Chapter 7
A Review of Recent Issues and Challenges of Fault Management Techniques in Underwater Wireless Sensor Network

Nonita Sharma
Dr. B. R.Ambedkar National Institute of Technology, Jalandhar, India

Krishna Pal Sharma
Dr. B. R.Ambedkar National Institute of Technology, Jalandhar, India

Rajneesh Rani
https://orcid.org/0000-0003-2104-227X
Dr. B. R.Ambedkar National Institute of Technology, Jalandhar, India

ABSTRACT

Underwater wireless sensor networks (UWSNs) are deployed to conduct cooperative surveillance and data gathering tasks in an acoustic region. Different nodes and ground-based stations use these networks interactively. UWSNs are currently facing problems and difficulties related to restricted bandwidth, substantial delay in propagation, 3D topology, control of media access, routing, use of resources, fault management, and energy limitations. The research community has given various methodologies over the past few decades to address these problems and challenges; however, owing to varying attributes of the underwater environment, some of them are still open to research. In this chapter, a survey of fault management techniques in UWSN regarding types of faults and their classification, environmental factors influencing the identification of faults, fault detection schemes, issues, and future directions is performed. This chapter outlines available fault management techniques and their pros and cons for further advancement in underwater sensor networks to highlight new research trends.

DOI: 10.4018/978-1-7998-3640-7.ch007

INTRODUCTION

The application of sound propagation techniques to send and receive messages in underwater environments is the basic premise of acoustic communication. The underwater telephone developed for the U.S. Navy during World War II was one of the first underwater communication devices (Headrick, Robert, & Freitag, 2009). Because of its numerous science, military, and commercial applications, acoustic communication has gained interest. These applications vary from strategic supervision to aquatic life analysis, including driverless vehicle activity, oil mining, mapping, oceanographic data processing, and aquatic environment commercial exploitation.

UWSNs consists of several mobile vehicles and sensors that work collaboratively to monitor and collect information in an aquatic area. As a matter of course, the surveillance of the ocean bottom is done through oceanographic sensors, which records data at a fixed place and perform analysis of the same after job completion. The main drawback of the traditional methodology is the absence of interactive communication between distinct ends, and therefore recorded data can never be obtained during any task, and information collected will be destroyed in the event of any failure (Goyal, Dave, & Verma, 2016)

For communication amongst underwater sensor nodes, electromagnetic, optical, and acoustic waves have been applied effectively (Stojanovic & Preisig, 2009). Nevertheless, radio waves are not considered viable for communication in the ocean due to high attenuation in water (Heidemann, John, Stojanovic, & Zo, 2012). Under the full constraints of UWSNs, the acoustic signals are considered viable as the sound speed is deemed continuous underwater. However, the underwater environment's factors like temperature, depth, and salinity influence the speed of sounds. Also, the variable characteristics of the acoustic channel pose several restrictions for using them for communication. For instance, multipath propagation causes fluctuations; the mobility of nodes causes Doppler effect. Also, nodes of underwater sensors are mobile, unlike nodes of ground-based sensor networks. Moreover, they move because of various underwater environment operations and conditions, generally 2-3m / sec with water currents (Mohamed, Jawhar, Al-Jaroodi, & Zhang, 2011)

Furthermore, underwater sensor nodes work under unfriendly and remote conditions. Faults in UWSNs, therefore, occur repeatedly and unpredictably as compared to conventional sensor networks (Benson, 2010). A fault is an unexpected change or malfunction, although it may not result in physical failure or breakdown. The provision of uninterrupted services to long-lasting aquatic applications is a significant challenge in UWSNs in the presence of these frequent failures. The erroneous information collected from faulty nodes may lead to wrong interpretations and false decisions. In some situations, the implications of a wrong decision can be served in terms of environmental effects, financial loss, and marine life. For example, in underwater warfare, if faulty nodes embedded around the suspicious area fail to give early warning correctly, the purpose of deploying the UWSNs vanishes (Goyal, Dave, & Verma, 2017).

The faults span from a single node behaving maliciously to the node crash, where it becomes completely inactive. As faults in nodes significantly reduce the data quality and decision capability, the faulty nodes need to be diagnosed correctly for filtering erroneous data and improving data quality. This chapter's significant contributions are not only to illustrate the classification of different faults but also to describe the impact of faults in the operating aquatic environment. Besides, the transmission of erroneous data not only reduces the decisive capability, but it harms in terms of wastage of constrained network resources like energy, bandwidth, etc. This chapter explores in-depth to facilitate the best use of available resources in the underwater environment under various faulty conditions. In Table 1, the most important terms related to fault diagnosis is elaborated so as to quickly explicate the current state of the art.