Abstract - The purpose of the paper is to report mainly the work developed in the areas of distributed instrumentation and geographic information systems for dolphins’ environment assessment. A smart sensing node mounted in a buoy expressed by water quality transducers, a low cost hydrophone materialize and a GPS delivers the information for an acquisition and wireless communication module that is connected through Wi-Fi to a laptop PC that is installed in a ship. Using the internet available connection (3G/UMTS modem is installed on the laptop PC) the data from different sensing nodes are transmitted to a host PC where specific software implemented materializing the geographic information system for dolphin life assessment (GIS). Thus, on-line environment assessment through dynamic web pages is carried out.

Keywords - water quality, underwater acoustic monitoring, smart sensors, geographic information system

I. INTRODUCTION

A Geographical Information System (GIS) [1], allows viewing, understanding, questioning, interpreting, and visualizing data in many ways, which reveal relationships, patterns, and trends, and can be used for environment quality assessment related to animal life conditions (e.g. dolphins of the Sado Estuary). In our application, water quality assessment includes different parameters such as pH, conductivity, temperature and turbidity [2][3]. These parameters are measured by the transducers characterized by analog output and additionally the digital information Basic TEDS (transducer data sheet) according to IEEE1451.4 [4] standard for smart transducers. Underwater acoustic signals are usually sensed using hydrophones that can be also used to acquire specific dolphin’ sounds (whistles, clicks and bursts) [5].

The paper also reports a designed and implemented Geographic Information System developed with a Windows server 2003, SQL server, ASP.net, AJAX and a GMAP technology, that supports the management of the information obtained from GIS, we may access data in a way that allows an easier interpretation, finding relationships, detect patterns and share data in a more understandable way. The method used to display data was supported by the GIS map. The map enables the visualization of queries to the database. Combining the data, we can get results such as the route of the ship in a given period. These features were implemented using the Google’s GMAP API [6] to map the data.

In terms of software, the project was developed in ASP.NET 2.0 AJAX 1.0 (C# language), in the Microsoft Visual Studio 2005 Express Edition platform. The Microsoft SQL Server 2005 Express Edition was used for database management. The application data mapping is made using the Google’s GMAP technology, accessible on the internet. The code to implement GMAP was done in JavaScript. The application provides a real-time monitor of successive measuring locations by a ship that travels the Sado’s river estuary. The preview is done in the GMAP by a set of markers (that identify the measurement points) connected by lines. This will give a rough idea of the route followed by the ship.

II. GIS HARDWARE

Taking into account that the dolphins’ population under observation is spread over a large area (Sado Estuary), the Geographic Information System receive the data from a nodes wireless connected to a field advanced processing and communication unit expressed by a Laptop PC. The measurement nodes (Figure 1) includes: GPS unit for sensing node localization, water quality transducer unit, underwater acoustic signal measuring unit and wireless communication unit. The measurement nodes prototypes include a GPS (GarminForetrex201) with RS232 communication capability that provides the information about the sensed node localization on the assessed area information is joined to the water quality parameters values measured using the WCQ expressed by a set of Global Water Sensors (WQ01, WQ201, WQ301 and WQ770) that measure the temperature, conductivity, pH and turbidity. The 4-20mA signals from the WQ sensors are acquired using a 16-bit ADC of an acquisition unit uUP8930 from IPSIL that present an Ethernet port connected to the sensing node Switch&Wireless. Additionally the basic parameters (TEDS) of each WQ sensor are stored in a 1-wire memory (DS2432). The digital information from each measurement channel is managed through a 1-wire network that also include a 1-wire bridge connected to the SerialEth unit. In order to monitor the underwater acoustic sound in the Sado Estuary the sensing node includes underwater acoustic signal measuring unit including a hydrophone (Cetacean Research 5003) with audio preamplifier that assure an amplified and filtered signal that is applied to the input of audio server based on VoIP technology (IP7).

GIS SOFTWARE - The developed GIS, called SonicQualSado, associated with Dolphin’s Environment Assessment, includes dlltwo components: a LabVIEW instrumentation control and a knowledge management. Data logging capabilities were implemented by using Windows server 2003, SQL server, and ASP.net, AJAX and GMAP technologies. From GIS, we may access data in a way that allows an easier interpretation, finding relationships, detect patterns and share data in a more understandable way. The method used to display data was supported by the GIS map. The map enables the visualization of queries to the database. Combining the data, we can get results such as the route of the ship in a given period. These features were implemented using the Google’s GMAP API [6] to map the data.

In terms of software, the project was developed in ASP.NET 2.0 AJAX 1.0 (C# language), in the Microsoft Visual Studio 2005 Express Edition platform. The Microsoft SQL Server 2005 Express Edition was used for database management. The application data mapping is made using the Google’s GMAP technology, accessible on the internet. The code to implement GMAP was done in JavaScript. The application provides a real-time monitor of successive measuring locations by a ship that travels the Sado’s river estuary. The preview is done in the GMAP by a set of markers (that identify the measurement points) connected by lines. This will give a rough idea of the route followed by the ship.

