3. 1 Consumption Test

For testing the electrical consumption, the AWAC and the GSM modem were connected in the laboratory and set to work for 3.8 days, while measuring the current every second. The voltage was constant, at 12 V.
Table 1 shows the minimum, the maximum, and the average current consumption on this period. From these values, the average consumption between AWAC and the modem is estimated to be ≈ 1 W/hr. From this, the average consumption between the AWAC and the modem, during 45 days, is estimated to be ≈ 1080 Wh.

AWAC + MODEM	CONSUMO [A]	
Consumo conjunto 3.8 dias (377.625 muestras)	Promedio	0,08337444
	Minimo	0,346
	Maximo	0,042

Table 1. Consumption AWAC + modem

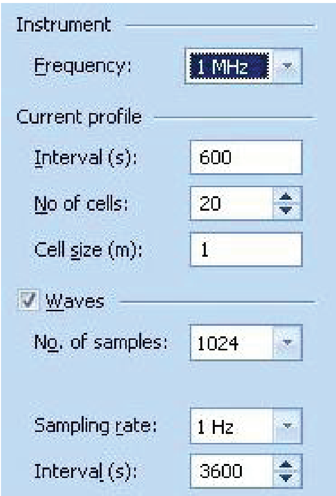


Figure 3. AWAC configuration

The parameters definitions and possible values are as follows:

- Acoustic frequency: 1 MHz, 600 kHz.
- Current profile interval: The time between each current pro file measurement.
- Number of cells and cell size: The number of cells, in combi nation with cell size, determines how far away from the sen sor measurements will be made.
- Waves: select to indicate that the AWAC has to measure waves.
- Number of samples: The wave spectra are calculated from the time series using FFT algorithms. This is why the number of samples is 512, 1024 or 2048. The highest number gives better accuracy, but requires more computational power.
- Sampling rate: As a general rule of thumb, the sampling should be set to 1 Hz for depths greater than 20 meters and 2 Hz for depths less than 20 meters.
- Interval: The time between each wave measurement (time series).

As shown in Figure 4, there are intervals where the AWAC sends data continuously, and there are also intervals where the AWAC sends data intermittently. These intervals depend on the configuration of the software SeaState AWAC and determine the average consumption (Figure 3).

The batteries chosen for this application are the ICR8650, shown in Figure 5. With this type of batteries, it is possible to reach an autonomy of 77 days. This provides a safety margin in case it is not possible to change the batteries at 45 days. Figure 6 shows the characteristic of the batteries, Cycle life vs. Capacity.

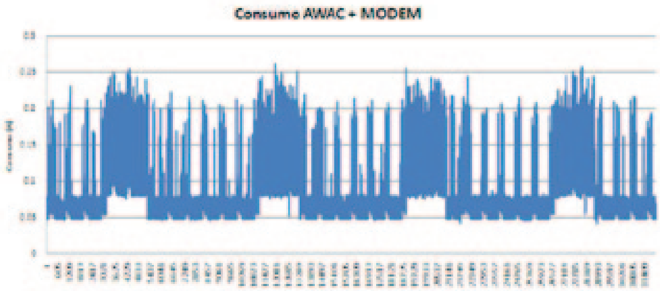
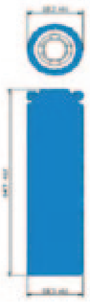


Figure 4. Consumption Graphics; Axis x: samples; Axis y: consumption [A] (Vcc = 12V)

Conclusion

In this document a proposal for measuring the power consumption of an AWAC and a GSM modem has been presented. It has been shown that the energy required is approximately 1 W/hr. Consequently, a set of batteries was proposed to warranty and autonomy of at least 45 days.



Model ICR18650 S3		
0.2C Capacity *	Nominal	2200 mAh
	Minimum	2150 mAh
0.5C Capacity	Average	2210 mAh
Dimensions	Diameter	Max. 18.4 mm
	Height	Max. 65.1 mm
Weight (Typical)		43.5grams
Nominal Voltage		3.6V
Internal Impedance		≤ 80 mOhm
Cycle Performance **		≥ 80% of initial capacity at 300 cycles

Figure 5. Battery characteristics

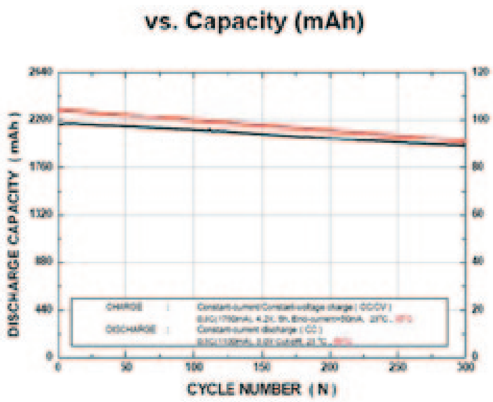


Figure 6. Cycle life vs Capacity (mAh)

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SPECIES HABITS OBSERVATION USING ACOUSTIC TECHNIQUES

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The aim of this project is to implement a system to monitor marine species using underwater acoustic technologies. The system is composed by coded transmitters which send data to different hydrophones installed in the seabed. The data stored by the different hydrophones is collected and analyzed after the experiments. A correct design and techniques of synchronization are taken into account to perform the tracking of the specie as a final purpose.
Nowadays, due to overexploitation of marine species, there is the need to increase the information available on the biology of some exploited species. The development of wireless communication systems and the increasing possibility of miniaturization of sensors, storage and data processing devices, have opened a door to a new generation of distributed smart sensor networks, spatially or geographically in the environment and connected by a communication network. The system we are proposing is composed by different transmitters (transponders), one for each individual, and five autonomous hydrophones located in artificial reefs near the coast, Figure 1.
The transmitter under consideration is the Vemco V6, which operates at 180 kHz, which operates well in both fresh and salt water. An interesting feature of this device is its size and weight (6mm diameter and 0.5 grams in water) and the possibility to program easily the latency of emitting, which can be changed from some seconds to minutes. This feature permits to extend the autonomy of the transmitter when the experiment requires long period of time (up to one year sending pings every four minutes).
The data transmitted will be processed by different hydrophones and stored with a time-stamp. With a known and accurate location of the five hydrophones, and a good synchronization between them, it is possible to achive the tracking of the specie using the acoustic triangulation technique [2]; to calculate the uncertenly range of tracking, different pingers will be located in known positions in order to correct the clock drift between hydrophones and also other problems in the field.
Actually, the project is under development, and some tests are currently in progress: reflections in closed spaces, interferences, downloading data from the hydrophone in water and so on. In parallel are being studied new materials to attach the transmitter to small species with shell, and some tries are made to avoid losing of the transmitter if the specie sheds.
In the next steps the hydrophones will be installed in the different reefs near Sant Carles de la Ràpita, Catalonia, and some experiments will be performed with juvenile European spider crabs Maja squinado.

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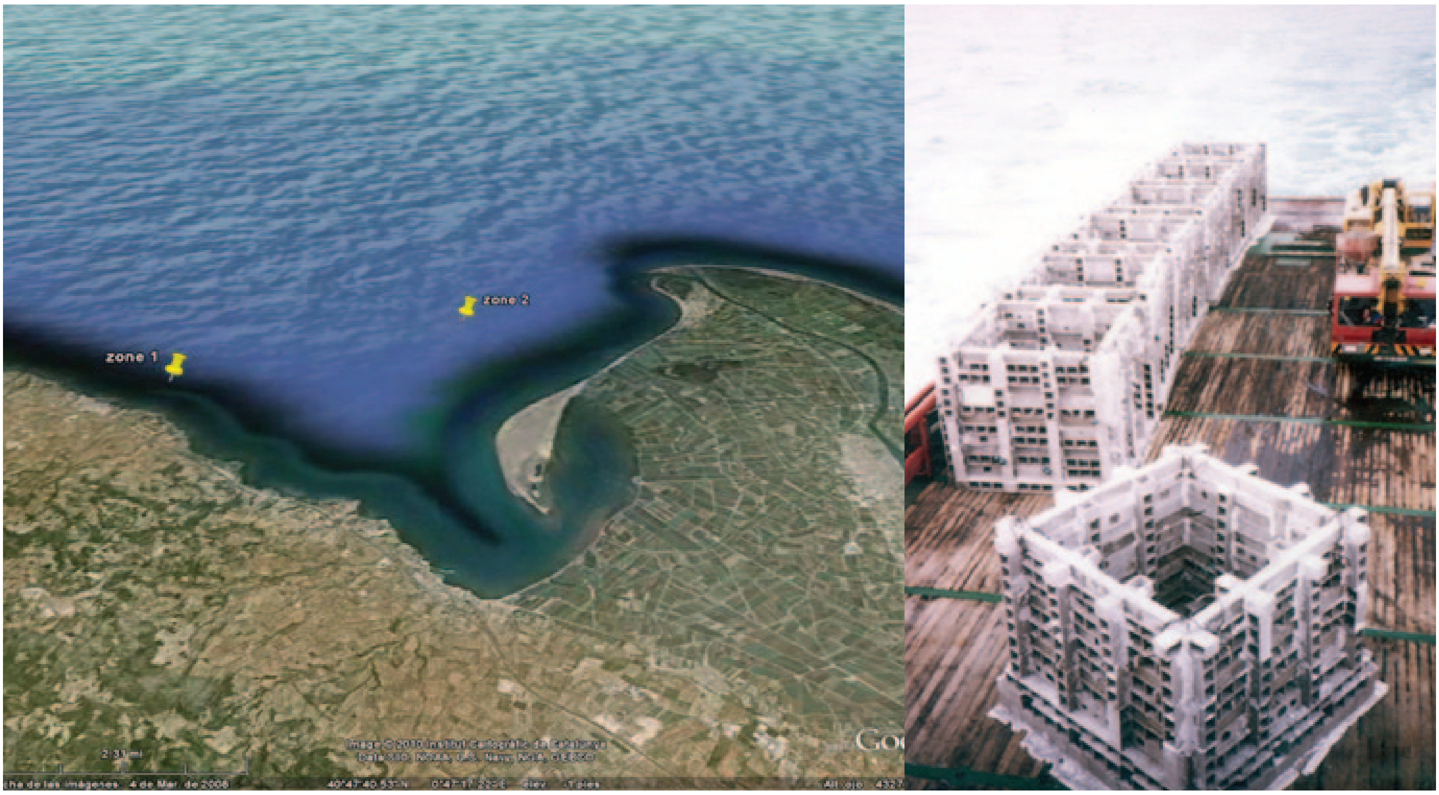

Figure 1 Artificial reefs and location in the area of study

INTEGRATION OF AN ACQUISITION SYSTEM FOR STUDYING THE ENERGY CONSUMPTION OF TRAWLER VESSELS

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Abstract- A remote data measurement and acquisition system has been developed to study the energy consumption of fishing trawler vessels, with the purpose to improve their efficiency. The system consists on a sensor network distributed along the vessel to monitor fuel consumption, navigation and fishing parameters. The data is acquired, stored and packaged in order to be sent via a GPRS modem to a land station, where data is analyzed and processed to study techniques, equipments and materials to improve the energy efficiency.

Introduction

Nowadays, fishing is an economical, social and environmental sensitive sector. The main cost of the industry is related to fuel consumption: in Catalonia, more than 50% of the fishing sales incomes are used for paying the fuel bill. Currently, this local fishing industry consumes about 78,000,000 liters of fuel per year. The continuous increase in fuel prices, in addition with the sales method, decreases the performance of the sector, which needs to improve or modify their fishing methods to reduce fuel consumption.

This work describes a remote acquisition system for measuring and collecting accurate data (navigation, fuel consumption, and fishing parameters) on the Catalonia fishing trawler vessels, on real working conditions. With the collected information and data, different test and analysis have been performed to improve the energy consumption, to study the influence of different navigation and fishing techniques and new materials. In addition, this tool will also help to reduce the environmental impact of this industry, as the consumed fuel is decreased.

System Design

The system consist on a sensor network, as shown in Fig. 1, that connects all the transducers with the acquisition system, composed of a RT processor and FPGA in which has been programmed the different communication protocols of the digital sensors. If data from digital sensors arrive in the right format, the FPGA sends the data to the processor using DMA, and is recorded with the time-stamp. The processor also stores data into files and manage the data transmission to the land station through the GPRS modem.

One part of the network consists on a set of different digital sensors with the RS422 (NMEA0183) and RS485 interfaces, which allows locating the sensors far away from the acquisition system. These sensors measure the GPS position, the ground and water speed, the pitch and roll, the heading, the wind speed and direction, the engine rpm, the fuel consumption, the battery current, and the strength of both fishing gears.

On the other hand, there is a group of analog current sensors (4 to 20mA) dedicated to measure temperatures (the engine room, the engine and its exhaust), the pressure (the engine room, the hydraulics and the exhaust), and the oxygen concentration in the engines' admission [1].

Data Transmissions

The GRPS communication system transfers the acquired data to the land station. This implementation does not provide a real-time monitoring, but it allows a periodic monitoring every time the vessel has GPRS coverage, which can be in a regular daily

