VADO: a Web based system for visualization and analysis of oceanographic data during field experiments

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SUMMARY

Four years ago, we set up a project to provide graphical user interfaces (GUI) for visualization and analysis of oceanographic data. At that time, Interactive Data Language (IDL) from the Research Systems Inc., was chosen as the programming language to build the software. However, the need to purchase a license of the IDL environment severely limits the diffusion, utility and portability of our project among the scientific community. The solution to overcome this problem has been to adapt our tools into a Web based environment. Here we describe the structure of our system that allows any user to make visualization and potentially, to perform analysis of data through the network. Briefly, the data and the IDL engine are hosted in a Web server and clients receive the output as a Web page with graphics. Thus any researcher may perform its own analysis or visualization without the need of having to additionally license the IDL. A direct advantage of such system is its integration into a ship data acquisition network during a field experiments. Here, we describe the performance of such system during the MATER-II and MATER-III cruises onboard the Hespérides R/V.

1. INTRODUCTION

One of the most unlikely aspects of oceanographic experiments is the combination of many different ways to obtain data about the ocean state. The reason lies on the necessity of acquiring both spatial and temporal information of a three dimensional system evolving in time. Usually, data come from different devices (termistors, conductivity cells, acoustic sensors, remote sensing images, etc.) that must be combined to get the ocean dynamic properties.

An exemple of common field experiments may combine data from mooring deployments, ship cruises and satellite survey. The main tasks during the experiment usually consist on providing a picture of the ocean state (visualisation) and to extract dynamical properties form the data set (analysis). In practice such different ways of obtaining data, makes both tasks a tedious and laborious work. On the other hand, during a field cruise and depending on the sampling strategy, near-real time information is crucial to make some decisions about the proper cruise development. Decisions can only be adequately taken if one has a friendly and efficient visualization and analysis system linked or integrated with the data acquisition system. Here, we present and describe a environment that satisfies the above requirements and can be easily integrated in ship acquisition systems.

The paper is organized as follow. First, we briefly introduce the VADO project and then we decribe the main elements of the web based system. Finally, to show the performance, we illustrate its use during recent ship cruises in the Western Mediterranean.

2. THE VADO PROJECT

Four years ago, at the Institut de Ciències del Mar of Barcelona, we set up an initiative for giving support to some tasks during oceanographic experiments: cruise design, pre-processing tools and data visualization and analysis. The project, afterwards named VADO (Visualización y Análisis de Datos Oceanográficos, García-Ladona et al., 1997, García-Ladona et al., 1998) was born from the increasing interest manifested by researchers of different disciplines in having friendly tools to carry complex data representation and powerful analysis. Developed on the frame of several research programs, VADO is now focused on two main aspects:

- to build graphic user interfaces (GUI) permitting a quick access to analyze and visualize data sets, and
- the integration of such tools through a network distributed system.

At that time, the solution was considered in terms of widget-based programs with object oriented architecture. However, the main problem was to decide which programming language would satisfy both requisites. It is crucial in order to simplify the developing tasks and get a full compatibility among different hardware platforms. Interactive Data Language (IDL) from Research Systems Inc. was choosen initially to start the project because it has several interesting properties. IDL is a complete structured language, that integrates a great number of high level mathematical routines and powerful graphical display techniques, in an easy to use programming environment. These aspects, togheter with the facility to build complex graphical interfaces (GUI), were the most important characteristics to make the choice of IDL. VADO started to develop three GUI tools: CTD, CORRENT and ADCP to deal with the visualization and analysis of data coming from different instrumental devices. CTD was designed to visualize data from an CTD probe. CORRENT was designed to manage time series of data from moored currentmeters and finally, ADCP was adapted to visualize time series of a vertical acustic profiler.

3. THE WEB BASED ENVIRONMENT

Recently, RSI has developed ION (IDL On Network). This package is a server of IDL sessions using networking technology. It connects a client network browser (such as Netscape or Explorer) to a server that executes IDL commands with the use of Java Applets and JavaScript routines, giving access to the full capabilities of IDL applications.

The advantages of this configuration are portability, because ION runs on almost any hardware/OS platform, and universal access, because the client does not require to dispose of IDL licenses. The operations are performed transparently by the Web and the ION servers. In addition, the IDL development phase is drastically simplified since improvements or updates of applications are restricted to the server. Furthermore, since version 5.0 of IDL, it is possible to develop programs with an object oriented architecture, which implies a compact and efficient way of programming. Thus, it allows us to encapsulate complex data structures (arising from the underlying mixture of devices, data and analysis techniques) in rather simple IDL commands. These two components, object oriented programming and browser interaction, can be combined to build a rather simplified WEB based environment of the VADO GUI tools.

In figure 1, we show a simplified schema of different parts of this environment. The first step has been to rewrite the tools as object oriented codes, separating the data I/O, analysis, graphical display and user interface in separate structures. Then, widget toolkits builded with normal IDL routines have been easily substituted by HTML pages. Each page normally contains a Web form (where the user can interact with the application), the ION Java Applet (that connects with the ION server and displays the graphical output) and a few support JavaScript scripts. Now the user interacts with the browser locally and the browser is charged to manage all the GUI events (buttons, labels, mouse selections, etc.) sending to. the ION server only IDL commands: Input/Output, calculations, analysis or data visualization. The resulting graphical output is finally displayed in the client browser.

