Use of NI LabVIEW on an Off-Shore Meteo-Oceanographic Buoy in the Ligurian Sea

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Prodotti utilizzati

Compact Fieldpoint

LabVIEW and LabVIEW Real Time 7.1

Settore Industriale

Research

University/Education

Settore Applicativo

Datalogging and Low Frequency Sourcing

The challenge

Ocean data acquisition systems (ODAS) operating all over the world routinely collect meteo-oceanographic measurements for several purposes, going from weather forecast to safely operating the maritime transportation up to pollution monitoring, etc. Our aim was to develop a meteo-oceanographic data acquisition and transmission system to be installed onboard an offshore large spar buoy: the system had to advance with respect to existing system in terms of increased flexibility, higher measurement sampling frequency, larger data storage, and better efficiency thus making the system capable of operating without any maintenance for long periods of time.

The solution

A new acquisition and control system was designed by using a custom REMO system, a product from SITEM based on the Compact FieldPoint product family. This REMO custom is able to acquire data from analog meteorological sensors as well as from sensors with serial output such as a meteorological station, a GPS, a netcam, and several other marine sensors.

Introduction

The off-shore meteo-oceanogrphic buoy ODAS Italia 1 deployed at the center of the Ligurian Sea monitors a complete set of meteorological and chemico-physical parameters in open ocean conditions. A new system based on NI products replaced an old acquisition system based on Motorola microprocessor with several dedicated acquisition and conditioning boards made on purpose.

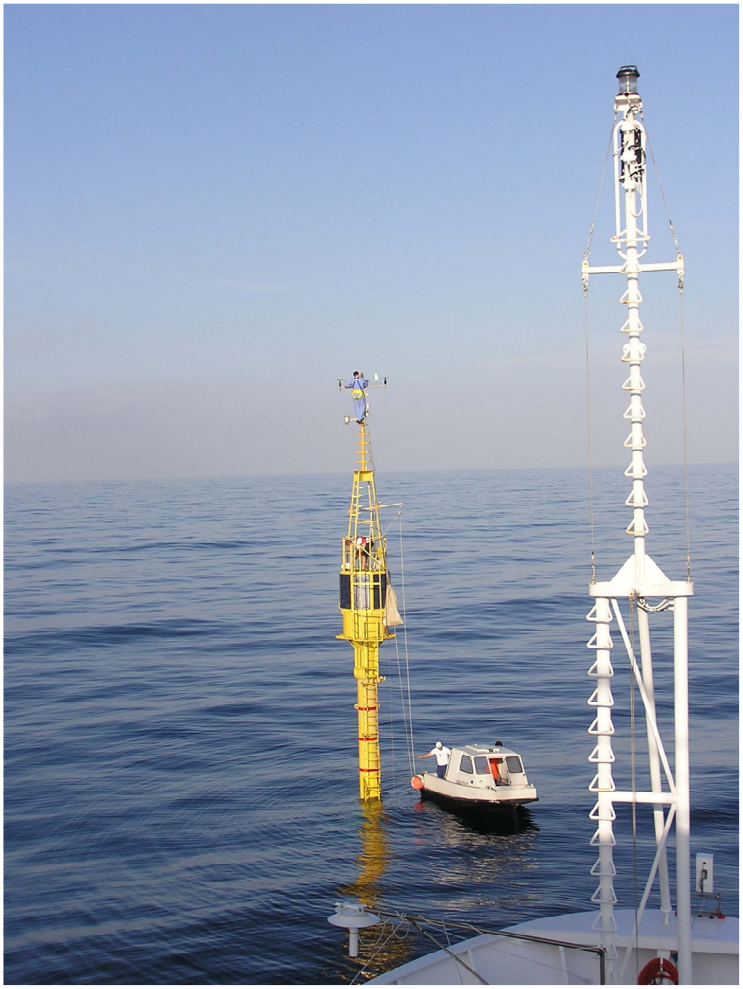

Figura 1: Vista della Boa Odas Italia 1 durante una fase di manutenzione.

The choice of LabVIEW and the NI Compact FieldPoint products greatly enhanced the performance of the system in terms of sampling capability, modularity, memory for data storage and, in general, easynes of interfacing different type of sensors with different electrical outputs (voltage, current, serial).

Paper

The ODAS Italia-1 buoy is a large spar buoy, 50 m long weigthing about 12 tons, specifically designed for air-sea interaction studies and the collection of meteorological data even in rough sea. Stability is the basic feature of this type of buoy with respect to the other more classical approach based on discus-shaped buoys. It was built in 1969 and since then it was deployed roughly continuously in the Ligurian Sea: currently, it is deployed at about 80 km far from Genoa on a 1370 m deep seabed. The mooring line is an S shape slack mooring usually employed to moor surface buoys in deep ocean.

All the equipment on board the buoy can be grouped into 4 subsystems:

- the control and acquisition module devoted to the management of all the equipment installed onboard and to the acquisition of the measurements;
- the communication system providing the necessary tools for exchanging commands, information, and data with the remote system ashore;
- the power supply system charging the battery pack that powers all the electronic devices onboard the buoy;
- the instrumental payload including all the sensors installed on the buoy.