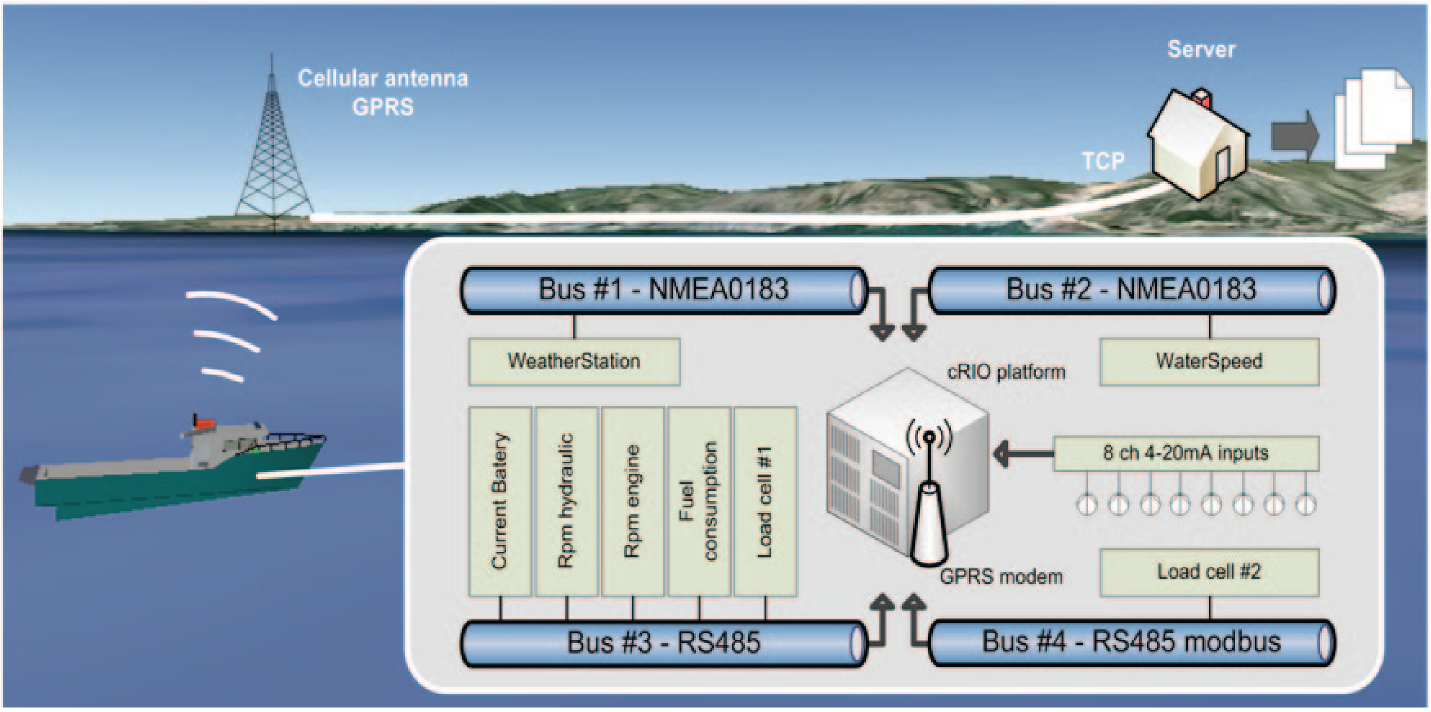


Fig. 1 System design

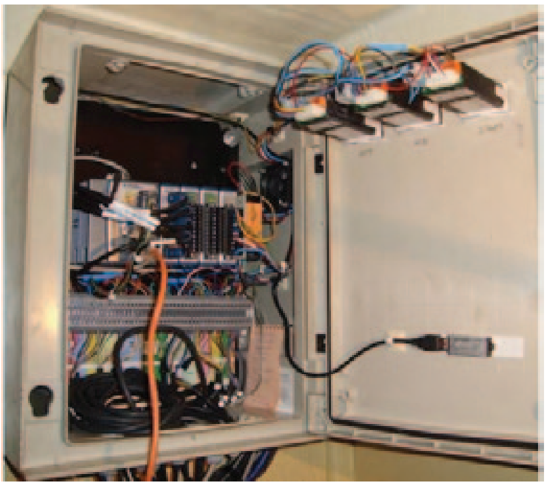
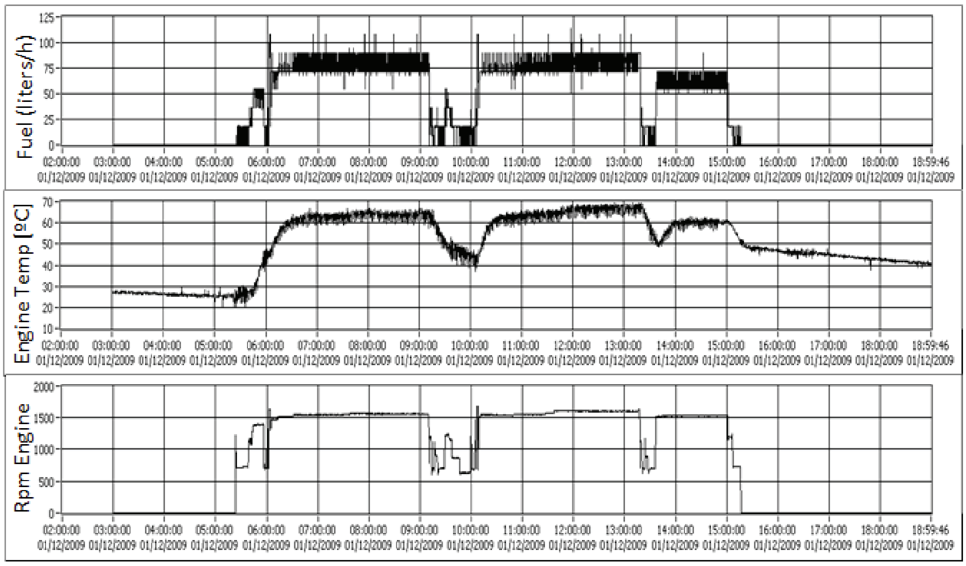


Fig. 2 Acquisition system

(down) Part of data from a trawler vessel



basis. Although the GPRS speed is low [2], the system is able to send all queued data before the vessel reaches port.

Results

The system has been installed on five trawler vessels and different tests have been carried out to study the fuel consumption. Studies show that it is possible to reduce the fuel consumption if some specific technical actions are applied. Specifically, current tests shown that it is possible to reduce up to 29% of energy per day, which is the consequence of reducing 41% of fuel during the trawler fishing activity, and 16% due to an efficient navigation management. This improvement can represent, to a standard Catalonia fishing trawler, a save of up to 18,000 Euro per year, approximately a reduction of 120 tons on CO2 emissions [3].

Conclusions

A robust and autonomous system for monitoring energy efficiency in trawler vessels has been designed. This system allows monitoring different navigation and fishing parameters related to the energy consumption during their fishing activities.
Successful results were obtained thanks to the remote monitoring using the GPRS communication. This system has shown to be a good solution (technically and economical), also if no real-time data is required, GPRS is an economical solution for data transmission. This acquisition system is currently in use by different trawlers of Catalonia, and the collected data is being used to study new techniques to reduce the energy consumption of these vessels.

Acknowledgements

The Project Desarrollo de un sistema autónomo de adquisición de datos para la mejora de la eficiencia energética de los buques de arrastre de la flota catalana is a joint work between Direcció General de Pesca i Acció Marítima, Departament d'Agricultura, Alimentació i Acció Rural Generalitat de Catalunya, Tragsatec, Col•legi d'Enginyers Navals i Oceanogràfics de Catalunya and the Technological Development Center Remote Acquisition and Data Processing Systems from Technical University of Catalonia (UPC).

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IN-TRA-NET, A PROJECT FOR EDUCATIONAL TRAINING

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Abstract
The project IN-TRA-NET is a proposal for designing a learning environment for specific continuous updating of European professionals and SMEs workers that use electronic and control apparatus. The UPC has developed three applications as a proof of concept, concerning a didactic course, and two monitoring systems for processes and electronic instruments.

Introduction
The IN-TRA-NET (INnovation TRAnsfer NETwork) [1] is a project funded by the Eurpean Comision under the "Leonardo da Vinci: Lifelong Learning Programme", with the main purpose of creating a specific learning environment for European professionals and SME (small and medium enterprises) workers that use electronic equipments.
The learning environment is based on a Web application where professionals or SME workers can access to didactic material and specific practical courses on different electronic equipments, or for monitoring processes, with the possibility to control the real equipments remotely using any standard browser.
The Technical University of Catalonia, through the research group SARTI, participates as a partner of IN-TRA-NET contributing with research activities focused on the design of automatic applications in the area of virtual instrumentation and technologies for the marine environment. The other partners of the project are: Italy, through the University of Sannio, the Benevento Industrial Union, and the enterprise Dida Network; and Slovakia, through the Technical University of Košice.

2. Project Development
The first activity of the project was to detect user's needs: to find the specific necessities of local enterprises and workers, in order to implement explicit courses or applications to improve their working performance using electronic equipments, or for monitoring remote processes.
In the case of the UPC, a specific questionnaire was produced and sent to key enterprises in the local area of Garraf, Spain. From the survey, three specific necessities were selected for development as a proof of concept for the project:

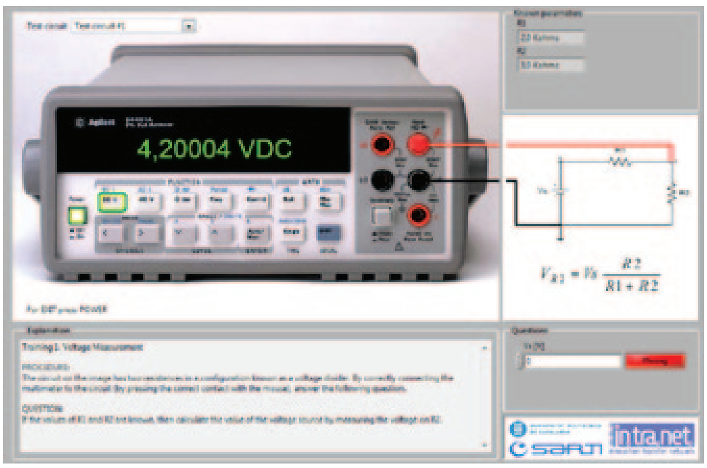

Figure 1. Digital Multimeter exercise application.

1. The design of a specific didactic course using a digital multimeter;
2. The implementation of a remote monitoring system for observing fishing trawler vessels performance;
3. The realization of an application for remote observation of marine scientific measurement equipments.

2.1 Didactic course for basic measurements with a digital multimeter.
The course consist on a web application where users can access an interface that has been divided in different areas, as shown in Figure 1. The main area shows a commercial multimeter and an "exercise" selector. At the bottom, the instructions for the exercise are shown, and finally, the values of the parameters and the answer area are located to the right. With this application, workers can learn how to use and make measurements using this kind of instruments.

2.2 Remote monitoring of trawler vessels.
A remote monitoring system was developed in order to observe different parameters of fishing vessels [2] (speed, temperature, position, fuel consumption, wind speed and direction, etc.), Figure 2. This monitoring allows the fishing companies, and workers to test different fishing strategies and technologies, in order to improve the efficiency of fuel consumption.

Figure 2. Monitored trawler vessel.

2.3 Remote observation of marine scientific measurement equipments.
Using the Spanish underwater observatory OBSEA [3], Figure 3, a remote control for scientific measurements instruments was implemented. The OBSEA is a cable observatory located at 4 km offshore from the coast of Vilanova i la Geltrú (Spain). Its cabled connection to land allows the use of electricity and fiber optics connection for control and data transmission.
OBSEA currently has connected a video camera with live streaming and sensors for measuring temperature, pressure, salinity, currents, etc. Different applications have been implemented for monitoring the measurements of the scientific instruments, and observing the video images of the camera [3]. These applications allows students, academic personnel and scientists to observe on real-time the measurements of the different equip-

ments located in the laboratory, giving a real feeling and experience with this sophisticate instruments.

Conclusions

The IN-TRA-NET philosophy has shown to be interesting for companies that try to improve their performance through continuous updating of their workers, using web applications for remotely control equipments or monitoring processes. It has been applied to a didactic course for learning basic measurements with a multimeter, and for remote monitoring of a trawler vessel and scientific marine instruments.

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Figure 3. OBSEA observatory.

OBSEA SOFTWARE DATA STRUCTURE

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Introduction

The OBSEA observatory must provide data and services in a suitable way to users who may use different platforms and programs. The purpose of this work is to provide a service transparent to the customers and compatible with the different platforms and programs.

Nowadays, the most widely used protocol is the WWW, and a Website can reach many users. However, there are other types of customers who need specific formatted data; the reasons are the tools and programs that they may use to study and process the information. In this case, several solutions have been developed: DataTurbine, SQL, metadata, and custom formatted data.

From sensor to client

The RAW data from the OBSEA instruments is routed to the Lluna server, where the data is collected and stored by a proprietary program developed at SARTI. Before the copy is performed, the data is resent to several ports and destinations. The aim of this application is to send the incoming data to any service required and be able to change destinations and services with minimal impact. Therefore, the application is able to resend data to whatever destination and port is required. The destinations and ports are stored in a configuration file that is read by the program during its execution.

Another SARTI proprietary application in Lluna server processes the incoming data, separating the CTD, the Weather Station, and the AWAC data, in order to insert the measurements in a SQL database. This application uses also a configuration file to know the format of the RAW data and decodes the measurements required for each instrument.

In this application, also NMEA sentence has been built, with the data from instruments as well as time-stamp from instruments and server. This implementation will become in the near future a metadata to offer new services.

Data in the Website

The website presents the data from the different sensors using different methods. The data from the CTD is retrieved from a SQL database. In the other hand, the AWAC and hydrophone data is stored in a folder, so the website gets the data from this folder.

Conclusions

A modular designed system for providing information to different users has been presented. This configuration and applications allow an easy expansion of the network and the system, and it is compatible with all the platforms and Operating Systems.

MARINE FAUNA IDENTIFICATION VIA IMAGE ANALYSIS FROM OBSEA

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Abstract. The OBSEA laboratory has integrated an IP-Video camera that works 24 hours per day recording images of local fauna. These images have been analyzed in order to identify the different marine organisms in the vicinities.

Introduction

OBSEA is an underwater observatory connected to an earth station via a cable that provides electrical energy and a fiber optic link. One of the instruments attached to the OBSEA is a digital video camera that takes real-time images of the seafloor, which allows the observation and recognition of several different marine organisms near the area where OBSEA is located, Figure 1.
The study evaluates the fluctuations in counted individuals for several fish species by video image analysis, Figure 2. Long-term data sets were acquired as an example of the high scientific value and practical application of OBSEA. With derived counts the local biodiversity in an artificial reef from a marine protected area has been estimated.

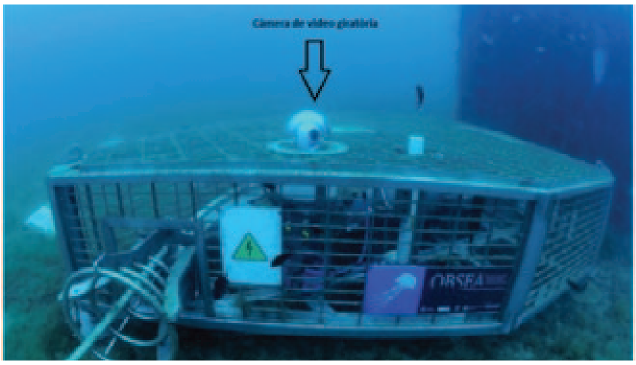

Figure 1. Expandable Seafloor Observatory in front of Vilanova i la Geltrú with the side detail of the artificial barrier.

Figure 2. Artificial reef in Colls Miralpeix Marine Reserve.

Acquisition

Digital images were acquired only during daylight hours, one each 60 min at different angles in order to cover a complete 360º rotation. This spatial and temporal transect was composed by 8 positions (images): 3 focusing on the artificial reef; 4 focusing on sandy bottom where the algae Caulerpa racemosa dominates; and finally 1 focusing on the water mass. Two images with reef and two images without reef were taken at the beginning of each hour of the day during the first two weeks of every month, on alternate days from July to November 2009. Both pairs replicas were used in order to: 1) to study the effect of reef presence/absence, on recognized fishes, biodiversity and the relative abundance of their local populations; and 2) to characterize the temporal patterns of distribution at daily and seasonal scales (i.e. intraday and seasonal replicas). Variables studied were: 1) identified fish to species 2) total fish number per species; 3) the Shannon biodiversity index, see Figure 3 and Figure 4. In frames where fish density were too large (i.e. in schools and banks) we considered the total number as equal to 50, but in few clear cases the number was 100.

Results

Our results indicated that the local specific composition was similar to other Western Mediterranean areas. There were 38% of visualized but not identified fish species, since too distant individuals were not distinguishable. Fish species, such as Common two-banded Seabream (Diplodus vulgaris), Damselfish (Chromis chromis), Black Seabream (Spondylosoma cantharus), Withe Seabream (Diplodus sargus), Annular Seabream (Diplodus annularis) and Common Dentex (Dentex dentex), showed different levels of diel and seasonal variation. Daily variability is important for few species as top-down predators (D. Dentex) which appeared mostly in crepuscular hours. Seasonal variability is very important and determines the principal changes suffered in reefs populations during the year cycle. The reef exerted a strong influence on species composition. The effect of increasing structural complexity on biodiversity was already detected in several previous studies. Fish schools were often located in one side of the reef or in the other. That behavior optimizes efforts in front of strong current episodes. Some author argued fish come to feed on reefs, and concluded that energy is transferred from artificial reefs to fishes through decapods, amphipods and juvenile which are concentrated on these structures. The numbers of individuals per group and biodiversity levels were maintained within certain constancy over time sustained by the replacement of some species to another.
The advantages to have the video camera located on OBSEA are: the high sampling frequency over extended temporal windows, and the avoidance of diving (which is invasive and influence fish behavior). In conclusion, long-term studies based on powerful biological data series from image analysis represent a suitable tool for observing marine species.

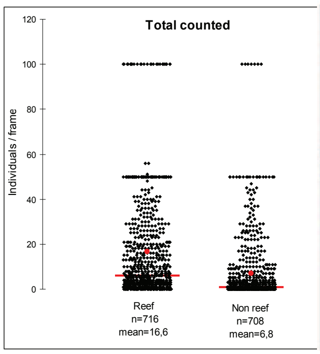

Figure 3. Number of fishes observed in frames from the artificial reef and non reef (seabed). Red circle corresponds to mean and red stripe to median values.

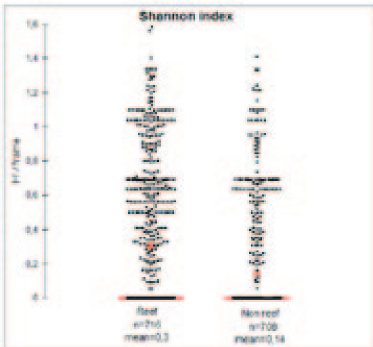

Figure 4. Values of Shannon biodiversity index for frames from the artificial reef and non reef (seab ed). Red circle corresponds to mean and red stripe to median values.

OBSEA HOSTING HOUSE

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Introduction
The main features of the OBSEA seafloor observatory are the connectivity and modularity. Its design allows the easy connection of any device or instrument with Ethernet interface. Nowadays, the observatory has three instruments (which provide five measurements of data) that are connected to the hardware infrastructure, which has the tasks to manage the communications and to process and store data to RAW files, or MySQL records in a comfortable way.
The network infrastructure, shown in Figure 1, is composed by four servers, named as: Dofi, Lluna, Pop and Medusa. The Dofí server is the responsible for acquiring data from the hydrophone, as well as storing the sound samples and generating a WAV file, and temporal graph-files, which are then sent to Lluna server by FTP.
The main task of Lluna server is routing the traffic data between the private and the public networks. Pop server is the unique client of the IP camera, and it manages and provides the video services. Its main assignment is to serve video to every client that requests it, solving the connection limit (ten clients) that has the IP camera. The last server, Medusa, monitors the activity and status of every equipment in the network.

