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Overload Detection and Energy Conserving Routing Protocol for Underwater Acoustic Communication

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ABSTRACT

The underwater wireless acoustic sensors are facing several challenges due to their limited energy power that can significantly affect their network performances; hence, the design of an efficient and reliable routing protocol for the underwater sensor communication is becoming the main purpose for the researchers. However, in this article, a new mechanism is proposed to balance the underwater network energy consumption due to the frequent data packet forwarding, whereas the protocol uses a method that is based on the historical nodes energy, where sensor that are excessively consuming energy are considered as overloaded and congested nodes and have to be excluded from the forwarding process depending on their priority value. The implementation and simulation have been performed using NS-2 network simulator, based on the well-known protocol for the underwater acoustic communication 'vector-based forwarding routing protocol'. The results has shown the effectiveness of the proposed mechanism over the VBF in terms of energy consumption and efficiency, successful delivery data, end-to-end delay and packet loss.

KEYWORDS

Energy Variation, ODEC-VBF Routing Protocol, Overload Detection Mechanism, Underwater Wireless Sensor Network, VBF Routing Protocol

INTRODUCTION

Since more than 66% of the earth is covered by water, principally oceans, it becomes crucial for humans to explore the oceans for a future development purpose (Nazareth and Chandavarkar, 2020), however their explorations presents a great challenges for the scientific researchers due to the greatness of the oceans, the presence of a high water pressure, and predatory fish, which makes the task difficult to manage, hence the underwater wireless sensor networks have bring a large interest to the scientific community, for the various applications that they can brings for different fields, such as oceans surveillance, disaster prevention, assisted navigation, mine detection and oceanographic data collection (Hussein, 2014). Whereas the underwater wireless sensors are confronted to several challenges that can significantly affect their performances due to the unpredictable conditions of the

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marine environment, the limitations of UWSN are mainly focused on their insufficient bandwidth and power energy, their high signal absorption due to the use of the acoustic medium, the large propagation delays, deployment cost, the presence of a significant noises and interference, high bit error rates, localization challenges, and void zones (areas where the acoustic signal is not reachable) (Bouk et al., 2016), hence several studies has been conducted recently in order to support the acoustic communication and overcome the present issues in the marine environment (Rahman, 2017), while those technologies are still confronted to many challenges nowadays. Based on the well-known routing protocol for the underwater acoustic communication 'Vector Based Forwarding' (VBF)(Xie et al., 2006), the protocol that adopts a virtual routing pipeline formed from the source node to a destination node named 'target' and defined by a radius threshold, allows only sensors located inside the pipeline to forward the incoming data packet, otherwise it discards it, however the protocol presents some limits, as the sensors within the pipeline are continuously forwarding the data packet, their energy might be exhausted which results in wireless link interruptions problems. In other hand, when a sensor node is the most qualified node to transmit, forwards and receives data it becomes overloaded in somehow, the energy is severally consumed that might reduce the received acoustic signal, moreover the delay time is significantly impacted which may decreases the successful delivered packet, hence the performance of the underwater acoustic network worsen. The design of a robust, efficient and reliable mechanism to prevent from overloaded sensors became important. In this paper, the author has proposed a new approach ODEC-VBF (Overload Detection and Energy Conserving routing protocol) that is aimed to balance and conserve the consumed energy caused by the overloaded sensors in a cross-layer manner, the method mainly computes the variation energy of each sensor involved in the forwarding process based on its historical energy information, and compare it to a predefined threshold to determine if the current sensors is concerned by the overload (Aouiz et al., 2018), in addition, among the main weaknesses of the VBF protocol, is its sensitivity to the radius threshold, where more efficient path could exist outside the pipeline (Nicolaou et al., 2007), hence lack of sensors inside the virtual pipeline might affect the successful delivery packet, for that, the proposed mechanism tend to preserve more the forwarding data packet, in order to prevent from the packet loss, where the overloaded sensors that are less prior than others should not participate in the forwarding process, sensors concerned by the overloaded and are more prior can continue to forward after a certain time. The proposed study was conducted to reduce the occurrence of congestion by avoiding transmission through overloaded sensor, saves more energy and enhances the acoustic network lifetime. The paper is organized as follows: First some of the proposed works related to the discussed contribution are cited and briefly explained. In section 2, the acoustic communication models are presented. The problem description and the proposed approach are described and detailed in section 3. The simulation environment and performance evaluation are presented in section 4. Finally, the author concludes the paper by presenting some perspectives and future works in section 5.

RELATED WORKS

This section is aimed to present some of the realized works and approaches that are aimed to detect congestions through the network and balance the load, some of the other proposed works are conducted to avoid overloading in order to preserve and conserve the sensors energy and extend the network lifetime.

(Goyal et al., 2016) proposed a technique to control the congestion and balance the load through the network, where sensors are organized as clusters, where each cluster has it member head (CH), the technique is aimed to detect congestion intra and inter cluster, where the congestion level is balanced at the intra cluster according to the buffer occupancy rate and the overflow rate measurement, and transmission rate adaptation, however, the inter cluster congestion is detected at the gateway node, where the traffic load, the channel condition or link quality are measured, if any congestion is detected the gateway node distributes then the traffic to a set of other neighbor gateway nodes in order to