In order to accomplish the requirements related to the development of such a distributed system coupling both efficiency and applicability to such a particolar environment, a solution with a remote onboard acquisition, control and transmission system connected to the receiving station astore was developed.
The remote acquisition system is based on a SITEM s.r.l. custom REMO system developed by using several Compact FieldPoint modules, one controller cFP-2120, three acquisition boards for analog voltage and current signals (one cFP-AI-112 and two cFP-AI-110), one combined input/output module (cFP-AIO-610) and one relay module (cFP-RLY-421) for controlling the activation of the several groups of sensors.

All the six marine sensors installed along the buoy's body have a serial interface and two serial device drivers and an Ethernet switch have been used to acquire the measurements. As an experiment, the ODAS Italia 1 buoy was also equipped by an Ethernet camera making it one of the first (or perhaps, unique) buoy in the world able to collect visual sea-truth measurements: once a hour during the daylight, the acquisition system collects a frame from the camera thus having important information about the real sea state and general meteorological conditions.

Since the buoy is located offshore, the Globalstar satellite system was selected as the only affordable mean to guarantee the connection with the station ashore for data and commands exchange. A Qualcomm GSP-1620 modem, suitable for monitoring, remote-control, and scada applications, was integrated into the system. The modem programming is possible with the standard "Hayes" AT command set.
All the equipment onboard the buoy is powered by a combination of solar and wind energy charing a 12 V @ 180 AH battery pack.

The instrumental payload onboard the buoy can be grouped into three classes depending on the type of measurements produced and/or on their position along the buoy's body. The meteorological set composed by precision spectral pyranometer, wind speed and direction sensors, two piezoelectric

barometers, two thermo-hygrometers. Marine sensors measure the most important chemico-physical properties of the sea water (temperature, conductivity, dissolved oxygen, turbidity, chlorophyll-a) at six depths along the buoy's body. Three echosounders installed at about -9.4 m depth on 120° supports measure the distance from the sea surface above thus inferring the wave forms. The last set of sensors includes a double axis inclinometers, a compass, and a GPS receiver. The power supply system is monitored by a voltage sensor indicating battery charge and by a group of electronic current detector sensors measuring power generated by each photovoltaic panel and the wind turbine.

Since the acquisition system was designed with some modularity, other types of measurements could be acquired provided the feasibility of the sensor's installation onboard the buoy, the availability of the necessary power supply and the capacity of measuring and treating the type and the amount of data extracted by the sensor.

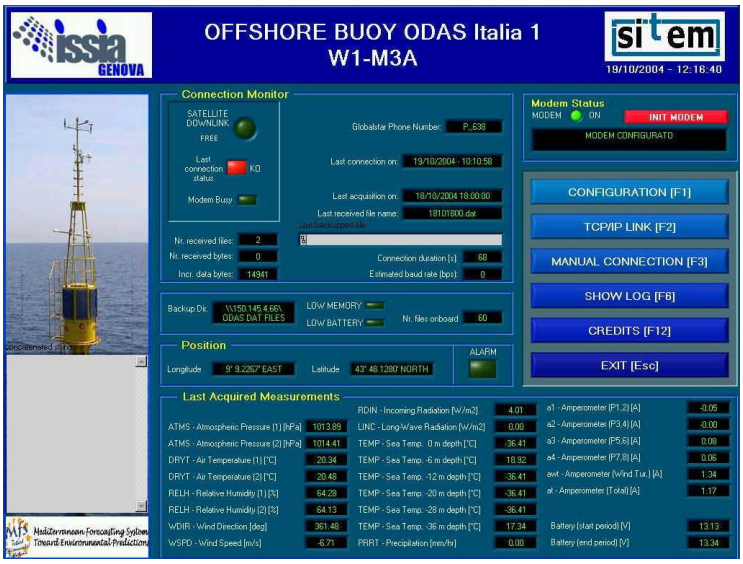

Figura 2: Pannello frontale della applicazione di controllo remoto.

Two software programmes have been developed by SITEM and CNR-ISSIA by means of the LabVIEW and LabVIEW Real Time of National Instruments.

The main program runs on controller module cFP2120 of the REMO system. Besides the scheduling for the acquisition and control of the cFP modules, three different serial communication (two RS232 and one RS485) drivers have been developed for managing the Globalstar modem, the GPS receiver and the meteorological station unit, respectively. The control of the serial marine sensors occur by means of a TCP/IP connection through the serial device drivers. More in detail, a scheduler switches on and off the different groups of sensors at pre-defined time instants, and acquires the measurements from the sensors during different time periods and with different sampling frequencies. The whole time series are store on the compact flash memory for their retrivial during the maintenance missions whereas some basic

statistical parameters are computed and stored in datalog files on the compact flash memory. These datalog files are regularly transmitted to the station ashore on the basis of predefined time intervals.
Different alert conditions, i.e. related to low battery and memory levels, may automatically modify the functioning mode in order to preserve the available resources as much as possible. The normal operating mode autonomously restores when the alert conditions cease.
The programme running on a PC at the station ashore stores on the local hard disk the data received from the remote system onboard the buoy. It operates for 24-hours, seven-day-a-week continuously waiting for the remote system to phone it. More in detail, it decodes the received files making the data available in an ASCII format. Furthermore, by means of the program interface some basic changes to the buoy configuration can be applied and downloaded into the remote system.
The described system was successfully installed onboard the buoy on September 2004 and upgraded again on June 2006. The status of the system can be partially monitored by visualising the data transmitted to the station ashore through the web portal of the buoy www.odas.ge.issia.cnr.it.