International Journal of Electronics, Communications, and Measurement Engineering
Volume 11 • Issue 1

A Predictive Mechanism Based on Newton Interpolation for Underwater Wireless Sensor Network

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ABSTRACT

Despite their many applications and advantages inside the marine environment, the UWSN encounters many challenges that can affect the network performances; hence, many issues have been raised and have been discussed recently. In this paper, the authors have focused on the link failure and the probability of their occurrences caused by the node's mobility, water current, the limited battery of the sensor, or even the presence of some interference. The approach is based on the newton interpolation formula, used to evaluate the link quality between sensors, before that, a packet is sent and operates in a cross-layer fashion. The purpose is to detect and predict if a sensor node could move out from its sender's range or it can regain its current position. In addition, the authors defined a predictive zone, where the sensors are evaluated before they are selected as forwarders based on the well-known routing protocol vector-based forwarding (VBF). The authors have implemented their approach called CPN-VBF using the Aqua-Sim with ns2-simulator. The simulation results have proven the merits of the study.

KEYWORDS

CPN-VBF, Cross-Layer, Link Failure Prediction, Newton Interpolation, Underwater Wireless Sensor Network

INTRODUCTION

Even if the Underwater Wireless Sensor Network (UWSN) have been introduced to enable many discovering applications, such as disaster prevention, sea monitoring, and oceanographic data collection (Pouryazdanpanah et al., 2014), this technology can encounter many challenges and issues, as the marine environment is considered as a large scheme where the sensors are densely deployed in a 3-Dimensional patterns (Ahmed et al., 2017), and since the underwater WSN are more complex than terrestrial WSN (Sun et al., 2015) due to their limited battery that cannot be easily recharged, their costly deployment and maintenance, their temporary loss of connectivity, the frequent change of network topology, and their limited bandwidth (Awan et al., 2019 ; Khalid et al., 2017), several approaches have been implemented to overcome those above cited problems (Khan et al., 2018). One

DOI: 10.4018/IJECME.296280 *Corresponding Author

of the UWSN main issues is the link breakage or failure problem, caused by multiple reason such as low remaining energy of the sensor, the presence of some interference that may reduce the received signal strength, or node's mobility in a major time, the network topology change can have a harsh effect on the network performances in term of the delivered data and delay time, many studies have been discussed the link failure's problem (Zenia et al., 2016) . In this paper, our study has been focused on the link interruption or failure and the probability of their occurs that can be caused by multiple reasons, to prevent from such inappropriate behaviour, we proposed a new method based on Newton Interpolation formula to redefine the forwarder selection policy, the method operates in a cross-layer manner to exploit the advantages of the two layers: MAC-layer and Network layer, in order to evaluate the efficiency of the link quality at first and detect if a link interruption may occurs or not, and prevent from this issue before any packet transmission. For that, when a sensor node is located at the predefined zone the effectiveness of the link has to be evaluated by the use of the well-known formula Newton Interpolation, to distinguish from both situations, when a node is moving out the transmission range of its sender's node that makes the node no longer reachable, or it could regain its current position inside the range. In other hand, when a sensor node has a low residual energy or there is a presence of interferences, that can affect and reduces the received signal strength, in this case, the node should not be elected as forwarder. The method is divided in to three phases as follow: First the determination phase is processing when a node is inside the routing pipeline and it sender's transmission range, it has to ensure if it belongs to the predefined threshold zone, if so, the prediction phase is launched, otherwise the received signal strength is compared with a predefined signal threshold, to ensure the efficiency of the link quality. Once the node is detected at the predefined threshold zone, in this case the received signal strength of three data packets from the same sender node are collected to evaluate the link quality and predict if the concerned node laying at the predefined threshold zone could move outside the transmission range or it can regain it last position, the prediction value of the received signal is computed using the Network Interpolation formula. When a node is concerned by a future link interruption, a weak link, or a low residual energy, it will be directly isolated, and not being selected as the forwarder for the previous sender. The paper is organized as follows: first we have presented some of the realized works related to our study in section 1, second in section 2 we gave an overview about the VBF routing protocol, third the proposed protocol is presented and described along with the obtained results in section 3 and finally we have concluded the paper and presents some future works and perspectives.

LITERATURE REVIEW

Link Failure Prediction and Node's Movement Issue

In (Yazgı and Baykal, 2016), due to the temporary connectivity loss problems for UWSNs that can occurs, authors have redefined the forwarder selection policy by the control of the network topology, and define a node as an actor that can move to the mid-point position localized between source and target, to improve the communication range and achieve a maximum number of nodes. In other way to solve the problem of the imprecise transfer caused by the frequent change of the network topology due to their mobility, the authors Qingwen et al. (2016) have redefined the probability of transmission modeling by Markov Chain, after the reception of a packet by a node the transmission area is first calculates to check if it is within this area, in order to avoid unnecessary transmission. In (Han et al., 2016) a new method for a localization based routing protocol for a dynamic UWSNs based on the VBF routing protocol has been implemented where nodes can frequently change their positions and moves out the range, it aims to select the more suitable candidate route with a new forwarding mechanism. In other way authors Agarwal and Rakesh (2017) have focused their study on the node's mobility issues that can provide a topology change, their approach aims to divide the network into four quadrants, to evaluate how nodes can communicate with each other, the method