III. RESULTS AND DISCUSSION

Using the implemented system, several tasks, such as water quality parameter measurement, underwater acoustic signal acquisition and recording are carried out. During the field measurement session, water quality parameters measured on different location were delivered from measurement nodes were received and processed on the Laptop of the field unit. Several results are presented on Table 1.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Lat.</th>
<th>Long.</th>
<th>T(°C)</th>
<th>pH (units)</th>
<th>C(cm^-3)</th>
<th>T(U NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.06.08</td>
<td>12:01:44</td>
<td>38.29048</td>
<td>-8.91856</td>
<td>18.34</td>
<td>9.23</td>
<td>31.4</td>
<td>8.2</td>
</tr>
<tr>
<td>25.06.08</td>
<td>12:36:21</td>
<td>38.49795</td>
<td>-8.89395</td>
<td>21.19</td>
<td>8.82</td>
<td>50.9</td>
<td>33.4</td>
</tr>
<tr>
<td>25.06.08</td>
<td>13:31:10</td>
<td>38.51363</td>
<td>-8.90155</td>
<td>19.55</td>
<td>8.68</td>
<td>51.3</td>
<td>73.4</td>
</tr>
</tbody>
</table>

The underwater acoustic signals and the measured data are uploaded on the GIS that include web publishing capabilities through dynamic pages. The GIS uses a digital map as the main element of the user interface. Not just data is visualized in the digital map, but also the map is also used to input data for searching tasks. Measured values of water quality parameters are associated with the map locations.

REFERENCES

Keywords - Tug winches, electronic instrumentation, data acquisition, electronic sensors, control system

The objective of this work is the design and implementation of an experimental electronic instrument that will be used for the automation control of a hydraulic towing winch. This electronic instrumentation system integrates the controller and the human machine interface (HMI). For this reason, an experimental programmable automation controller has been developed.

The heart of most machine control applications is an electronic controller such as a programmable automation controller (PAC) or programmable logic controller (PLC) [1]. The controller is used to receive sensor data and to control the machine using analog and digital I/O signals, and mathematical algorithms like PIDs [2]. Traditionally PLCs have been used in machine control and they are programmed using tools such as ladder diagrams or sequential function charts. One of the biggest benefits of using a PAC is the ability to add other tasks to the control application, which could not be handled by a traditional PLC [3]. For this reason, increasingly machine control is moving to PACs because they offer higher performance and more functionality, allowing operations such as high-speed data acquisition and processing, as well as motion control and vision which are not supported in traditional PLCs [1, 4, 5].

The designed electronic instrument must accomplish the control requirements for a naval deck machinery, composed by a tug winch with an hydraulic pump feeding four hydraulic motors, linked together to a towing drum [6]. The electronic instrument architecture, including the machine controller hardware and software, has been defined considering the following characteristics: (i) combination of HMI and real-time control in the machine control system; (ii) ruggedness, flexibility and modularity; and (iii) the availability of common intuitive development software for programming all the elements of the system [4, 7].

From the previous considerations, the adopted solution was based on a National Instruments (NI) CompactRIO PAC, a modular low-cost reconfigurable control and acquisition system designed for applications that require high performance and reliability. The system combines an open embedded architecture with small size, extreme ruggedness, and hot-swappable industrial I/O modules. NI CompactRIO is powered by reconfigurable I/O (RIO) field-programmable gate array (FPGA) technology. This solution comprises a CompactRIO chassis and real-time embedded controller (NI cRIO-9014) and several I/O modules (NI 9205, NI 9203, NI 9265, NI 9425, NI 9477). Figure 1 illustrates the architecture of the electronic instrument and software tasks running in HMI and Real-time Controller.

To take advantage of all the features and capabilities of a PAC, it is fundamental that the application code was well designed, coordinating various controller processes such as I/O, process control logic, communication to a HMI and other tasks [1, 5]. The LabVIEW Real-Time Module 8.6 introduced powerful new features for programming CompactRIO hardware that reduce development time and complexity as well as provide tools for monitoring and maintaining CompactRIO applications [8]. The basis of the CompactRIO PAC is the FPGA which performs the interconnection of the I/O modules and offers performance maintaining the flexibility. CompactRIO is entirely programmable with LabVIEW, including the FPGA, real-time processor, and human machine interface. The system was divided in several independent basic functional blocks or modules. These functional blocks improved the modularity and the flexibility of the system. This structure facilitates the addition of new elements to the system or the design of whole new system, simply by the design and addition of new software modules, or by the reuse of the existing ones.

Since the state diagram considers each possible state of the system, the use of LabVIEW Statecharts provides a system-level view that describes the complete function of a module, a system or an application [9]. Therefore, the use of Statecharts reduces the possibility of unexpected behaviour, because the state chart definition of a module forces to take into account the possible scenarios to which the software needs to respond.

The LabVIEW development tool also provides a powerful debugging and testing platform, so each module was previously verified and simulated using virtual panels and virtual machines (inputs/outputs). This virtual panels and machines allowed the functional verification of each module and the whole system.

REFERENCES