Chapter 2
IoT Underwater Wireless Sensor Network Monitoring

Low Tang Jung
Universiti Teknologi PETRONAS, Malaysia

ABSTRACT

Water is a crucial resource for all life on earth, and it is fast becoming one of the limited natural resources to humankind, especially clean drinking water and water for agricultural uses. Sensor technologies and wireless communications (both terrestrial and underwater) have been seriously investigated by researchers to find ways to integrate these technologies for a novel data-sensing and data-collecting network for long-term water pollution monitoring purposes. This chapter describes an IoT-based underwater wireless sensor network (UWSN) which is believed to have a huge potential for monitoring the health of river, lake, reservoir, and marine environment. The sensed data from IoT sensors are communicated wirelessly via acoustic channels to a data collection center for further processing and interpretation. It is foreseeing that judicious deployment of IoT-based UWSN is a promising solution for long-term water quality surveillance.

INTRODUCTION

Water is a crucial resource for all life on earth and it is fast becoming one of the limited natural resources to humankind. It can be foreseen in near future that water, especially clean drinking water and water for agricultural purposes, is realistically becoming a scarce resource. Clean drinking water is already a revenue generating commodity since the past decade. It is therefore been observed in many countries (Water Framework Directive WFD, Council Directive 2000/60/EC) that water quality monitoring in a long-term continuous mode is beginning to catch on as an essential component in the environmental pollution monitoring and control systems. Thanks to the worrying realistic effect from industry waste and climate change, the sensor technologies, and wireless communications (both terrestrial and underwater) are being seriously investigated by many researchers to find ways to integrate these technologies for a novel data-sensing and data-collecting network for long-term pollution monitoring systems.

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The application of wireless sensor networks in underwater domain has a huge potential for monitoring the health of river, lake, reservoir, and marine environment. By deploying the in-situ sensors for continuous sampling of the environmental parameters or indicators offers the advantage of reducing the operation costs and to provide real-time information on pollutant fluctuations. Essentially, the UWSN monitoring system comprises of a network of underwater sensors deployed at key locations for a time frame of months in a continuous operation mode. The sensed data from the sensors will be communicated by wireless means via an acoustic channel to a data collection center for further processing and interpretation. It is believed that judicious deployment of underwater sensor network is a promising solution for long-term water quality surveillance.

BACKGROUND

A handful of underwater wireless sensor network (UWSN) have been deployed for water quality or pollution monitoring and two prominent works in this area are briefly mentioned here. Smart-Coast (Regan, Lawler, & McCarthy, 2009) was a project aimed to develop a wireless sensor network with a distinct "plug-and-play" feature that incorporates novel sensor nodes and low power consumption. This system was based on Zigbee communications standard. The "plug-and-play" platform was designed to sense pH level, temperature, conductivity, depth, and turbidity.

The Fraser River Water Quality System by Ethier & Bedard (2007) was a project initiated for monitoring water quality and meteorological parameters in real-time mode all year round. A moored buoy platform was used for station location and in-situ water sampling. A 3m tall Oceanographic Data Acquisition System (ODAS) buoy was designed for this purpose. The monitoring operation was scheduled in continuous mode with a biweekly sampling. ODAS was claimed to be able to distinguish tidally driven events to initiate sampling of organic contaminates.

Practically there are three general network scenarios for UWSN deployment: static two-dimensional UWSN for underwater bottom environment monitoring, static three-dimensional UWSN for underwater column monitoring, and three-dimensional mobile network with autonomous underwater vehicles (Akyildiz, Pompili, & Melodia, 2005). However, in terms of aquatic applications, UWSN can be classified into two categories: long-term non-time critical aquatic monitoring, and short-term time critical exploration (Cui, Kong, Gerla, & Zhou, 2006). The use case study in this chapter falls in the first category. The use case in this chapter is about a long-term water pollution monitoring application. Other applications fall into the first category may include marine biology, oceanography, ocean floor seismic monitoring, etc. As for the second category, the applications may include setting up of ad-hoc UWSN at the site of a shipwreck for liquid toxic leakage monitoring, radiation detection, etc.

This chapter starts by describing the possible UWSN architecture for underwater pollution monitoring application which includes the description of a basic architecture and an extended architecture. It should be mentioned here that the use case study in this chapter is based on the extended architecture. Then, the details of data transmission and data acquisition scheduling process for the proposed UWSN monitoring is described which leads to a proposed scheduling algorithm. Next, the sink node battery power capacity issue is discussed, and a battery power capacity estimation method is proposed. A conclusion is provided at the end of this chapter.

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