Update of the Control System for the OBSEA Underwater Observatory

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Abstract – **This article provides an overview of the recent advancements and updates made to the control systems of the OBSEA underwater observatory. The paper delves into the key technological enhancements implemented to improve the overall efficiency, reliability, and functionality of the observatory's control systems. Topics covered include hardware upgrades, software developments, and innovative integration of sensor technologies. The article aims to highlight the significance of these updates in enhancing the capabilities of the OBSEA underwater observatory for monitoring and research in oceanic environments.**

Keywords *- Marine Technology, Marine Instrumentation, Environmental monitoring, Control System Update, Flexible Instrument Connectivity*

• INTRODUCTION

In the realm of marine research, the demand for vast volumes of environmental data with unparalleled resolution has driven the exploration of innovative data acquisition methods. Traditional approaches using oceanographic vessels, buoys, or seabed sensors are limited in their ability to provide continuous, high-resolution data over extended periods. Seafloor observatories, such as the OBSEA [1] underwater observatory located off the coast of Vilanova i la Geltrú in Barcelona, Spain, offer a transformative solution. Connected to the mainland by a 4 km cable and situated at a depth of 20 meters within a protected fishing area, OBSEA excels in providing uninterrupted, high-resolution data that enables the scientific community to analyse both annual trends and singular events.

The OBSEA observatory's distinctive advantage lies in its cabled infrastructure, facilitating a high-bandwidth communication link of 1 Gbps. This real-time communication capability eliminates the limitations associated with battery-powered systems, enabling continuous data transmission from a network of connected oceanographic instruments. The implementation of an optical ethernet network ensures a seamless flow of real-time information, allowing researchers to observe multiple parameters of the marine environment. The Ground Station, located on land, not only supplies power to all devices but also manages alarms and data storage, creating a robust and efficient system.

The improvements presented in this work covers the updates of the hardware components located in the control cylinder of the OBSEA observatory, and the updates of the instrument control software and monitoring system, including alarm generation. These improvements are intended to increase the observatory's ability to acquire, process and transmit data with greater efficiency and precision. The upgraded control system is designed to meet the changing demands of marine research, solidifying OBSEA's position at the forefront of providing valuable information about the dynamic marine environment.

• DETAILED INFORMATION ON THE ARCHITECTURE OF OBSEA's CONTROL SYSTEM

Since the installation of the OBSEA observatory in 2009, the control system located at the underwater station has undergone several significant changes. Initially, in 2009, a design based on a 32-bit ColdFire MCF5282 microcontroller and a RS-232 relay drive system was implemented [2]. Subsequently, in 2018, a system update took place, replacing the control system with a Raspberry Pi 2 single board computer.

The most recent update encompasses broader changes in terms of capacity and versatility. It includes the implementation of a redundant system based on 2 Raspberry Pi 4 units and a complete redesign of the relay and power management of instruments connected to the control cylinder. This new design, in addition to enhancing reliability and redundancy, allows for the connection of up to 8 underwater ethernet instruments and powered by 12V or 48V.However, the crucial difference of this update lies in the transition to a distributed system.

The new electronic architecture consists of a main control board, to which 8 independent boards for instruments can be connected. This approach not only facilitates individualized component repair but also enables more precise detection of potential faults. Through I2C protocol, the main control board manages the connection of each instrument and also collects their power consumption profiles. Furthermore, it monitories the overall consumption of the other integrated components in the control cylinder, including the ethernet switch and the 2 Raspberry Pi 4 units.

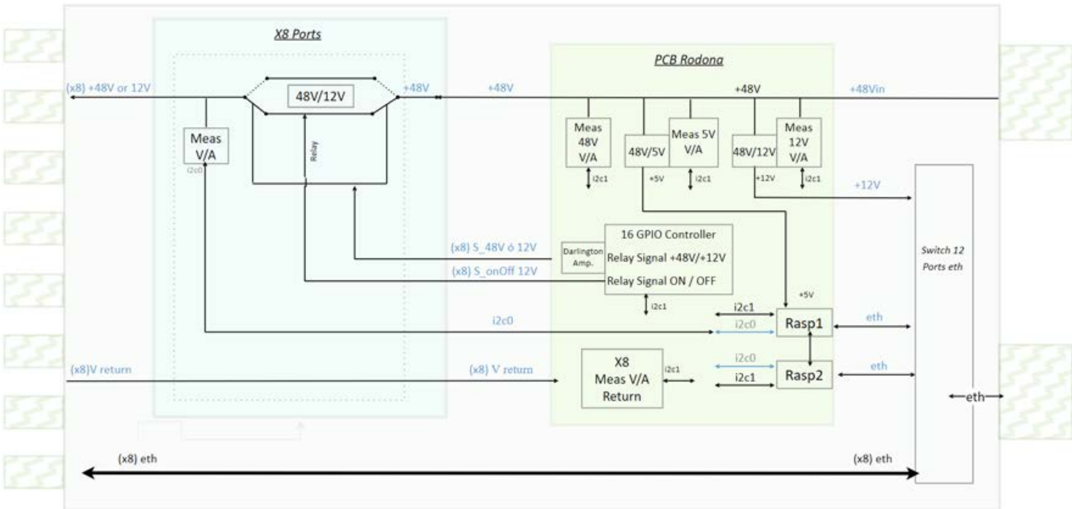

Figure 1. Diagram of the control system located in the underwater station of the obsea observatory

Regarding updates, in 2009, the control system was developed using programs written in C, the protocol for acquire analog information from intruments was the RS-232 protocol. Additionally, relays were triggered through the SNMP protocol.

In 2018, a software update took place, transitioning the control cylinder firmware to Python. In the latest update, the control program is also developed in Python, but both the activation system and the reading of instrument data now occur through I2C protocol. This change has allowed the elimination of several electronic components, reducing costs, and improving the detection and understanding of associated circuits.

The control layer also provides monitoring through SNMP protocol and via Zabbix agents located on Raspberry Pi units. This gives even more control to the system, as real-time information is obtained.

Zabbix agents are linked to a Zabbix server where flexible thresholds can be set to identify issues and trigger alarms by referencing values previously collected in the database. Additionally, customized notifications are sent to different recipients and platforms such as Telegram or Discord. Monitored items are graphically represented, creating a visual control system where problems can be intuitively detected.

- CONCLUSIONS

The article highlights significant improvements made to the control system of the OBSEA underwater observatory, emphasizing advancements in hardware, software, and electronic architecture. The observatory's distinctive advantage lies in its cabled infrastructure, enabling high-speed communication that allows continuous data transmission from a network of connected oceanographic instruments. The recent update includes the adoption of a distributed electronic architecture with redundant Raspberry Pi 4 units, enhanced relay and power management, and a flexible system for connecting up to 8 underwater instruments.

In terms of software, the transition to Python programming and the implementation of the I2C protocol for data acquisition represent significant enhancements. The monitoring system, through SNMP and Zabbix agents, provides real-time information and customizable alarms, offering efficient control and detailed analysis in marine research. These updates solidify OBSEA's position at the forefront of obtaining accurate and continuous data in marine environments, providing the scientific community with enhanced tools for studying annual trends and singular events in the marine environment.

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ACKNOWLEDGMENTS

This work has been financially supported by the European Commission's HORIZON-INFRA-2022-TECH-01-01 under the ANERIS project (grant agreement 101094924).