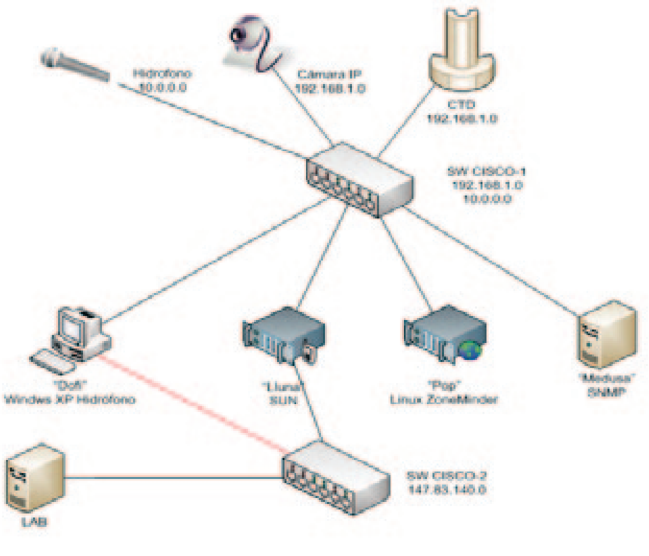

Figure 1. Instruments and hardware infrastructure of the OBSEA

OBSEA Website
The data acquired from the underwater laboratory instruments is shown in the OBSEA web site in real-time (www.obsea.es). Also, there is a weather station located in SARTI facilities that provides meteorological information to the web site. With these data, from sea and land, it is possible to analyze and correlate the seabed data with the weather conditions.

Server Sizing
The server Lluna has the best features of the network, because it manages and controls the traffic inside and outside the OBSEA network, shown in Figure 2; and on the other hand, it controls and buffers the high traffic data of the instruments.
In order to have an efficient system, and to avoid blocking the traffic, the different tasks and services have been programmed independently. Some services have been programmed using different programming languages and O.S., taking advantage of the specific capabilities and resources that they offer. Using virtual machines was a key to allow all the systems to work together, and sharing the resources, without blocking themselves.

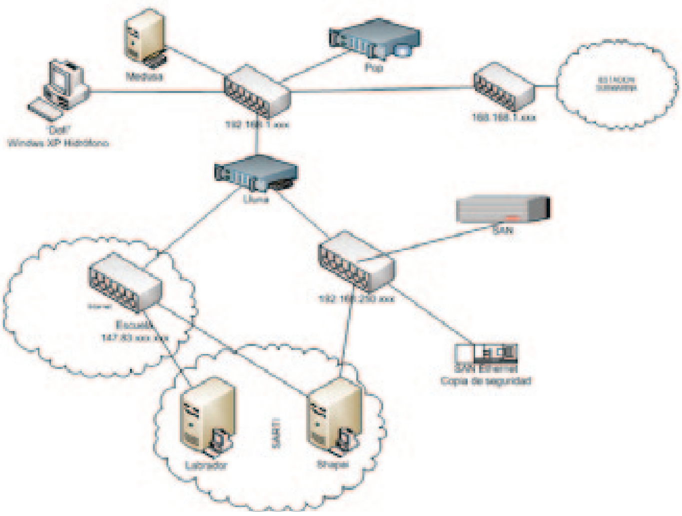

Fig. 2 OBSEA network infrastructure

Data storage
The infrastructure has an own range in the private network to store data (Fig. 2). The data storage system is composed by a Storage Area Network (SAN), with redundant storage able to manage up to ten iSCSI disks. The disks management is done on the Lluna server.
The data storage is scalable by adding disks to the slots, and the system is able to recognize them and expand the storage automatically. If the disks capacity exceeds the maximum storage, up to 10 disks, it is possible to add more SAN's to the private network to expand the system.

Conclusions
A hardware structure in the OBSEA network that permits the connectivity of any device or instrument with Ethernet interface has been developed. The network and the equipments installed allow retrieving, process, and storing data from instruments, as well as redirect the data to anywhere. It is a modular system, and the unique limitation is the capability of the Ethernet network.

DESIGNING OF A VOLCANO SIMULATOR

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Introduction

In order to study the behavior of magmatic fluids in volcanoes, a small scale simulator chamber has been designed and it is in process of implementation. The system under development reproduces the conditions inside volcanoes in three different faces: before, during and after an eruption. Two main experiments are planned to be tested in this magmatic chamber:

1- First, two liquids (water and water with dye) are injected in the chamber and mix until a desired pressure is achieved (from 1 up to 4 atmospheres). Then, gas (compressed air) is introduced in order to decrease the density of the mixture at a given pressure. When the mixture is ready, it is heated until a desired temperature (from ambient temperature up to 150 ºC), at this precise moment, a valve opens to simulate a fissure in the rock and a slight loss of pressure (eruption). This is the point desired to be studied, the behavior of the mixture during the loss of pressure. Also, it is possible to introduce more liquid or gas if it is necessary for the experiment.

2- In the second experiment, a force is applied on top of the chamber (a solid metallic cylinder compresses the mixture), simulating the weight of a rock. By opening an exhaust valve, the pressure inside the chamber will decrease, and when the force produced by the cylinder is equal or greater than the pressure inside the chamber, the cylinder will begin to fall inside the chamber, and the fluids inside will flow through the gap in-between the cylinder and the chamber. The behavior of the liquid flowing through the gap is the main interesting part of the process, and it will be observed and studied. The actual pressures and mixtures will be defined on the basis of the experiment, trying different combinations.

The volcano simulator is a complex system that can be divided in different modules: a) the magmatic chamber; b) the pneumatic and hydraulic system and its control;

a) Magmatic chamber characteristics

The chamber is a crystal cylinder that allows a visual analysis of the processes developing inside the container. It will hold pressures of up to 4 atmospheres and temperatures of up to 150 ºC. Because of these specifications and the type of material, glass, it requires a protective shell of methacrylate to protect the scientific staff in case of a crystal break.

b) Pneumatic and hydraulic systems and its control

Two separated deposits store the liquids that will mix inside the chamber. The fluids can be pre-heated (up to 100 ºC) before enter the chamber. A pneumatic system has been designed to control the output pressure of the liquids, Figure 1. Since it is a system of high pressures and temperatures, the structure has an exhaust valve as security system, and a stop in case of a breakdown.

At the base of the chamber, there is a fluid distributor that introduces the liquids to the chamber trough either one or several holes. This allows simulating different scenarios of fractures, providing a single or multiple inputs to the chamber.

c) Acquisition system

Different variables are required to be observed during the experiment, as are the temperature, the pressure, and fluids flow at different points of the system. For this purpose, an acquisition system, connected to a PC, has been implemented, which also allows to control the operation and stores the data of interest.

Conclusions

A tool for studying the behavior of magmatic fluids inside volcanoes has been proposed and developed. This design permits to study and simulate the volcano activity in a laboratory, and to observe the fluids before and during the simulated eruptions.

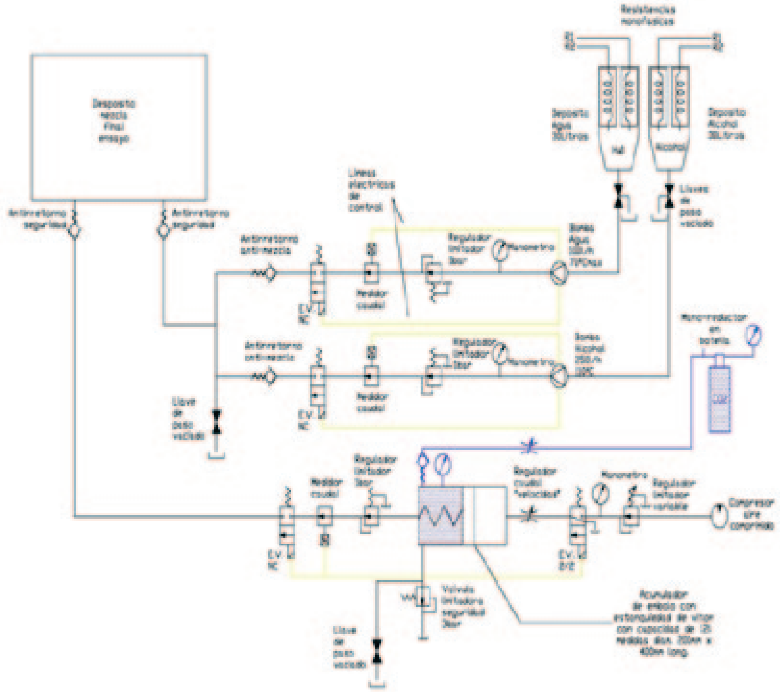

Fig. 1 Diagram of the pneumatic and hydraulic systems

LINEAR CONTROL DESIGN FOR A PATH PLANNING OF AUV-CORMORAN

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Abstract- This work shows a linearization for a AUV-Cormoran dynamic mathematical model with the aim of designing linear controllers for trajectory control. The model is developed under 3 degrees of freedom and the whole system has been simulated in Matlab Simulink environment. The linearization model is based on understanding the dynamics of the vehicle under different operating speeds, which present a different behavior, yet to be controlled by a single linear controller. For the linear control has raised the PD control that allows eliminate the position error, performing simulations of different trajectories and comparing its results in stability.

Introduction

The Cormoran is a low-cost vehicle for ocean observing, is a hybrid of the AUV (Autonomous Underwater Vehicles) and ASV (Autonomous Surface Vehicles) which was built in the Mediterranean Institute of Advanced Studies (IMEDEA), from Mallorca (Spain), for a group of Oceanography, in collaboration with the University of the Balearic Islands. Figure 1 shows a picture of the vehicle.

The vehicle was designed to sail just below the water surface along a predetermined path following way-points, in which it sinks vertically and obtains samples of the water column. Then it emerges also vertically and transmits by GSM messages with the most relevant data (temperature, salinity, depth and position, given by a GPS on board).

Afterwards, it moves to a new way-point repeating the process, and so on until a mission is completed [1].

Figure 1. AUV Cormoran

Vehicle Model in 3DOF

Due to the movements of the vehicle described above, the heave, roll and pitch can be neglected, so that the characterization of the vehicle can be achieved through a 3-DOF model for the advance ( ), lateral movement ( ) and yaw angle ( ) [2]. Vectors position, speed and strength can be expressed as shown in (2.1).

$$\eta = [x, y, \psi]$$
$$\nu = [u, v, r]$$
$$\tau = [X, Y, N] \qquad \textbf{(2,1)}$$

II-A. Vehicle Dynamics

Equation (2.2) is the nonlinear dynamic equation of an underwater vehicle,

$$M_{RB}\dot{\nu} + C_{RB}(\nu)\nu = \tau_{RB} \qquad \textbf{(2,2)}$$

where,

M_{RE} is the mass and inertia matrix.

C_{RE} is the centripetal and Coriolis matrix.

τ_{RE} is the hydrodynamic force and moment general vector (produced by movement of the hull in the water, forces due to the control surfaces, the forces generated by the propulsion system and the forces due to environmental perturbations).

ν is the velocity vector.

Taking into account the dynamic equation of the vehicle in (2.2), and making an assessment of forces and moments of terms, the equations can be expressed describing the nonlinear model of the vehicle as Cormoran shows in (2.3). In the same equation, combine the terms of the rigid body dynamics, the added mass, the damping terms, and the terms of the thrust (see Figure 2 for the block diagram of this dynamic).

$$m\dot{u} - mvr = X_{\dot{u}}\dot{u} - Y_{\dot{v}}vr - Y_{r}r^2 + X_{u|u|}u|u| + \\ + X_{prop} \qquad \textbf{(2,3)}$$

Linearization

To design a linear control system, first it is necessary obtain a linear model of the system to which these techniques will be applied. The model is linearized respect the forward speed u, neglecting the velocities v and r, because they are small compared with u; similar approaches were carried out work on the vehicle REMUS [3], as well as in the Infante AUV [4]. Consequently, the operating point on which we will work is (u,v,r) = (un 0,0).

Applying Taylor series approximations [5] to (2.3), produce the linear vehicle model expressed in matrix form, equation (3.1). For this model, the propulsion motor X_{prop} and the rudder angle δ are considered the system inputs.

$$
\begin{aligned}
m\dot{v} + mur = {} & Y_{\dot{v}}\dot{v} + Y_{\dot{r}}\dot{r} + X_{\dot{u}}ur + Y_{v|v|}v|v| + \\
& + Y_{r|r|}r|r| + Y_{uvf}uv + Y_{urf}ur + \\
& + Y_{uuf}u^2\delta_r \\
I_z\dot{r} = {} & N_{\dot{v}}\dot{v} + N_{\dot{r}}\dot{r} + Y_{\dot{r}}ur - (X_{\dot{u}} - Y_{\dot{v}})uv + \\
& + N_{v|v|}v|v| + N_{r|r|}r|r| + N_{uvf}uv + \\
& + N_{urf}ur + N_{uuf}u^2\delta_r
\end{aligned}
$$

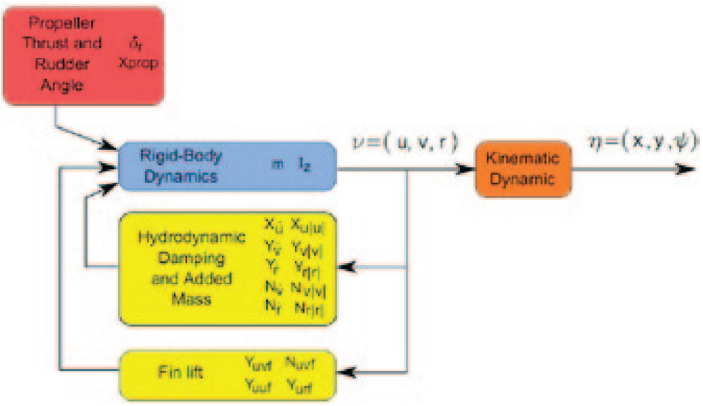

Figure 2. Block diagram of vehicle dynamics

$$
\begin{bmatrix} -2X_{u|u|} & 0 & 0 \\ 0 & -Y_{uvf} & m - X_{\dot{u}} - Y_{urf} \\ 0 & X_{\dot{u}} - Y_{\dot{v}} - N_{uvf} & -Y_{\dot{r}} - N_{urf} \end{bmatrix}
\begin{bmatrix} \Delta u \\ \Delta v \\ \Delta r \end{bmatrix} u_0 +
$$
$$
+ \begin{bmatrix} m - X_{\dot{u}} & 0 & 0 \\ 0 & m - Y_{\dot{v}} & -Y_{\dot{r}} \\ 0 & -N_{\dot{v}} & I_z - N_{\dot{r}} \end{bmatrix}
\begin{bmatrix} \Delta\dot{u} \\ \Delta\dot{v} \\ \Delta\dot{r} \end{bmatrix} =
\begin{bmatrix} X_{prop} \\ Y_{uuf}u_0^2\Delta\delta_r \\ N_{uuf}u_0^2\Delta\delta_r \end{bmatrix}
$$

(3,1)

III-A. Analysis of poles and zeros

Following the linearization of (3.1) are calculated the transfer function of yaw with respect to the rudder angle, for different speeds advance from to . These transfer functions have a pole and a zero that are very close between them, so it was decided to cancel them to simplify the transfer function.

Figure 3 shows these poles in closed loop with negative gain (due of the opposite relationship between the yaw angle and rudder angle) so that the system is stable. It is important to know that while increases the speed, the system response becoming faster, and at the same time maintains the overshoot.

Control Design

The tracking of requirements focus on designing a controller that takes the whole nonlinear system to a desired dynamic area. This dynamic area will be defined as desired specifications are achieved, such the time in (4.1).

