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A Review of Routing Protocols in Underwater Wireless Sensor Networks – Localization Free Routing

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ABSTRACT
The networks used in the acoustic medium between ground stations and sensor nodes are Underwater Wireless Sensor Networks. The difference between the terrestrial sensor network and underwater networks is behind the mentioned sensor networks cannot use radio signals instead for effective communication acoustic channels are used. UWSN deploys small-size sensors in deep sea water with energy, memory, and bandwidth limitations. It utilizes localization-based and localization-free routing protocols. The former type requires the two- or three-dimensional position coordinates information of the sensor nodes, while the later type requires only the pressure of the water on the sensor nodes (depth) to identify the routing trajectories. This review considers only the localization-free routing protocols. This protocol is described in terms of its routing strategy. The description of the routing strategy of this protocol makes its routing operation easily understandable. The demerits found, in turn, leads to the development of new protocols that are robust and efficient.

Keywords – Comparision, Review, Routing Protocol, localization free routing protocols, UWSN.

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I. INTRODUCTION

I. Introduction

This paper reviews the methods used for monitoring and identifying the underwater scenarios using localization free routing protocols. It works in many situations, environmental monitoring, emergency monitoring, military, and data collection, sensors that are deployed in deep sea water with energy, memory, and bandwidth limitations are of small size. The batteries cannot be recharged or replaced. The required data are collected by sensors and forwarded to sinks that are present on the shore. Underwater wireless sensor networks cannot use radio waves instead for effective communication acoustic channels are used .High end-to-end delay and low bandwidth are characteristics of acoustic links. In off-shore, the sink receives the data packets through acoustic links and further forwards it to the base station and sinks through radio waves.

Recently, the routing protocols are used to investigate the underwater medium for a number of applications including monitoring of the underwater environment for military and civilian purposes, forecasting disasters, leak detection [7] and general underwater exploration [8].Protocols used for other networks cannot be applied to UWSN.

There are many surveys conducted on routing protocols for UWSNs in the literature [6-9]. However, these surveys do not consider the recent routing protocols for UWSNs and some of the surveys do not address the parameters such as routing strategies of the addressed protocols or their merits and demerits

In time-sensitive applications, such as military surveillance and disaster prevention, the most effective protocol is the protocol selecting the shortest path to shorten the propagation delay is as compared to other protocols. Also, applications which does not require time such as underwater pollution detection and equipment monitoring require that the network operates for a significantly long time. Therefore, energy-efficient routing protocols needs to be selected for the requirements of these applications

2. Localization Free Routing Protocols

These protocols use pressure sensors with the sensor nodes to measure the pressure of water on the sensor nodes. This water pressure is then used as a measure of the depth of the sensor nodes to construct and follow the routing paths. These protocols make the network easily scalable because only the depth or pressure information is required, which can be obtained easily by the pressure sensor attached to the sensor node. This makes these protocols the best choice for underwater applications where scalability is desired such as underwater military operation, surveillance and underwater exploration. These protocols are discussed as follows.

2.1. Depth-Based Routing.

Any earlier information is not needed by Depth-Based Routing (DBR) protocol [5]. The depth information of each node is mainly considered a parameter here. A node starts sending data to the higher nodes when some movement is sensed by the node with the highest depth, and the depth is compared with neighbor nodes. The packet is sent only to those nodes with a lower depth than the sender node. The process is repeated until the sink gets the data packet delivered. This process requires continuous power to be provided to the sinks.

As DBR considers only depth as a parameter, it may lead to a few drawbacks such as less network lifetime data is sent to the detected higher node as no check is done which leads to dead nodes. No proper path selection is implemented so that the shortest path may not be selected.

2.2. Energy-Efficient Depth-Based Routing

When a node forwards its data in Energy-Efficient Depth-Based Routing (EE-DBR) [6] protocol, the residual energy, and the receiver node depth are considered. The depth is compared first; then the residual energy of the receiving node is checked if the depth is smaller than the sender. The next hop for communication is selected among the neighbors considering the node with less depth and higher residual energy. The information on depth and residual energy about their neighbors is available in each node.

