Designing an Underwater Sensor Node for Ocean Monitoring

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***Abstract*—Oceanography is one area that can benefit from the research in underwater sensor networks (UWSNs) which is gaining attention due to its possible applications in many scenarios, such as ecosystem preservation, disaster prevention, oil and gas exploration and freshwater reservoirs management. The main elements of an UWSN are underwater sensor nodes (UWNs). In this paper we describe the main elements of an underwater sensor node for ocean monitoring. Due to its multipurpose design, it can be used in different oceanography studies, including climate change, algae blooms, and save in people work hours and money.**

I. Introduction

Underwater sensor networks (UWSNs) is an important research area that is attracting increasing interest both from the research community and also from the industry. Oceans, rivers and lakes are critical to the life on our planet and monitoring these environments is a hard and costly task. Thus, there is a large number of applications where UWSNs are important, such as ecosystem preservation, disaster prevention, oil/gas exploration, and freshwater reservoirs management.

An underwater sensor network is formed by many autonomous sensor nodes. An underwater sensor node (UWN) can sense the environment, collect data, as well route data in the network. One of the main challenges of deploying such a network is the sensor node development, including its high cost when compared to terrestrial sensor nodes. Most hardware architectures of sensor network nodes aimed at very specific applications, lacking in generality, and researchers lacked a unified platform to test practical performance of network protocols.

The objective of this paper is to describe the design of a sensor node for ocean monitoring, therefore aiding the research of UWSN system protocols, configurations and applications.

II. Background

Current ocean monitoring requires teams and equipment locally present. Otherwise, data may take months before being collected. An option is to use transmissions via satellites. This is very expensive and satellites may not be available all times. Current monitoring systems use drifters [4], AUVs [2] or .

We propose underwater sensor network for monitoring oceans and delivery data in almost real-time. In order to develop an underwater sensor network, we first need to build an underwater sensor node. In this paper we describe the characteristics of a sensor node architecture. The architecture should provide functionalities that will enable network operation, such as localization [1], [3] and routing [5].

III. Underwater Sensor Node General Architecture

Despite many possible architecture models, underwater sensor nodes present functions that can be grouped in specific units. Hence, we here propose a general architecture for underwater sensor nodes, depicted in Figure 1. In this architecture, an UWSN is composed by five main units: processing unit; communication unit; sensing unit; power supply and energy management unit; and a possible depth control unit. They all need to be protected by a housing unit, that ensures that water will not go inside. The underwater sensor node architecture is shown in Figure 1.

The processing unit is the central part of an UWSN. It coordinates all other units operations. The sensing unit is composed of a group of sensors. The sensors can be classified in two primary ways: analog and digital sensors. The communication unit is the underwater sensor nodes module responsible for handling communications. The Power Supply and Energy Management Unit must provide the node with a reliable energy source, as well as control energy consumption. The Depth Control Unit sets the depth in which the node operates. Because water conditions vary greatly with depth, one desires to be able to measure these characteristics along a water column, for example.

IV. Realization of an Underwater Sensor Node

Here we show a realization of such architecture, used for example in Hydronode [6]. Its components is shown in Figure 2.

There is one board to connect to various types of sensors, called acquisition board. In this implementation, there are up to 7 sensors that can connect to the acquisition board, which is responsible for reading the sensors values at a predetermined time intervals. Reading time intervals can be

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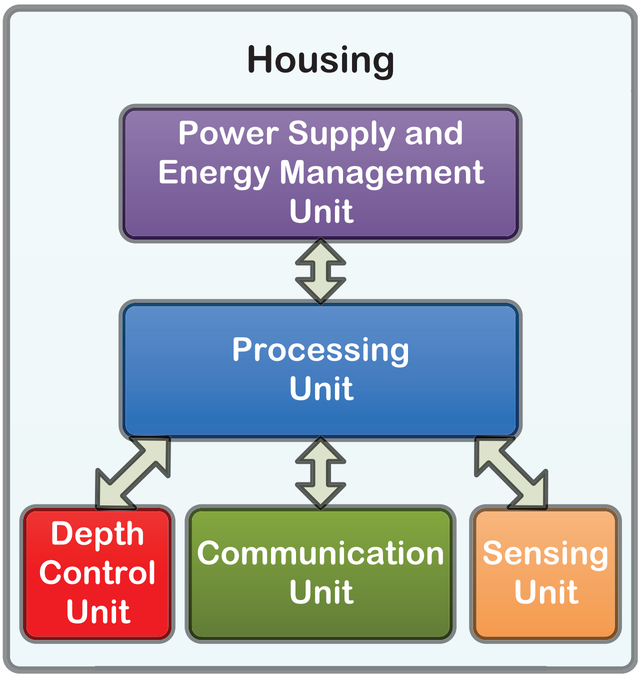

Fig. 1: General underwater sensor node architecture.

configured according to scientists interest and also consider the energy left on the batteries. Those sensed values are transmitted internally to another board, the manager board, which, in turn, can send those to an outside computer, to a micro SD card (via data logger board) or can send it to the modem board. The modem board will transmit or receive the data wirelessly via the acoustic modem. Any acoustic modem with serial ports can be used. Once data are received by another underwater sensor node or an outside computer, they can be stored and processed by any data management software, such as databases and web servers.

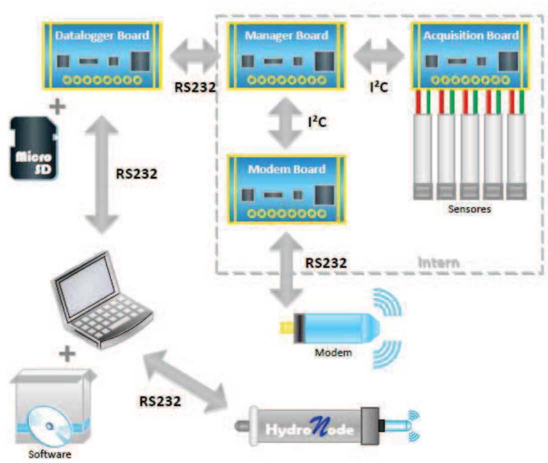

Fig. 2: Sensor node components.

The node is built to carry heterogeneous sensors, allowing a more complete view of the environment. The outside view of the underwater sensor node is shown in Figure 3a.

Fig. 3: Outside view.

Current water quality sensors are measuring: temperature, dissolved oxygen, ph, chlorophyll, conductivity and turbidity. We plan to increase the number of sensors used, while maintaining a low power consumption. Temperature, dissolved oxygen, ph, Chlorophyll, electric conductivity and turbidity are all measurements important for biologist and oceanographers. With those values, they can study how the environment is proper for marine biology development and relate green gas emission.

V. Conclusion and Future Work

In this paper, we presented the design of a sensor node for ocean monitoring.

Future work are related to improving the node's cost and energy efficiency, as well as the development of the network layers, new UWSNs protocols and applications.

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