In Figure 4, the dynamic target zone is delimited for the vehicle showed in (4.1)

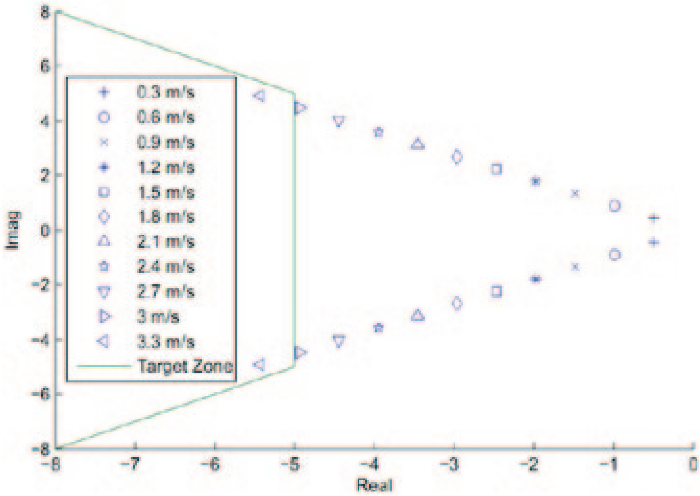

Figure 3. Closed loop Poles in yaw with gain k=-1 for differents u

IV-A. PD Control

For the controller design, it is sufficient to implement a PD control in the system linearization to eliminate the position error and reach the target zone stated in (4.1).

When the system is at a rate of 3.3m/s, the desired dynamic is already accomplished by simply applying a proportional control with gain k = -1, as shown in Figure 3; for other linearization it is

$$
\xi \leq 0.707
$$
$$
t_{ss} \leq 0.8seg \qquad \textbf{(4,1)}
$$

necessary to move the poles with a PD control.

A zero to the plant has been added applying linear control techniques, so to move the system poles at a speed of 0.3m/s to the target dynamic area, matching the system poles for the speed 3.3m/s in closed loop with gain k = -1. The result was a zero at s = -5.44, with a gain k = -22.25.

Similarly, it was the same PD control design for the linearized system at the other speeds, resulting in different PD controls, each of them to bringing the poles to the desired dynamic area. However, making a comparison between different PD controls design, it was concluded that it was only necessary to create one PD control to move the system poles for the different linealizations to the target zone.

$$
G_C(s) = -22.25(s + 5.44)
$$

(4,2)

Results

Following the study shown above, the same linear PD control was applied throughout the plant. In this case, the control that was used is the designed for the first speed (4.2). The outcome was represented in the S-plane, showing all the modified poles for the different speeds, Figure 4 shows these poles for different linearizations between 0.3m/s and 0.6m /s, which show that as speed increases, the conditions significantly improve the design.

V-A. Position Error

This PD control has been applied to the nonlinear model operating at different speeds. Figure 5 shows their responses to a step input. It is evident that as the speed increases the settling time decreases, as well as the maximum on impulse (and that going to increase the speed the system tends to be first order).

Conclusions
In this study was created a nonlinear model for the Cormoran vehicle with 3 degrees of freedom, this model has been linearized by taking one constant speed.
For the control action, it has a single PD controller designed for the entire system, showing that it is possible to define a target dynamic area eliminating the position error at steady state. It

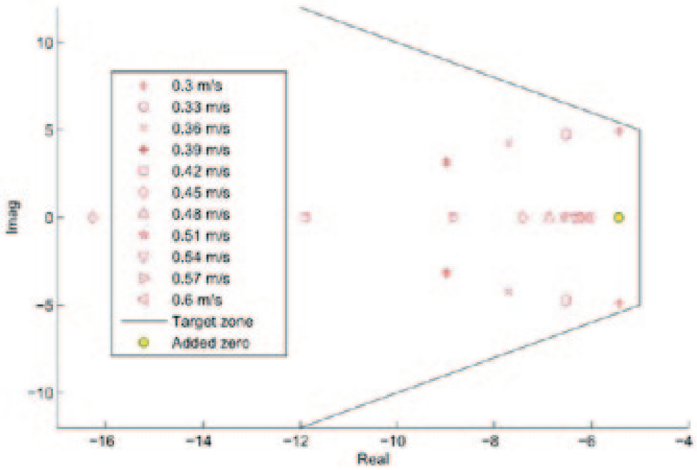

Figure 4. closed loop poles applying the PD control

also showed that when the vehicle is at higher speeds the response is even better, and therefore it is sufficient to design a single PD.

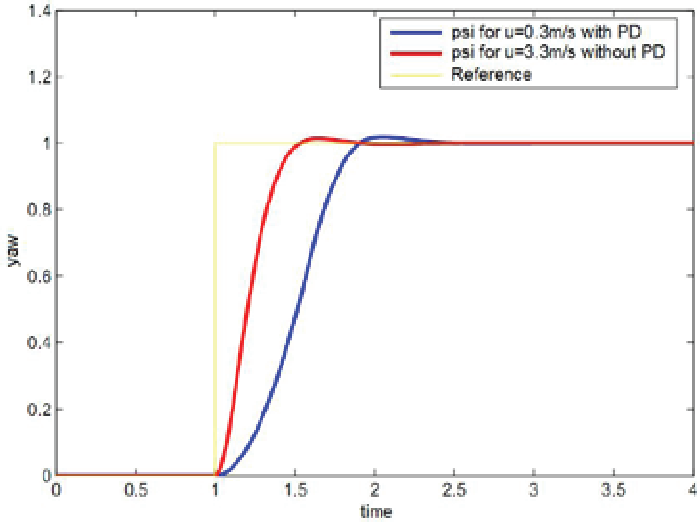

Figure 5. Responses to step input for different speeds using PD control

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CONSIDERATIONS ON THE ELECTRONIC CONTROL SYSTEM FOR AUTONOMOUS UNDERWATER VEHICLE

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Abstract—This work proposes the development of a control system for an autonomous underwater vehicle dedicated to the observation of the oceans. The vehicle, a hybrid between Autonomous Underwater Vehicles (AUVs) and Autonomous Surface Vehicles (ASV), moves on the surface of the sea and makes vertical immersions to obtain profiles of a water column, according to a pre-established plan. The displacement of the vehicle on the surface allows the navigation through GPS and telemetry communication by radio-modem. The vehicle is 2300mm long by 320mm wide. It weighs 85kg and reaches a maximum depth of 30m. A control system based on an embedded computer is designed and developed for this vehicle that allows a vehicle's autonomous navigation. This control system has been divided into navigation, propulsion, safety and data acquisition subsystems.

Introduction
Traditionally, oceanographic vessels have been and are the most important observation platforms where multidisciplinary oceanographic studies are carried out. The high cost of using them prevents to get data with spatial and temporal resolution required. A recent alternative way, which allows ocean observations with good spatial and temporal resolution simultaneously and with lower costs are the Gliders, the Autonomous Underwater Vehicles (AUVs) and Autonomous Surface Vehicles (ASVs) [1] [2].
There is a type of hybrid vehicle in underwater observation that lies between the AUVs and ASVs, ie moving along the surface of the sea and makes vertical immersions to obtain profiles of water column. [3] [4].
The vehicle control system developed belongs to the latter group [5] [6]. It has a double hull structure where the outer hull,

Figure 1. Autonomous Underwater Vehicle used

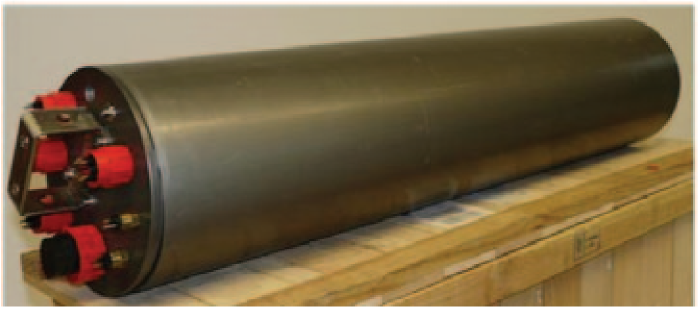

Figure 2. Interior Watertight Module.

made of fiberglass, provides a good vehicle hydrodynamic behaviour (see figure 1), but not watertight. Inside the outer case a cylindrical watertight aluminium 6063 module is attached that contains the immersion and emersion actuator, the battery pack and control system (see figure 2). The immersion actuator is a commercial pneumatic stainless steel cylinder with a displacement of 1500 cm3 and a linear electric actuator which can cover a maximum distance of 200 mm and thrust force of 3KN. Power batteries are Ni-Cd providing 21Ah, and 24V voltage [7]. In order to supply 5V and 12V voltages required for different electronic devices Mornsun dc-dc switching converters have been used.
This work is organized as follows: section II shows the control system structure and design of communication subsystems, navigation, propulsion and safety. Section III presents the experimental results obtained in the laboratory. Finally, Section IV presents the conclusions.

Control Unit

The control system is designed in a modular way with different subsystems, managed by the module control unit, which consists of a PC104 embedded computer. Figure 3 shows a block diagram of the control system. As seen, there are six modules: the control unit, the navigation system, the propulsion/immersion system, safety system, communication system and data acquisition system. The following describes each of these systems, except the data acquisition system that will be configured according to the objectives of the mission.

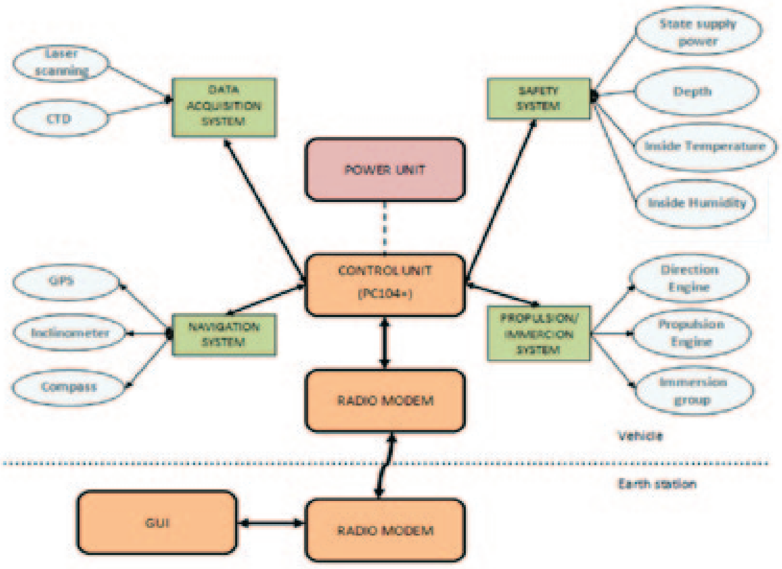

Figure 3. Block diagram of the structure of the control system designed.

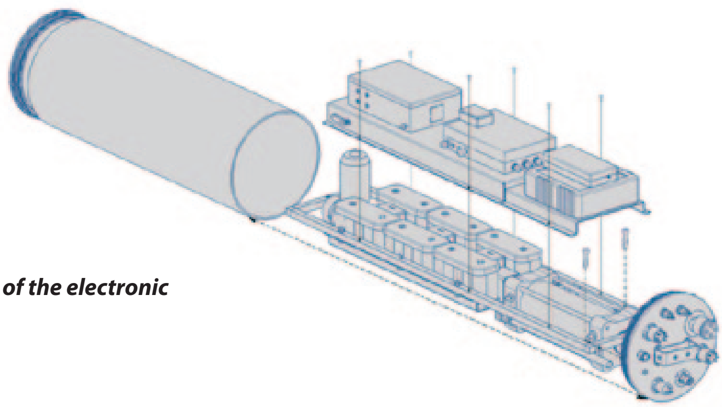

Figure 4. Location of the electronic control system

A. Control Unit
The vehicle is controlled by an embedded computer with Aewin PC104+ assembly [8], model PM_6100. It works
with a CPU AMD® Geode™ LX800, 500MHz. It has low energy consumption (max. 12W) with a right size. It operates with Windows XP operating system and the data storage system is a compact flash that provides good protection against vibration. Programming is performed through the graphical programming tool NI_LabVIEW.

B.Navigation System
In order to know the position of the vehicle, it has been equipped with a GPS navigation system. The receiver is the Magallen DG14™ [9], which offers high accuracy by incorporating signal Satellite Based Augmentation Systems (SBAS. Also, the navigation system features a digital compass and a 3-axis altitude indicator integrated in the TCM-2.6 [10].

C.Propulsion Immersion System
The propulsion/immersion system comprises: a main engine, which provides the propulsion, two side engines, which monitor the direction of the vehicle and a pneumatic stainless cylinder allows to dive. The main engine, the Seaeye SI-MCT01-B [11] provides a nominal power of 300W to 960rpm together with the drivers, integrated control and power. The side engines are BTD150 Seabotix [12] engines, providing a maximum thrust of 25N to a maximum power of 80W. For these engines a specific driver was designed for control and power. Finally, the immersion/emersion system is a Festo CRDNG-100-PPV-A pneumatic stainless cylinder [13], controlled by a driver designed specifically for this task.

D.Safety System
The vehicle has been equipped with safety systems that allow monitoring system variables that can become critical to the overall operation. These are:
State of battery charge: is monitored through a RS232 port, indicating the remaining power in batteries by means of a Texas Instruments charge status indicator. This device uses Coloumb Counting control system, to sense the incoming and outgoing energy from the batteries.
Depth: a watertight module of a pressure sensor, GEMS 2200 series with a range of 0-6 bar and a sensitivity of 0.833 (V / bar), has been placed outside the vehicle. This allows us to monitor the depth of the dive between 0m to 60m.
Humidity/Temperature: a humidity and temperature sensor has been placed inside the watertight module to check the level of sealing and to ensure the proper functioning of electronic systems.

E.Radio Modem System
The vehicle is connected to the base station via a radio link, which allows receiving real-time data and vehicle parameter monitoring, making it easier to control. The radio link is a TMOD-C48 Farrell radio modem, [15]. The transmission power is 0.1W to 5W, allowing a maximum range of 10km.

Control System Implementation
All electronic control system of the vehicle is placed in a rack above the battery and immersion system, according to Figure 4. All electronic control system of the vehicle is located inside four PVC boxes. There boxes are distributed on an aluminum support that allows easy handling and installation.
The control unit, located in the first place, has forced ventilation and external connections for the control of the CPU (monitor, mouse, keyboard and USB). Below is a box with regulators switched 12V to 5 V supply. In another box the motor control drivers and the SSC-32
controller were grouped. Finally, the box with the GPS navigation and compass/altitude, the radio modem and the humidity sensor. All PVC boxes were distributed on an aluminium support which enables convenient handling and installation.
All electronic control system designed has been tested and verified by laboratory tests and field trials.

Conclusions
This work provides a control system for an autonomous underwater vehicle. The developed platform is robust, relatively small and lightweight, factors which facilitate its manageability and operability. It incorporates an embedded computer that manages the navigation, propulsion and safety systems of the vehicle. Laboratory testing have shown their proper operation.

Acknowledgements
This work has been funded by the Spanish Ministry of Education and Science and the European Union (FEDER), project nº: CTM2006-12072/MAR.

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INTEROPERABILITY EXPERIMENTS AT OBSEA

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Introduction
ESONET needs a Web portal with real-time web interface from online observatories. In order to do so, online data are urgently needed. This was one strong demand during the 2009 review of ESONET in Brussels.
Actually each observatory has their own software architecture and data management processes. Some standards can be applied on top of each observatory's data management in order to access data from internet in a standard way. Some of these standards can be SensorWebEnable, IEEE1451.0. or initiatives like DataTurbine for high speed real time data streaming.
The use of these standards in an observatory to access data and metadata from a general web interface can provide interoperable data visualization from the user point of view.
Another issues, not related with data access or data visualization, are important to archive interoperability between observatories as plug and work capabilities of the instrument. Initiatives as MBARI PUCK protocol (for RS232 or IP), interfaces like the SmartSensorBoard (Ifremer,UPC) or recently the SID, Sensor Interface Descriptor (52North), are being tested at Western Mediterranean Observatory OBSEA.
Other interoperability issues for standardization about access to data archives is now starting at OBSEA taking into account the experience about previous initiatives like SeaDataNet and standards proposed by INSPIRE for metadata specification like ISO19115 and NetCDF for data transport.
Time synchronization in cabled observatories by Ethernet networks can be achieved implementing IEEE1588 Precision Time Protocol (PTP) versus NTP or SNTP for applications with needs of synchronization under milliseconds. Actual observatories had been deployed before IEEE1588v2 was released, and for these reason junction boxes are not equipped with IEEE1588v2 Ethernet switches. Some test experiments has been carry out in order to test PTP under non PTP switches in order to evaluate the time synchronization accuracy for these type of networks. Figure 4 shows one of the test setup to provide GPS information to an instrument through a IEEE1588 synchronization network.

