HydroNode: An Underwater Sensor Node Prototype for Monitoring Hydroelectric Reservoirs

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ABSTRACT
The research of underwater sensor networks (UWSNs) 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 a UWSN are underwater sensor nodes (UWNs). In this paper we present HydroNode, an underwater sensor node prototype for monitoring hydroelectric reservoirs. The objective of this paper is to describe the design of HydroNode for Hydroelectric Reservoirs Monitoring. We only used commercial off-the-shelf components to build our underwater sensor node. Due to its multipurpose design, HydroNode can be used in different UWSNs, therefore aiding the research of UWSN system protocols, configurations and applications.

Categories and Subject Descriptors
C.2.1 [Computer Communication Networks]: [Network Architecture and Design.]

General Terms
Design

Keywords
Underwater sensor networks, underwater sensor node, hydroelectric, reservoirs, monitoring

1. 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 [2, 1].

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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 [6, 7]. Recent experimental work in underwater networking includes [3].

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 [5]. 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.

Nowadays hydroelectric reservoirs monitoring are very important. The water reservoirs, besides being used for producing energy, contain large stores of formerly terrestrial organic carbon. In addition, significant amounts of greenhouse gases are emitted, especially in the early years following reservoir creation.

The objective of this paper is to describe the design of HydroNode for Hydroelectric Reservoirs Monitoring. We used only commercial off-the-shelf components to build our underwater sensor node. Due to its multipurpose design, HydroNode can be used in different UWSNs, therefore aiding the research of UWSN system protocols, configurations and applications.

2. UNDERWATER SENSOR NODE
The underwater sensor node architecture and components is shown in Figure 1. There are up to 7 sensor 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 configured according to scientists interest and also consider the energy left on the batteries. Those sensed values are transmitted internally to 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.

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Figure 1: HydroNode 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 2. The inside view is shown in Figure 3.

Table 1: Water quality sensors

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Model</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>WQ101</td>
<td>Global Water</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>WQ401</td>
<td>Global Water</td>
</tr>
<tr>
<td>PH</td>
<td>WQ201</td>
<td>Global Water</td>
</tr>
<tr>
<td>Chlorophyll</td>
<td>6025</td>
<td>YSI</td>
</tr>
<tr>
<td>Conductivity</td>
<td>WQ-Cond</td>
<td>Global Water</td>
</tr>
<tr>
<td>Turbidity</td>
<td>WQ730</td>
<td>Global Water</td>
</tr>
</tbody>
</table>

3. CONCLUSION AND FUTURE WORK

In this paper, we presented HydroNode, an underwater sensor node for hydroelectric reservoirs monitoring. Future work are related to improving HydroNode’s cost and energy efficiency, as well as the development of the network layers, new UWSNs protocols and applications. It includes the development of MAC, routing [4, 8] and transport protocols, considering duty cycle and battery management improvements.

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5. REFERENCES


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