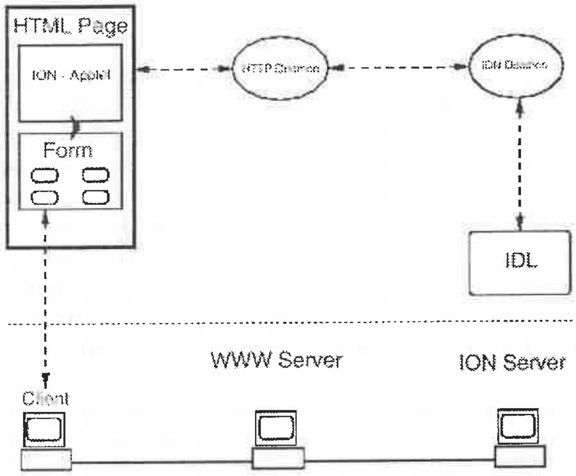
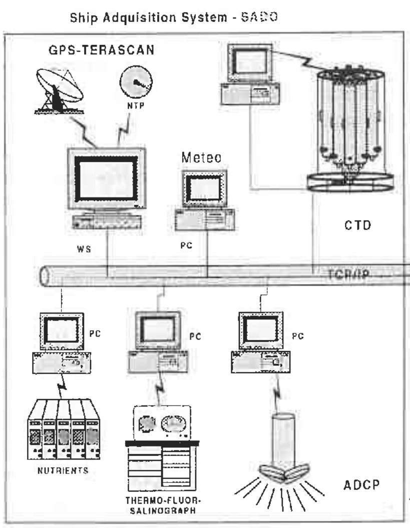


Figure 1. Structure of ION-IDL interaction with client browser

4. MATER 2-3 CRUISES

Recently, two ship cruises Mater-2/3 has been carried out with the main objective of performing multidisciplinar and intensive samplings of the Alboran Sea and the Algerian basin (Western Mediterranean). Several devices were used aboard a research vessel: an undulant and a fixed CTD, XBT probes, continuous ADCP sampling, etc. Data were stored in almost real-time in an array of hard disks. To manage such amount of information, we implemented our visualization system in a web server and it was integrated within the network adquisition system (SADO, Sorribas et al., 1998) of the Hespérides R/V. This network supports a TCP/IP protocol that relies several SUN workstations and several PC for data adquisition (fig.



2).

Figure 2 Schema of the Hespérides data adquisition system.

The Web an ION servers hosted on a O^2 Silicon Graphics workstation with 64 Mb of RAM and 4 Gb of disk, during MATER-3 and on a PC under LINUX, with 64 Mb of RAM and 9 Gb of disk during MATER-2 cruise. In both cases, from any computer in the network, any researcher was directly connected with the web server and through menu pages they accessed the visualization system. Figure 3 is an example of a web page designed to visualize vertical sections of CTD casts. Through this page the user could select the CTD casts section, the variables to represent, the depth ranges or to modify the graphical options as curve levels, colour bar, etc.

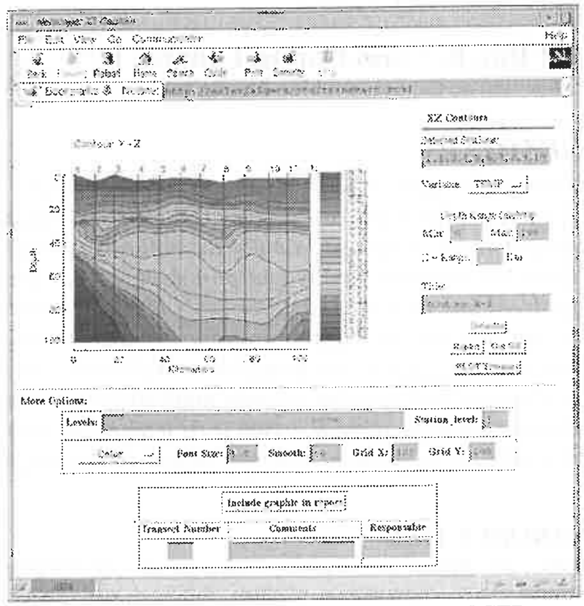


Figure 3. Web interface to build vertical sections of CTD casts

During the cruises, the kind of data available included satellite images, trajectories of satellite tracked lagrangian buoys and continuous recording of surface water properties as well as meteorological parameters. Little and minor changes were needed to migrate the system from the Silicon Graphics platform used during MATER-3 to the PC platform used in MATER-2. The system was very useful during the cruise to make decisions on sampling strategies but also to obtain preliminary results and illustrate them with high quality graphics.

Further implementations, related with the system configuration, need to stablish standard data file formats and to improve the structure of the web site, in order to get a total independency on the hardware platform. Also, in the future the system may benefit of the inclusion of modern data analysis procedures and data assimilation techniques.

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5. REFERENCES

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