About OBSEA
OBSEA is a cabled seafloor observatory 4 km offshore Vilanova i la Geltru (Barcelona, Spain) coast located in a fishing protected area, and interconnected to the coast by an energy and communications mixed cable.
The main advantage of having a cabled observatory is to be able to provide power supply to the scientific instruments and to have a high bandwidth communication link. In this way, continuous realtime data is available. The proposed solution is the implementation of an optical Ethernet network that transmits continuously data from marine sensors connected to the observatory. With OBSEA, we can perform a real time observation of multiple parameters in the marine environment. SARTI research group from the Technical University of Catalonia (UPC) is devoted mainly in the design and deployment of sensor networks, from the elecronical, mechanical and data managment point of view. In this case, OBSEA was a new challenge, and now it is a perfect place where scientist are able to collect data, test new instrumentation and procedures.

IEEE-1451 and OGC SWE Integration into actual Observatories
In most cases, actual observatories are using a proprietary Data Management and Instrument control framework. We can divide the interoperability problems in different parts from bottom (instrument or sensor side) to top (user access to real-time data and archive). At figure 2 we can see a simple approach to achieve interoperability to real time data. The integration at the actual proprietary Data Management system of different observatories of different services like IEEE1451 server or SWE SOS server can offer access to data using web clients without disturbing the actual functionality off the observatory.

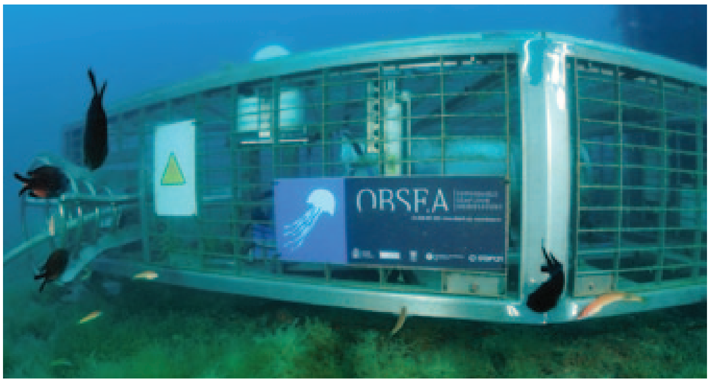
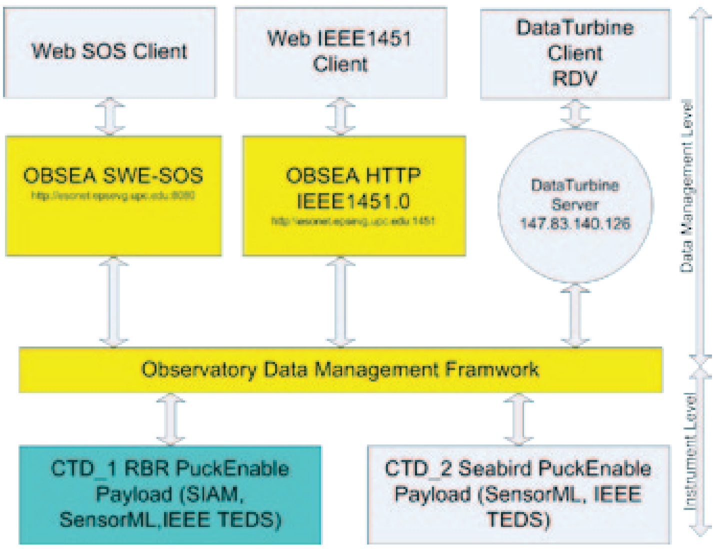


Figure 1 OBSEA Structure

The IEEE 1451 provides a specification to add a digital layer of memory, functionality, and communication to sensors. For example it enables sensors to be controllable and their measurements accessible through a network with sufficient information on the sensor characteristics and history.
OGC Sensor Web Enablement (SWE) provides a specification to Web-enabled sensors to be accessible and, where applicable, controllable via the Web. SOS provides a broad range of interoperable capability for discovering, binding to, and interrogating individual sensors, sensor platforms, or networked constellations of sensors in real-time, archived or simulated environments.
Up to now, we can consider these standards in the top level services to provide real-time data to users in a standard way.



(before) Figure 2 Access to real-time data using standards like SWE SOS or IEEE1451

PUCK protocol and SensorML with Sensor Interface Descriptor (SID)

Another approach for instrument manufacturers is to implement PUCK protocol in their instrument firmware. PUCK has been formally proposed as an OGC Sensor Web Enablement standard. PUCK does not itself fully implement interoperability, but rather provides the lower tier in a hierarchy of standards that achieve this goal. PUCK protocol is a simple command protocol that helps to automate the configuration process by physically storing information about the instrument with the instrument itself. The protocol defines a small "PUCK datasheet" that can be retreived from every compliant instrument; the datasheet includes a universally unique identifier for the instrument as well as metadata that includes manufacturer and model. Additional information called "PUCK payload" can be stored and retrieved from the instrument. The payload format and content are not constrained by PUCK protocol, and can include executable driver code that implements a standard operating protocol as well as metadata that describe the instrument in a standard way, or any other information deemed relevant by the observing system. PUCK protocol commands augment rather than replaces existing instrument commands, and so manufacturers do not have to abandon their existing software. PUCK protocol is simple, and readily implemented in even simple instrument processors; several manufacturers now implement MBARI PUCK protocol in their instruments. PUCK protocol was originally defined for instruments with an RS232 interface. A proposed revision extends the protocol to Ethernet interfaces; the "IP PUCK" protocol includes the use of Zeroconf to enable easy installation and discovery of sensors in an IP network.

The OBSEA team has developed an automatic algorithm to detect the installation of RS-232 PUCK instruments. The host computer periodically interrogates the serial ports for a PUCK enabled instrument. When the host receives a PUCK response from the serial port, the host retrieves the UUID to determine if a new instrument has been installed. If so, the host retrieves the PUCK payload and uses this information to collect data from the instrument and register it in WEB using standards like IEEE 1451.0 or OGC SWE.

The detection algorithm for IP PUCK-enabled instruments is based on the Zeroconf standard. When an IP PUCK instrument is plugged into a local area network (LAN), it automatically gets an IP address and is registered as a PUCK service via Zeroconf. An application that runs in the same LAN can discover the instrument and retrieve the PUCK payload through PUCK protocol and automatically register the new instrument in a standard way in WEB.

Thus standard IEEE-1451 and OGC SWE components can be automatically retrieved and installed by the host when a PUCK-enabled instrument is plugged in, overcoming the difficulties of manual installation.

An important component to achieve the plug and play capability with PUCK protocol is the payload information attached to each instrument. The payload should describe entirely the functionality of the instruments in a standard way and should be machine and human readable. To accomplish this task SensorML with Sensor Interface Descriptor (SID) can be used, which provides standard models and an XML encoding for describing sensors, measurement processes, and instrument control information.

As we know, instruments are using proprietary command protocols to communicate. The development of software drivers is needed in order to integrate them in each platform. SID can help to avoid the process of write instrument drivers. The generation of a machine readable document with information about how to communicate and parse the information will help the plug and play process.

Figure 3 shows how services running a SID interpreter can establish the connection to a sensor and are able to communicate with it by using the sensor protocol definition of the SID. SID instances for particular sensor types can be reused in different scenarios and can be shared among user communities.

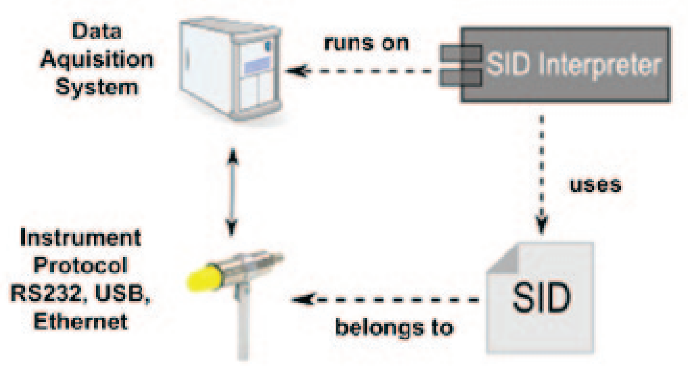


Figure 3 SID interpreter in a data Acquisition System (proposed to OGC by 52North)

The Smart Ocean Sensors Consortium

The Smart Ocean Sensors Consortium (SOSC) is a group of manufacturers and users dedicated to improving the reliability, utility and economy of hydrographic sensor networks. The SOSC aims to accomplish these goals through the development, adoption and promotion of practical standard interfaces and protocols. The SOSC was founded on the initiative of Canadian instrument manufacturer RBR Ltd in early 2009 following an OGC-sponsored interoperability workshop in St John's Newfoundland. Neil Cater of Memorial University's Marine Institute was elected first consortium chairman. Sensor manufacturer members include European companies SEND Electronics Gmbh and SiS Gmbh, as well as manufacturers from Canada and the USA. Non-manufacturer members include representatives from ESONET, SARTI-UPC, the Monterey Bay Aquarium Research Institute (MBARI), the US Ocean Observatories initiative, NOAA, and other organizations. Members pledge to offer and use instruments that comply with interfaces and standards designated as "consortium approved". Membership is open to organizations that share consortium goals, and membership requests are subject to approval by the SOSC chairman.

The SOSC collaborates with the Open Geospatial Consortium (OGC), which has established the Sensor Web Enablement suite of interoperability standards. The two consortia have signed a formal memo of understanding, resolving that they will cooperate to pursue common goals. SOSC manufacturers plan to provide a standard description of each of their instruments, and are evaluating the OGC's SensorML markup language for this purpose. The manufacturers also agree to define a standard protocol to uniquely identify the make, model, and serial number of each compliant instrument. The two consortia have agreed to collaborate on formal submission of PUCK as an OGC standard. Instrument manufacturers provided very useful feedback to the OGC standard working group during this process, and SOSC member SARTI-UPC has actually implemented an "Ethernet PUCK" instrument to verify the feasibility of the proposed standard. The SOSC and OGC also work together to demonstrate sensor network technologies such as PUCK, OGC Sensor Web Enablement, IEEE 1451, and other standards. These "live" demonstrations are held at conferences, and usually involve SOSC-OGC team members and sensors distributed across the planet, integrated in real-time thanks to the Internet and interoperability standards.

REMOTE CONTROL AND MONITORING OF FIRE ALARM SYSTEMS

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Abstract- Most of the actual fire alarm systems used in small and medium size places in the market works as a standalone systems without the possibility of remote monitoring or configuration.
This article shows a new development that provided for one hand, an Alarms and Events Reception System (AERS) that provide remote monitoring of fire alarm systems status based on a LabVIEW application and an additional hardware installed on the fire alarm system providing internet access.
And on the other hand, the development of a web server embedded in the fire alarm systems providing system monitoring and configuration based on internet access.

FIGURE 1. Fire Alarm System

Introduction
Nowadays, most of the fire alarm systems, figure 1, are installed in places where the system works standalone and are configured and managed locally. The possibility of remote management and monitoring using internet access open to fire systems manufactures different possibilities to extend the services given to final users.

The development of a new alarms and events reception system using LabVIEW allows centralizing the management of a group of fire alarm systems providing information about real incidents, faults, manipulations, archive, etc…
On the other hand, the fire alarm systems equipped with the new hardware with an embedded web server are able to be programmed and configured remotely thanks to a developed JAVA web page that provide direct communication with the fire alarm system. In that case, when the alarms and events reception system is receiving information from some fire alarm system, the operator is able to access the fire alarm system and monitor what is happening remotely in order to discard false alarms or provide confident information if a real problem is detected.

System Description
The aim of the project is provide internet access to commercial fire alarm systems in order to be managed remotely. The fire alarm systems are commercial off the shelf devices, and no firmware or hardware modifications are allowed. Then the additional software and hardware to be developed in the project has to take into account this restriction.
In terms of hardware, the fire alarm systems taken into account has a TTL/RS232 comunication protocol that allow the local configuration. In order to provide remote access an RS232 to TCP/IP interface has been added to the actual hardware. This component was the XPORT Direct+ from Lantronix. Thanks to this component the system is able to be connected to an IP network (LAN). The network configuration can be done by a web connection or using a serial terminal. The defalut configuration has to take into account the host IP address where the Alarms and Events Reception System is hosted. This configuration has to be done in all fire alarm systems in order to provide information to the Alarms and Events Reception System.
The Alarms and Events Reception System has been develoed using LabVIEW 8.5, figure 3, and is able to manage different TCP/IP connections from different fire alarms systems at the same time. The applications had implemented the original fire alarms systems' protocol. The application registers and monitors all the events in function of the fire alarms systems' model.

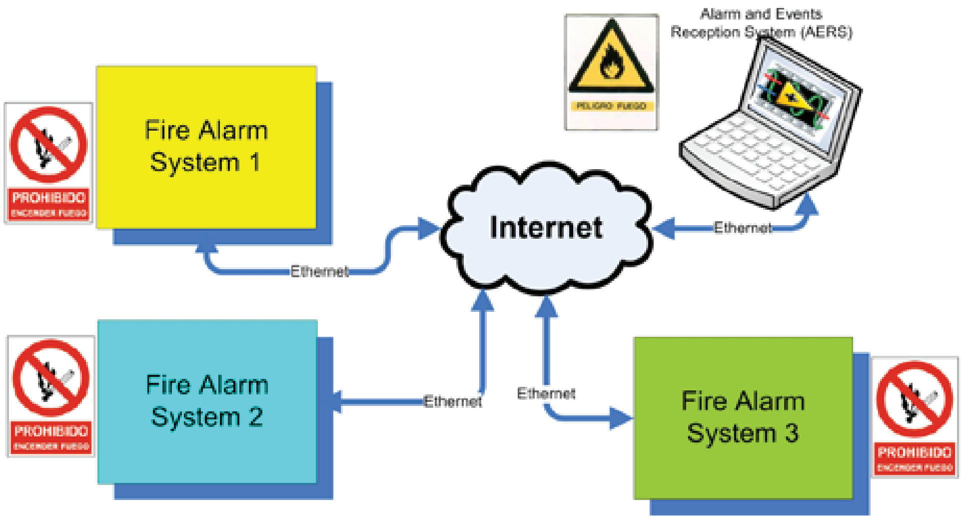

FIGURE 2. Simplified schema

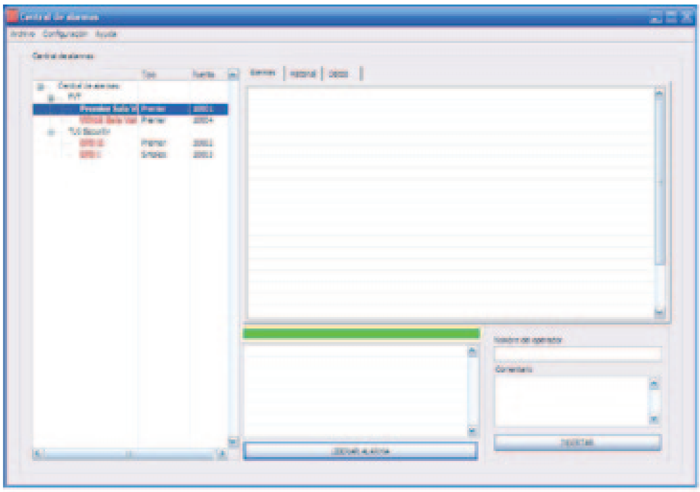

FIGURE 3. LabVIEW Front Panel of the developed Alarms and Events Reception System (AERS)

The most important features of the Alarms and Events Reception System (AERS) are:

1. Subscribe and unsubscribe fire alarm systems.
2. Email alert configuration
3. Event definition for alarm or alert generation
4. Multilanguage defined by the user

The AERS is generating an informative event that is sent periodically by e-mail and is checking continuously the properly function of the fire alarm system and its communications in order to detect hardware or communications failures.

Market Innovation

This Project wants to supply the necessity of the small companies to avoid the use of intrusion alarms in parallel with the fire alarm systems. In case the fire alarm system is able to be monitored remotely can be use as an intrusion detection system.
Another key point of the project was the unique identification of the fire alarm system. Due to no hardware or firmware modifications are possible in the fire alarm device, all of them are fully equal, and the communication protocol doesn't take into account any identification command.
For that reason, in addition to the XPORT device that provided TCP/IP communication a secondary small Renesas microcontroller was installed between the XPORT and the primary fire alarm hardware. This secondary microcontroller works totally transparent except for a known identification command. In order to indentify each device, the MAC address will be used as a unique address. The secondary microcontroller, each time the system starts, ask the XPORT device for his MAC address. When a identification command is received, the secondary microcontroller answer with the MAC address, and this data doesn't affect the normal behavior of the fire alarm device.
The schema is shown in figure 4.

Embedded JAVA Web Server

The XPORT device is able to allocate a web server with a small memory space to deploy a web page. A JAVA application has been developed using applet technologies to provide a remote interface to the fire alarm device. One of the challenges was the reduce amount of memory available for the web page allocation.
The JAVA application works as a TCP/IP server, and implements the fire alarm protocol in order to interrogate and then visualize the state of the system via a web page. The web page is able to configure remotely the fire alarm configuration.

Conclusions

The development of a new Alarms and Events Reception System (AERS) using LabVIEW has been presented. The development time was reduced thanks to the high level API functionality integrated in LabVIEW.
Thanks to the archive and log of alarms and events, system failures can be detected easily. The AERS design provides scalability in case more fire alarm models and their protocols has to be added. The additional hardware has being designed to be added to the fire alarm device, avoiding any firmware or hardware modification to the equipment. This capability enables the system with a plug&work functionality, avoiding manual or remote address configurations.

Finally, the embedded web page inside the fire alarm system provide direct remote monitoring and configuration of the fire alarm system using any internet browser.

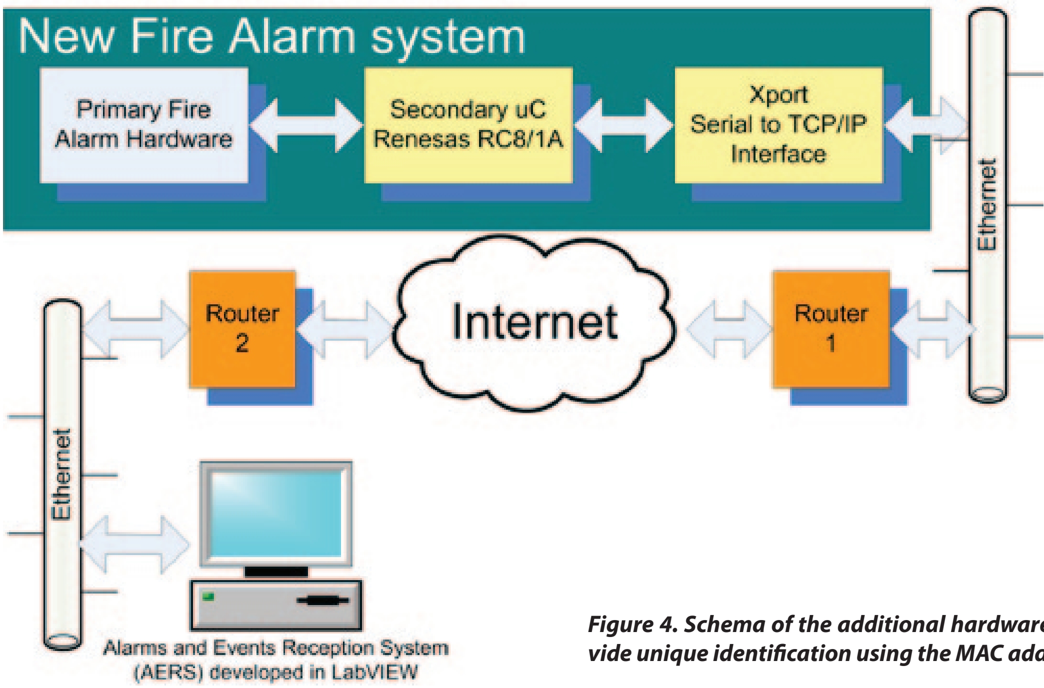

Figure 4. Schema of the additional hardware to provide unique identification using the MAC address.

ADC MODULE BUILT FOR AN OCEAN BOTTOM SEISMOMETER (OBS)

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Abstract- This paper presents the new data acquisition system designed for autonomous Ocean Bottom Seismometers (OBS) to study the earth dynamics and internal structure. This part is the responsible to acquire the signals from two different sensors to be processed. The analog-to-digital converter module is based on input amplifiers, modulator and digital filter.
Keywords- Ocean Bottom Seismometer (OBS), seismometer, Analog-to-digital converter, Acquisition system, differential signal.

Introduction

The Ocean Bottom Seismometer (OBS) is an equipment specially designed for the acquisition of seismic data in the marine environment. OBSs are fully autonomous equipments that can be deployed up to 6000 meters depth on the seabed [1]. When the instrument reaches the sea bottom, a geophone is dropped to acquire the earth vibrations. At the same time, the OBS is equipped with a hydrophone to detect the water acoustic pressure. The data detected by the sensors are acquired by the ADC board.

The control unit is a Coldfire MCF54455 microcontroller that can operate at low power. This device manages all tasks performed in the system. After receiving data from the ADC board, performs data compression and stores the data in a Compact Flash memory card. When the experiment is over, data is downloaded to a computer. The acquisition system main clock is based on a Seascan module with a temperature stability of 2x10-8. The OBS is recovered by sending an acoustic signal from the surface to detach the anchor weight, allowing the instrument to rise to the surface [2].

Figure 1: Hydrophone (on top) and geophone (on bottom)

The acquisition system

The OBS uses a Geophone module with three 4.5Hz geophones type SM-6 and it has a sensitivity of 25.8 V/ms-1. In the case of the hydrophone, the OBS uses a Hightech HTI-90-U with a 1778 V/Bar sensitivity. In figure 1 we can see the sensors used to collect data in the OBS. The picture shows the hydrophone on top and shows the geophone on bottom.

To make preliminary tests on the ADC board, we have not been used the previously described sensors. To make this test we have simulated the sensors with a differential signal using a low-noise system, the low distortion function's generator DS360 of "Stanford Research System".

With this generator we can simulate the desired signal in frequency and voltage. In the case of our board, it accepts frequencies in the range from DC to 2 kHz, and a maximum variation voltage of 5 Vp-p. The most important issue of this generator is its capability to generate a differential signal with low distortion and low noise.

The analog-to-digital conversion module is divided into three stages. The first one consists on fully differential amplifiers; the second one is the modulator (ADC); and the third stage is the digital filter which takes care of the decimation. Figure 2 shows the data flow in the ADC board.

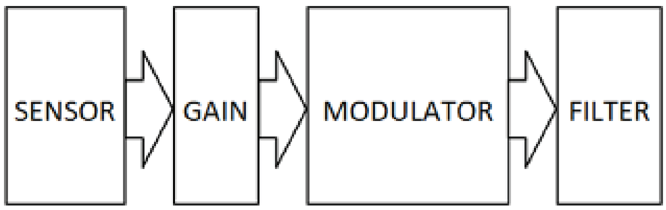

Figure 2: Data flow in the ADC module

In the first stage, which amplifies the signal, we use the CS3301 and CS3302 amplifiers for the geophone and the hydrophone respectively [3] [4]. The second stage is the CS5372 modulator. The Digital filter is the CS5376A, which carries out the decimation tasks too. This system provides a high dynamic range of 130 dB @ 103 Hz bandwidth, and lower total harmonic distortion than other modulators, while consuming significantly less power per channel. The modulators generate an oversampled serial bit stream at 512 kbits per second when operated from a clock frequency of 2048 MHz [5]. The CS5376A digital filter has decimation ratios that can support data output word rates between 1 sps and 4000 sps, although the designed datalogger can achieve programmable sampling rates ranging from 125 Hz to 1000 Hz, more than enough for any seismic application, while the power consumption is rated below 6 mW per channel [6].

The Figure 3 shows the analog to digital conversion module. The processed output signal though the elbow plug situated on bottom.

Figure 4 shows the interface between the ADC module and the MCF54455 microcontroller. Channel 1 corresponds to the hydrophone while channels 2 to 4 are the geophone channels (one for every axis). The ADC module interfaces with the microcontroller through and SPI bus. The ADC clock frequency is

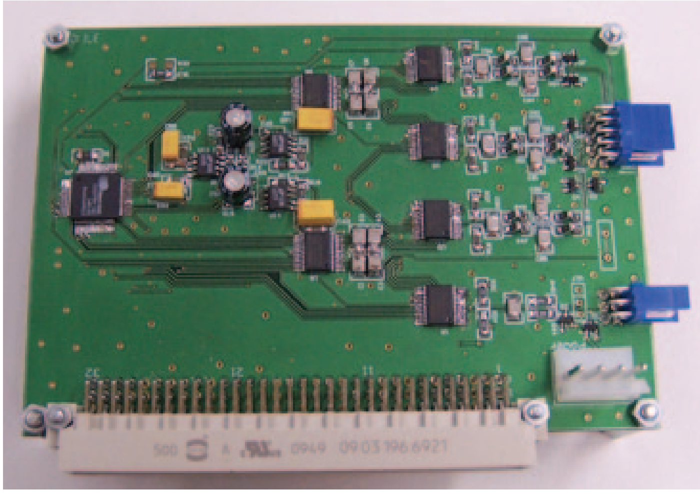

Figure 3: Analog-to-digital converter module

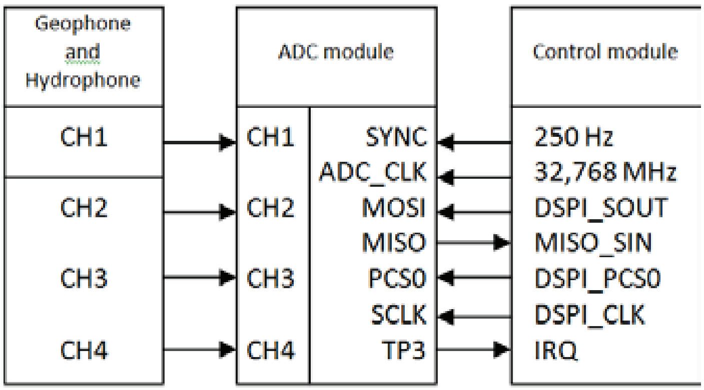

Figure 4: ADC module interface

32.768MHZ while the sampling frequency is 250Hz.
The power supply needed in the ADC module are a 3.3V, 2.5V and -2.5V. These will be generated by a DC-DC converter which generates the voltages from the main battery input.

Tests and results
In order to test the correct functionality of the system, the low noise and distortion DS360 function is used to generate the input signal. A sine wave is generated with 2 Vpp amplitude and 4 Hz frequency. Data is acquired by the acquisition system, compressed and stored in the Compact Flash memory card. A program in MATLAB extracts the data from each channel and represents them in separate graphs. Figure 5 shows the result of the acquisition.

This test has also shown a power consumption of 250 mW for the ADC module.

Conclusions
An ADC module was designed, built and tested in laboratory. The communication between the control module and the ADC module was carried out successfully, and the data was stored in the compact flash memory card. These results are conclusive with the simulation studies on real board. The acquisition system has to be tested in a real seismic refraction experiment in order to find the performance of the system in real environmental conditions.

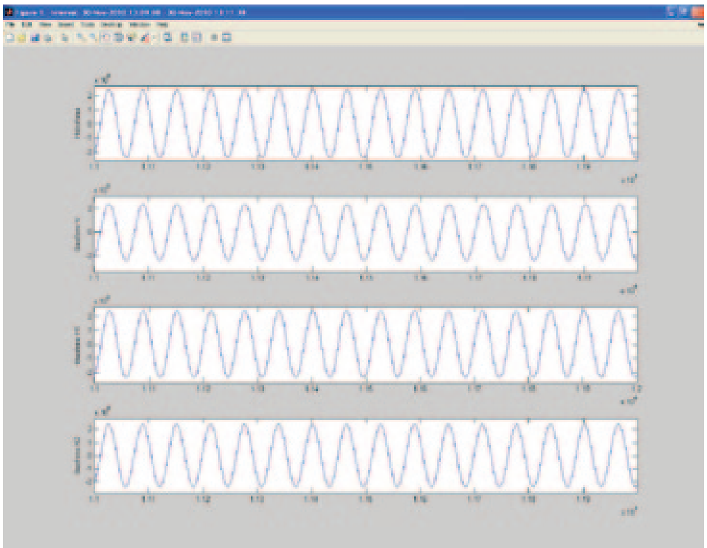

Figure 5: Result of the acquisition with a signal amplitude of 2Vpp and 4Hz frequency.

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CLOCK SYNCHRONIZATION OF A BROADBAND SEISMOMETER THROUGH IEEE-1588 PROTOCOL

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Abstract- In seismology, the time of the signal acquisition is highly important in order to know the magnitude and location of the earthquake. This paper presents the tests carried out to synchronize the seismometer clock through the IEEE-1588 protocol.

Introduction
Clock synchronization of seismometers is a key point to find the exact location of the earthquake. When seismometers are installed at seafloor observatories, data is collected through a marine cable and by using the Ethernet protocol. In IEEE-1588 protocol [1], instruments are synchronized through an Ethernet connection. They exchange timing data with a master clock through Ethernet in order to synchronize the clocks with an error below a microsecond. Therefore, instruments MUST be able to receive timing data from an external master clock. We have used the Trillium 120P/PA Broadband seismometer [2] together with Taurus data logger [3] to implement the clock synchronization Through IEEE-1588.
In order to equip Taurus with IEEE-1588 time synchronization capability, Taurus needs to receive timing data (TSIP: Trimble Standard Interface Protocol) and trigger (PPS) from an external clock. In a normal Taurus, GPS receiver [4] inside Taurus provides this information. In Figure 2, a description of how Taurus can be equipped with IEEE-1588 time synchronization capability is found.
We have been using Stelaris Luminary LM3S9B96 embedded system, Figure 1 [5], which supports hardware IEEE-1588 Precision Time Protocol (PTP). This module is a small embedded system. In our OBSEA seafloor observatory we plan to attach LM3S9B96 to Taurus externally, prior to its deployment.

Figure1: LM3S9B96 Board

It would be in charge of implementing the IEEE-1588 protocol with the master clock located at the shore station (PC), and also would provide Taurus with timing data (TSIP) and trigger (PPS) for time synchronization. Therefore, this module would substitute the GPS receiver inside Taurus. The block diagram of the overall system can be seen in the following figure(Figure 2):

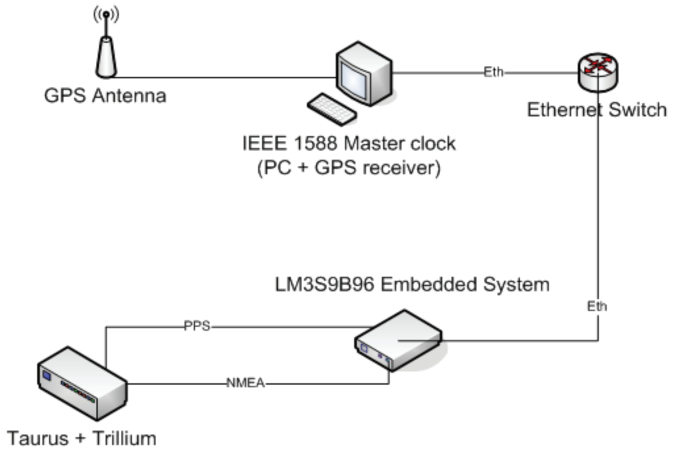

Figure2: Schematic functional diagram

In order to implement the system above, it is necessary to know the following information:
1- The data received by Taurus from the GPS receiver.
2- How to enable Taurus to receive this data from an external module (eg. LM3S9B96).

System implementation and tests
GPS receiver transmits to Taurus, using the TSIP protocol. Five frames every certain time interval. First of all, for initialization, it sends frames 0x45, 0x46, 0x4B, 0x4A and 0x41 that contains information about software version, receiver health, machine code/status, position output and GPS time. Then in order to notify Taurus that position fixes are available, it sends every second for four seconds, the frame 0x4A. And finally, repeatedly, sends every five seconds the packets 0x4A, 0x41, 0x46, 0x4B and 0x5C in this order. Last packet is sent to respond to the 0x3C received from the Taurus which contains information about satellite tracking status. Because the internal GPS receiver was removed from the Taurus, these frames are received via the serial port.
Luminary board will perform this operation as shown in figure 2. It sends to Taurus a TTL signal through the serial port with all the frames mentioned above. It also sends a PPS signal in order to trigger Taurus synchronization.
To test the correct operation of the system, first we have to be sure that the frames sent to the Taurus are correct. To do this we implemented a program in LabVIEW which sends all the packets, and the PPS via Luminary board with enet_ptpd program. Every subVI implements a packet to be sent to the Taurus.

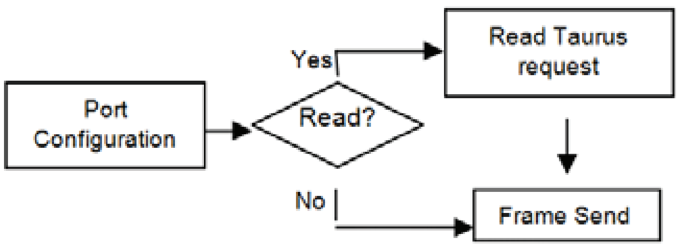

Figure 3: Packets sent for Taurus initialization

First packet is sent only for initialization, which is the first part of the sequence structure as we see in Figure 3, and the second part is the packet sent every time interval:

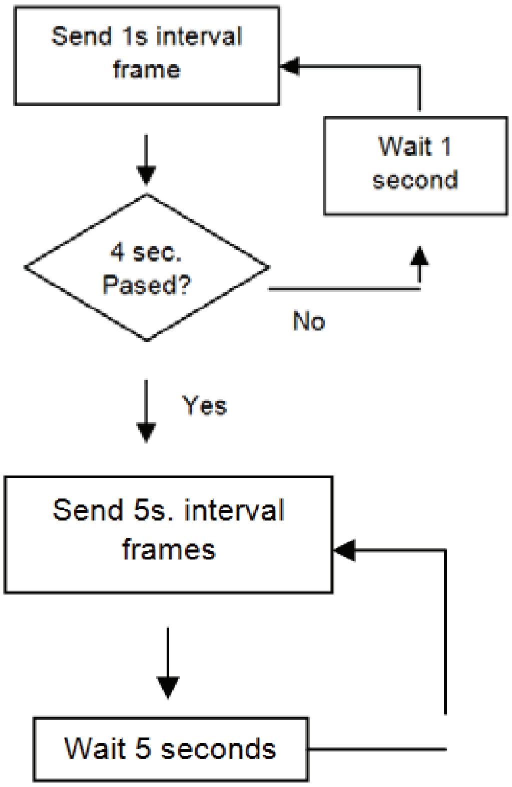

Figure 4: Packets sent every 5 seconds time interval

At same time, we can enable a read function which allows us to see if Taurus is sending a request, Figure 4.
In the front panel of this VI we only have to configure the last Sunday-date in order to get correct timing frames.

Results
At present, we have managed to configure many parameters of the Taurus via serial port and we are now testing time synchronization of the Taurus.
When the Taurus is working, we are able to find the timing information of Taurus, although timing precision is not much accurate. This can be due to incorrect time synchronization with shore PC. The Information of GPS satellites, and all the indicators from the status window of TAURUS, show that the system is operating correctly and the data is received in real time.

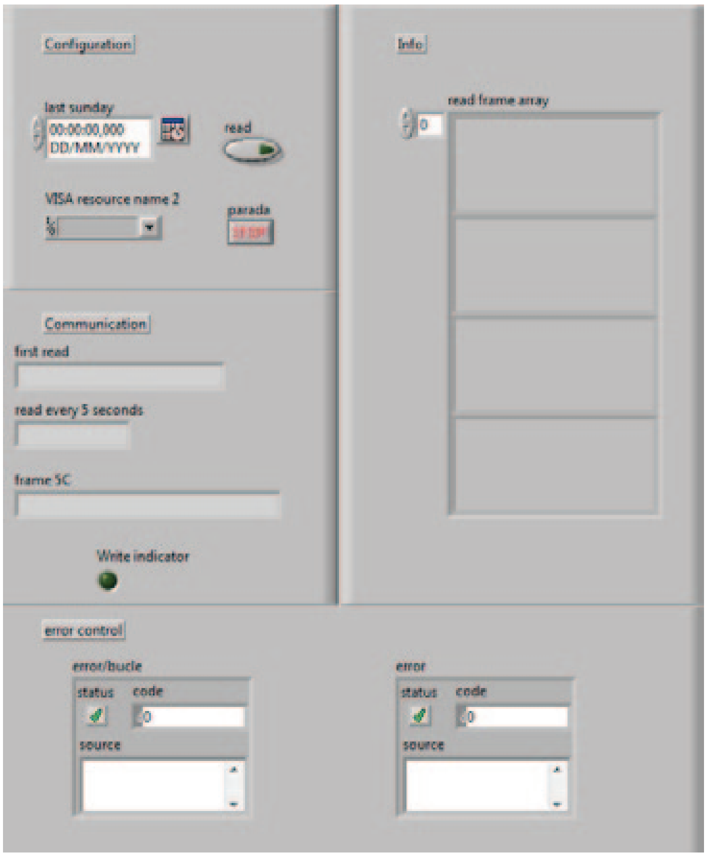

Figure 5: Front panel of the sending program

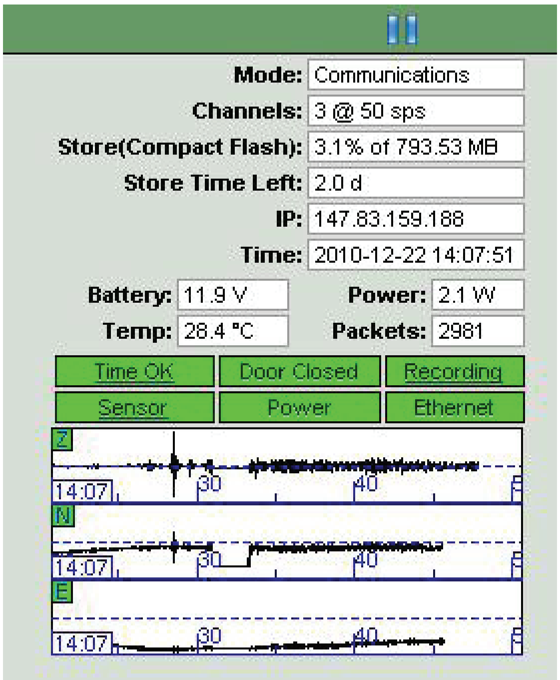

Figure 6 Taurus data logger Waveform window.

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[1] IEEE-1588 Precision clock synchronization protocol for networked measurement and control systems.
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DATA ACQUISITION SYSTEM FOR A CABLED OCEAN BOTTOM SEISMOMETER (OBS)

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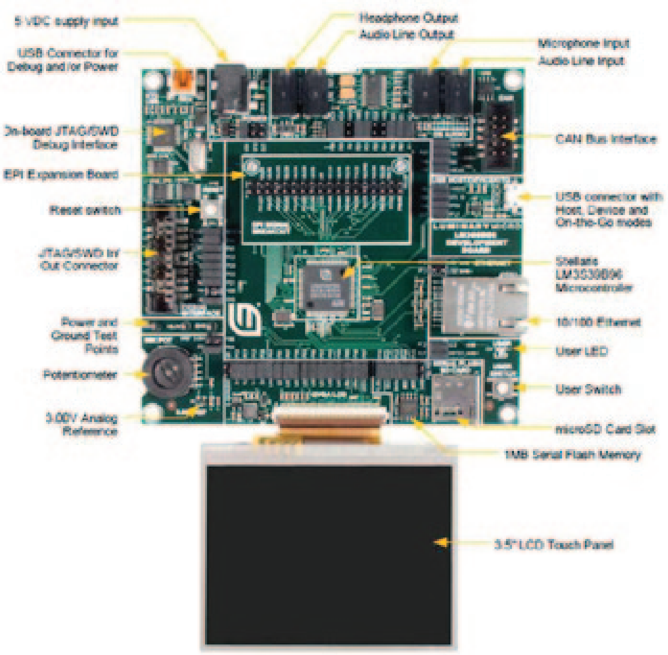
Abstract- Ocean Bottom Seismometers (OBS) are highly used to monitor seismic activities at sea. They are also used to detect tsunamis and generate warning alarms. This paper presents a data acquisition system built for an OBS with capability to synchronize time through IEEE-1588 protocol. This acquisition system provides real time data through the Ethernet making it suitable for OBSs deployed at seafloor observatories.

Introduction
Today Ocean Bottom Seismometers (OBS) are very popular and used in many places all around the world to detect seismic activities at the sea bottom. It is enough to mention scientific institutes in United States, Japan, Norway, Germany etc. The seismometer is a detector that is placed in direct contact with the earth to convert very small motions of the earth into electrical signals, which are recorded digitally [1]. In general, OBSs are used to study the sea bottom to detect earthquakes, tsunamis or to find oil reservoirs. In order to monitor continuous seismic activities in the ocean, OBSs are installed in seafloor observatories. OBSEA is a cabled seafloor observatory located 4 kilometers from Vilanova i la Geltru (Spain) in a fishing protected area. The main advantage of this observatory is its uninterrupted power supply to scientific instruments. It allows permanent power supply and avoids problems with battery powered systems. This way, OBSEA can perform real-time observation of multiple parameters in the marine medium. [2]

The acquisition system
Following tools were used in the design of the OBS acquisition system:

•DK-LM3S9B96 - board equipped with many modules as: SSI, GPIO, GPTM, UART etc. [3]. Used for executing the main program, acquiring data from the ADC board and sending it trough the UDP protocol for monitoring.



•CS5372-76A – analog-digital converter equipped with a 1 to 4 channel modulator and a digital decimation filter which is required to acquire the correct data. [4]

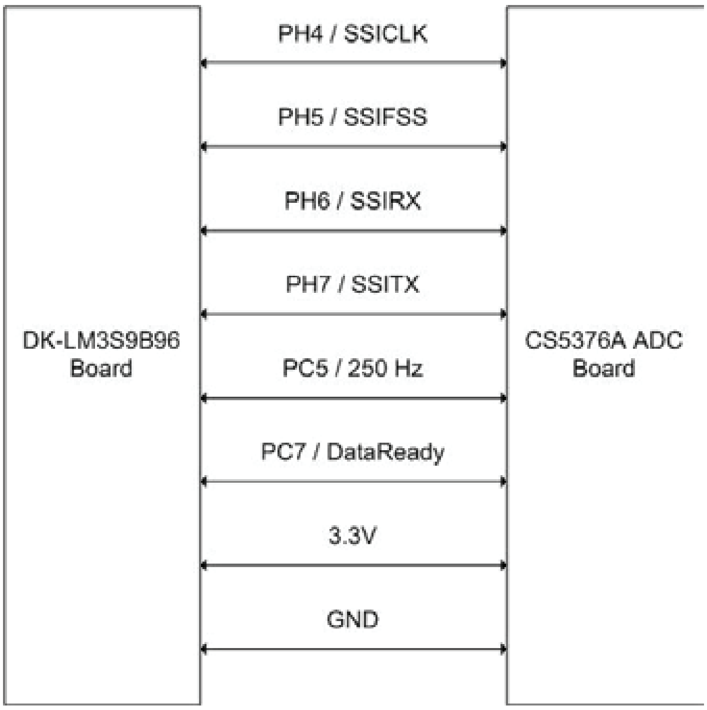


Figure 2: Connection between DK-LM3S9B96 and CS5376A

•CodeSourcery G++ - compiler where the C code was written. This software was also used to upload and debug programs to the Luminary Micro board.
•LabVIEW – graphical programming environment used to visualize data transferred through UDP protocol.
The main program is described in the following flow-chart:

As the flow-chart shows, first the system clock was enabled as well as all peripherals as SSI, GPIO bases, timers etc. The next step is to configure GPIO pins for all tasks needed. Later lwIP library was used to set MAC and IP addresses. Another step is to configure a filter in the ADC board to acquire correct data.
The last step is to enable interrupts. Interrupt handler function can be divided into four parts: sending data to ADC board through SSI protocol, acquiring data from ADC board through SSI protocol, processing data (creating frame contains time, date and data), sending data through UDP for monitoring.
Visualization was made by LabVIEW. The data is extracted from the main frame and data for each channel is shown in separate graphs.

(Left) Figure 1: DK-LM3S9B96 board

Figure 3: Flow-chart of main C program

Results
To test the system a sine wave generator was connected to all 4 channels of ADC board. Amplitude of signal is 1Vpp and frequency is 1 Hz. In LabVIEW graph the exact signal generated by the generator can be seen. Then the amplitude and frequency were changed, as well as the input signal from sine wave into square wave. All changes were observed in the LabVIEW graphs.

Conclusions
The data acquisition system of a cabled OBS system was developed. Continuous power supply is needed for the instrument. The system does not need any human intervention, but after some time the clock drift can be noted. Before immersing it under water, the system should be tested for long time to monitor the clock drift . The clock synchronization protocols as IEEE-1588: Precision clock synchronization protocol for networked measurement and control systems are needed to correct the time drift through the Ethernet network.

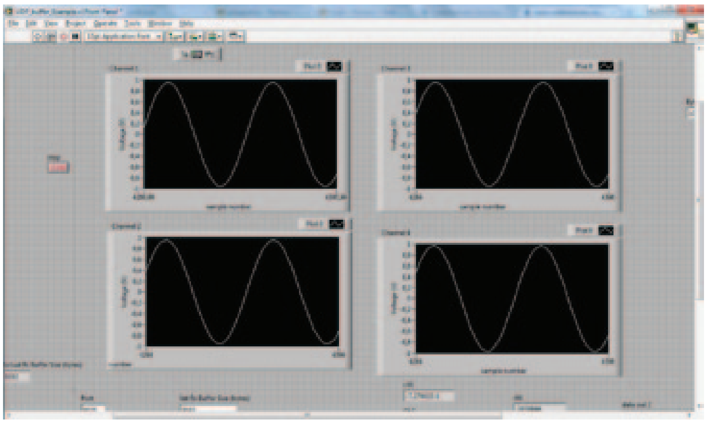


Figure 4: Front Panel of LabVIEW

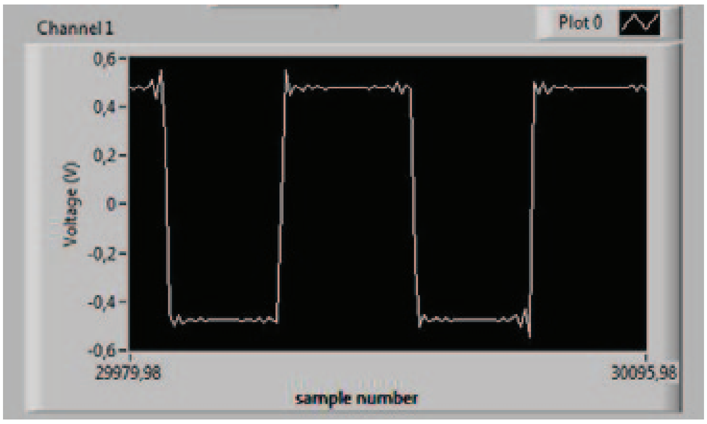


Figure 5: Square wave with noise

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GEOPHONE CALIBRATION PROCEDURE FOR OCEAN BOTTOM SEISMOMETERS (OBS)

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Abstract- This is a new calibration procedure for geophones using the expanded uncertainly [1] [2] of null-correction created in our laboratories.

Introduction

The geophone under study is the sensor used in an ocean bottom seismometer (OBS), with three orthogonal velocity transducers. It has been designed to work on the seabed, and has an external structure (Figures 1 and 2) designed especially to resist a pressure of up to 6000 m of water and to have good coupling to the sea bottom.

Figures 1-2. Geophone structure.

In oceanographic instrumentation and seismic prospecting, this equipment acquires the vibrations of the seabed, which can be either artificially generated (for example, compressed air-guns on board of an oceanographic vessels), or be natural seismic activity.

Development

Sensor calibration methods

The velocity sensor is a GS-11D at 4000 Ohms (with natural frequency of 4.5 Hz and 85.8 V/m/s of sensibility). The specification of the sensor is according to Geospace manufacturer.

Although we know the characteristics of the sensor working alone, this sensor is inside a structure which consequently modifies its seismic mass, and the coupling can modify the global specifications [3] [4]. For this reason we have developed a systematic calibration procedure for the geophones which can help to overcome this problem.

The calibration methods consist of repeating some frequency and amplitude sweeps, for every axis, to determine the following factors:

- Contribution to repeatability [2].
- Systematic error.

With this method we determine a constant value with an associated uncertainty [1][2].

Calibration Results

The results obtained after 4 repetitions of frequency sweeps, between 8 to 100 Hz in a range of 5 amplitudes, allow the determination of a sensibility in every axis X-Y of the geophone.

Figure 3 shows the results of the stability of the sensibility along the frequency when the frequency sweep operates in the X axis. In the other hand, Figure 4 shows the sensibility of the transversal axis when the movement is produced in the X axis.

Seeing the great variability of the sensibility from 64 Hz, we detailed the sensibility account of the axis between 12 to 64 Hz like a single value, with an extended uncertainty of the null global correction.

The sensibility of the device under test in the X axis is (85,78 ± 2,52 V/m•s-1)

Explanation: The study is centered on the interval between 12 to 64 Hz; this range has been selected because it covers the ranges of the input signals acquired by the geophone in a seismic earth prospecting.

Conclusion

We have developed a new procedure to calibrate geophones. With this method is possible to obtain the sensibility of each measured axis, and its extended uncertainty of the null global correction. In fact, the magnitude and direction of the velocity in the X-Y axis have been obtained.

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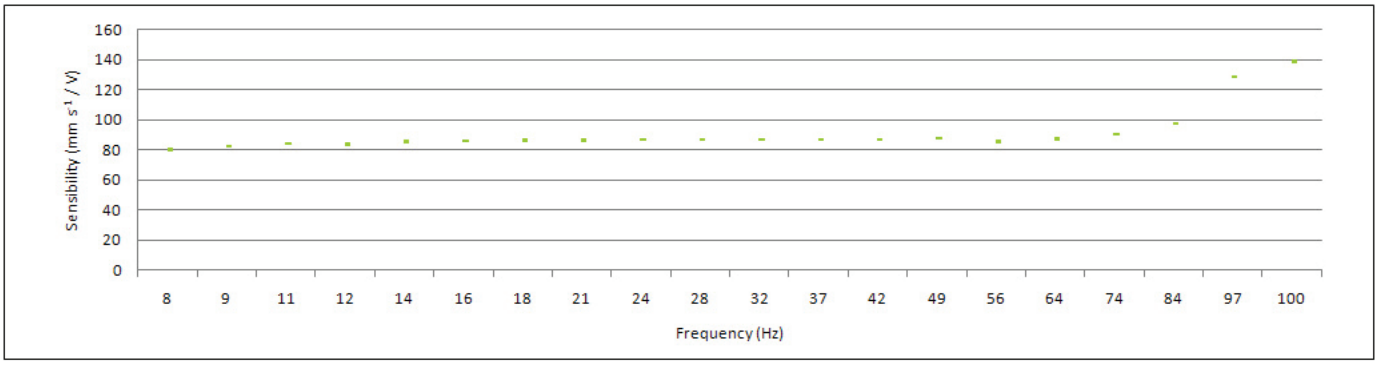
(below) Figure 3. Geophone X axis sensibility.



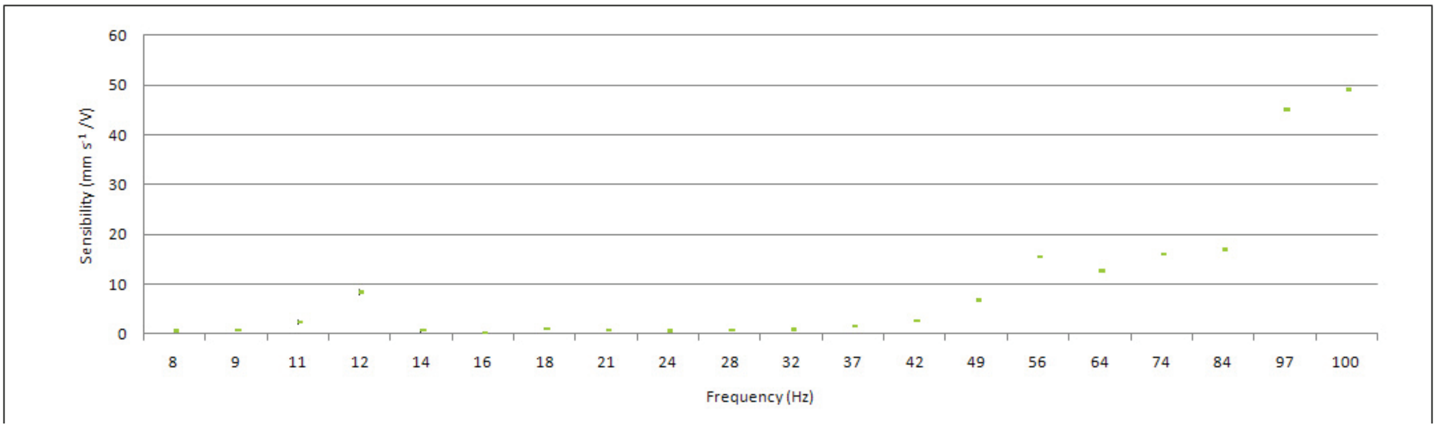


Figure 4. Sensibility of a Y axis when the vibration is in X axis.

DYNAMIC PACKAGING CHARACTERIZATION AUTOMATIC TEST SYSTEM

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Abstract- The optimization phase in the packet design process is important to ensure the integrity of the element to transport. For this reason, to know the frequency response of the packet in function of vibrations and other parameters an automatic test system has been design. In this article is shown test system and mainly the data acquisition system in order to acquire long temporal series of the vibration signals. The system is composed by a SCXI rack to provide accelerometer signal conditioning, USB data acquisition system and the real-time data processing is carried out by a personal computer and a LabVIEW application.

Introduction:
To ensure the packaging function in front of vibrations or shocks in freight transport is necessary to characterize the response of the packaging. It is considered the packagint as an element mechanically deformable and if we put a mass on top it can be modelled as a spring with a elastic constant Ks, and absorption coefficient , and theses parameters are being affected over the time.
In order to study the frequency response variation over time of the packaging and to know the evolution of its parameters Dr M. Garcia Romeu has designed a method in his PhD thesis for simulation of the real conditions that affect the packaging and be able to predict its behavior.
To know the temporal evolution of mechanical resistance of the packaging in front of the mechanical stress produced during transportation is the main objective of the design presented in this article.

System Description:
The design consist of a fatigue structure shown in figure 1, that provide to the device under test (packaging DUT) a gravitational

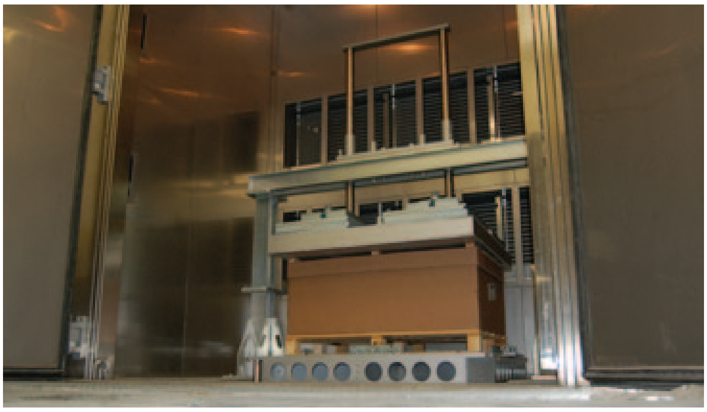


FIGURE 1. Fatigue Structure

load and a controlled vibration that is the mechanical stimulus. The frequency response to the stimulus (vibrations) are function of the dynamic parameters of the packaging Ks and . The signal processing of the stimulus and the packaging response, and the data acquisition of these two acceleration sensors has been carried out by a USB data acquisition system, a SCXI signal conditioning and a LabVIEW application, shown in figure 2.
The application developed provide configuration of the data acquisition and conditioning parameters, data archiving in files and data processing in order to visualize the frequency response of the packaging using the FRF (frequency respond function), extracting the characteristics parameters and his evolution over the time in a long duration test. This evolution defines if the

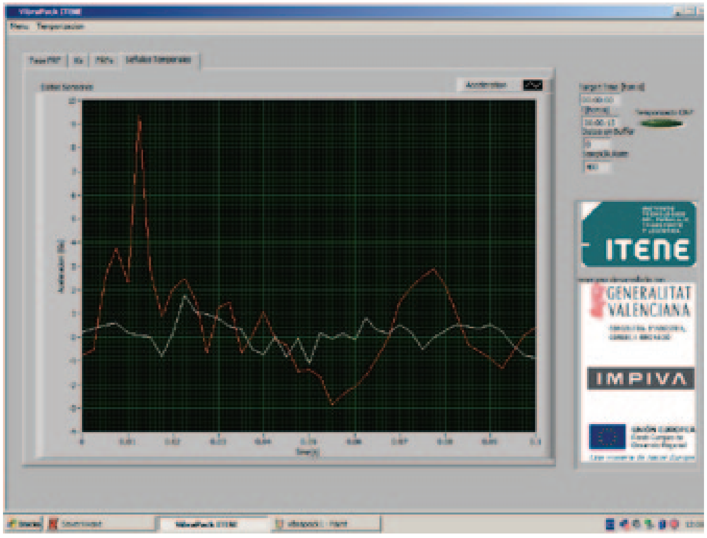


FIGURE 2. LabVIEW application Front Pannel.

packaging design was correct.
The design robustness of the application to ensure a perfect functionality of the system during long tests of hours or days was very important. The application allows configuration of the tests duration, parameters extraction for frequency response, frequency sampling for the data acquisition, paths for file archive of temporal signals and frequency response evolution.
The analog signal conditioning of the sensors is provided by a NI SCXI 1531 card and a SCXI rack that power and amplify the ICP accelerometers. The data acquisition is provided by a USB NI SCXI1600. The sensors response is configured bye a data acquisition task using the NI-DAQmx driver and Measurement and Automation Explorer software. A simplified schema of the system is shown in figure 3.

Hardware and Software Components of the Test System:
-50kN Vertical Shaker inside a climatic chamber in order to reproduce the ambient conditions.
-Fatigue Structure
-NI SCXI 1000 chassis
-NI SCXI1600 USB
-NI SCXI 1531 signal conditioning for ICP
-One axis Accelerometers from Kistler.
-LabVIEW 8.5.1
-Measurement and Automation Explorer.

Conclusions:
A dynamic characterization test system has been designed to characterize packaging aging in front of vibrations. The LabVIEW programming facilitates a quick and simple way for the data acquisition and processing. The hardware configuration of the system provided scalability and reusability of other projects.

Acknowledgments:
The system development was possible thanks to "Instituto de la Pequeña y Mediana Industria de la Generalitat Valenciana (IMPIVA)" and "Fondos FEDER".

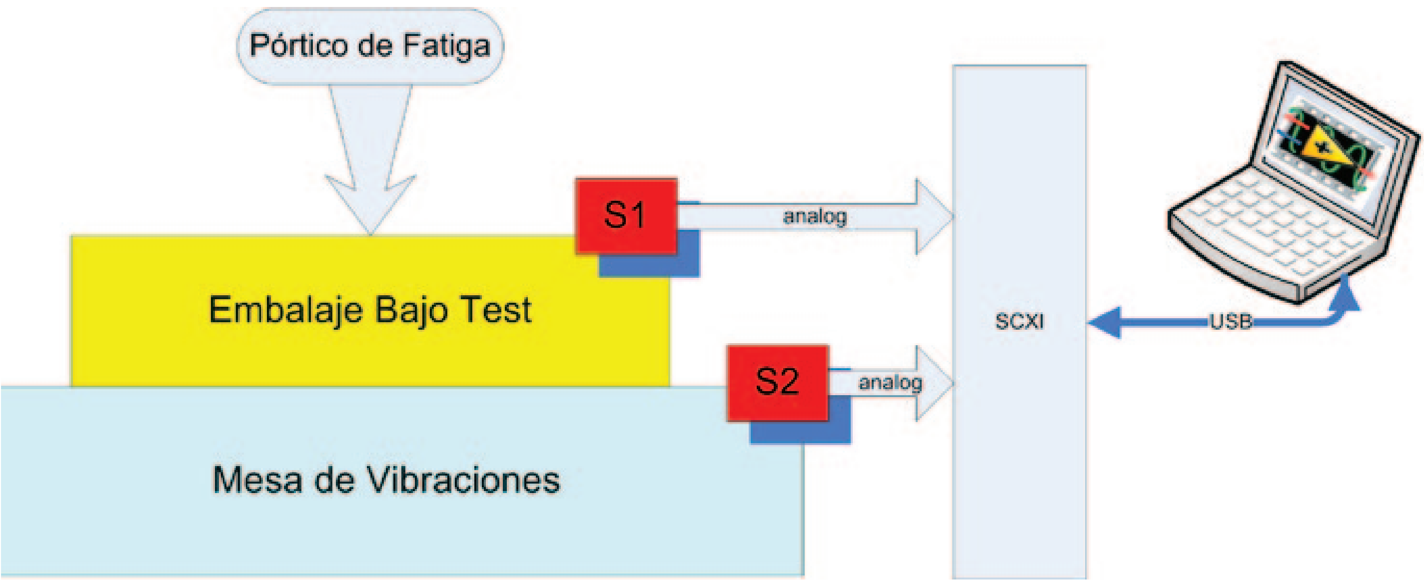
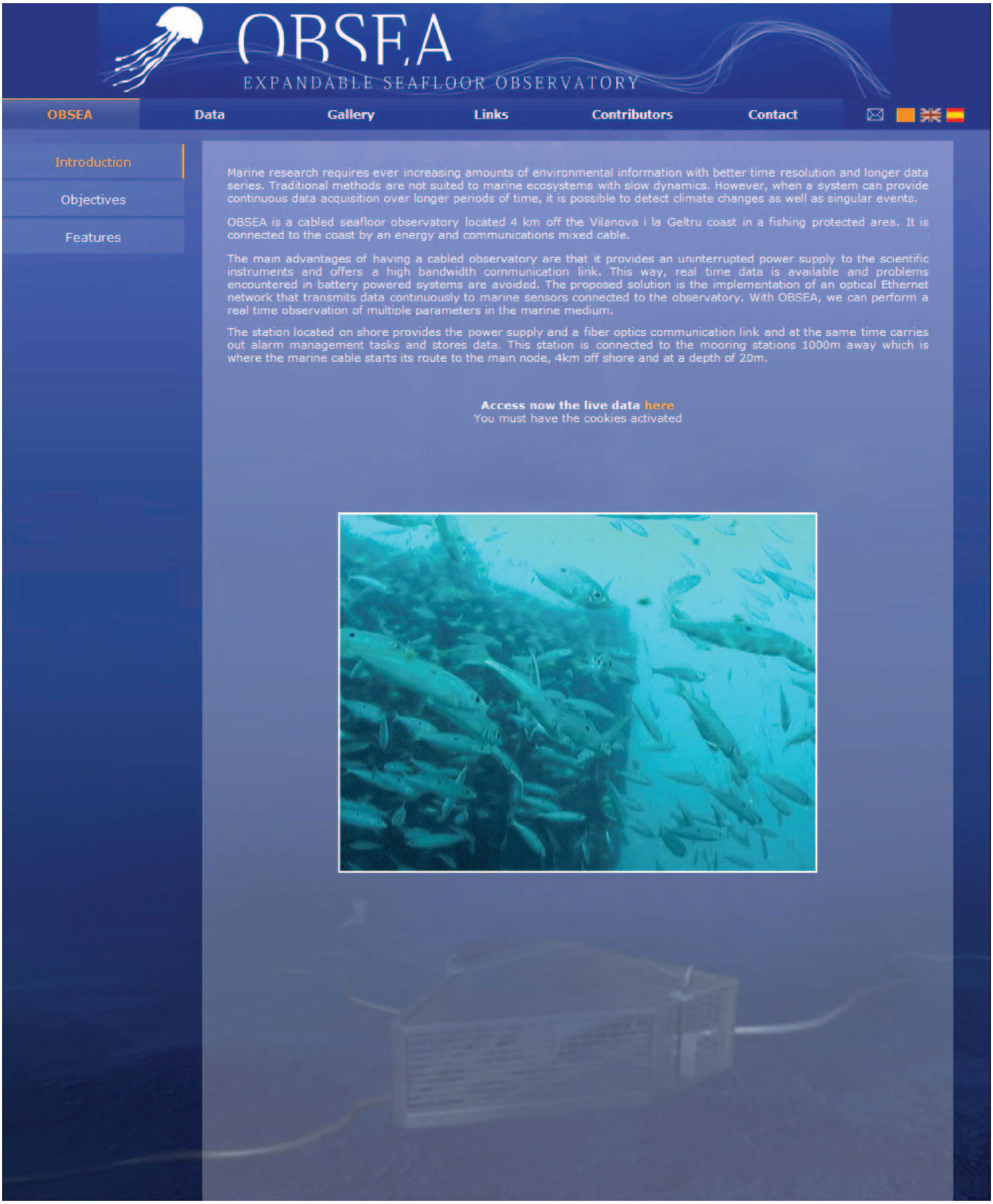


FIGURE 3. Simplified System Schema.



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