This protocol did not define any mechanism for multipath communication. Due to this, high energy consumption might result as a node forwards data to a node that is far away from the sender. This protocol does not define any parameter for finding out the shortest and most efficient route.

2.3. Delay-Tolerant Routing

Delay-tolerant routing protocol [9], is also called delay-tolerant data dolphin scheme. This is proposed for applications and delay-tolerant systems. The data dolphin, which acts as courier node, collects the data sensed by the static nodes while all sensing nodes stay static, which avoids the high energy consumption hop-by-hop. The high energy consumed in hop-by-hop communication is avoided in this methodology. The courier nodes are provided with continuous energy. Here, the sea bed has all static nodes deployed. These static sensors wake up when they sense some data periodically and find in sleep mode if there is no data sensed.

The desired data sensed is then forwarded to courier nodes called data dolphins, which is then delivered to the sink or base station. The number of courier nodes depends on the number of nodes deployed in the network and the kind of network and its application.

2.4. Hop-by-Hop-Dynamic Addressing-Based Routing (HH-DAB)

This HH-DAB routing [10], assigns varying addresses to nodes and destinations, initially, a Hop ID is allocated to each node. Every node in the network defines two types of addresses,

i) Node-ID
Ii) Hop ID.

Node-ID - Physical address of a node is Node-ID. It changes with the change in location.

Hop ID - Are assigned from top to bottom. Nodes having lower depth are assigned Lower Hop ID. A hop ID of 1 is provided to the node which is the nearest 1. Nodes having higher depth are assigned with higher Hop IDs. HH-DAB supports a multilink architecture; in which multiple sinks are present onshore. Radio communication connects the sinks to each other. The received data is the packet received at any sink.

This approach might create problems where any node cannot be found in the range which has a lower Hop ID from the sender node. The process is not energy efficient because in case of failure, the sender will retransmit the data packets and then wait again for a specified period of time. When there is no change in the result, the data will be forwarded by the sender node to a node having nearly or equal Hop ID and considered as the receiver node.

2.5. Energy-Efficient Dynamic Addressing-Based Routing (EEDABR)

In Energy-Efficient Dynamic Addressing-Based Routing [6], it consists of C-Hop ID, Hop ID, and S-Hop ID. Node-ID denotes the physical address of a node C-Hop ID consists of two digits which shows how many hops the receiving nodes are away from the source nodes. S-Hop ID also has two digits that denotes the number of hops away when one or two sinks are available. Initially, a simple query message asking neighbor nodes about their Hop ID will be sent by the source node. The sender node receives an inquiry reply packet in its reply which contains the three IDs of replying nodes. The data packet with Node-ID as a next hop is forwarded by the source node for further communication if two nodes of the same minimum Hop ID are received, the next hop will be selected by analyzing the node that replied earlier.

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II. GRAPHICAL REPRESENTATION

The three protocols based on the parameters such as alive nodes, dead nodes, and end-to--to-end delay are compared and the results are shown as graphical representations. (Fig.3, Fig.4, and Fig.5) .The analysis predicts that DBR (Depth-Based Routing) was found effective.

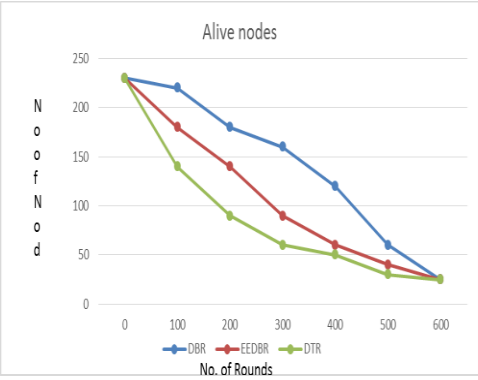

Fig.1.Alive Nodes

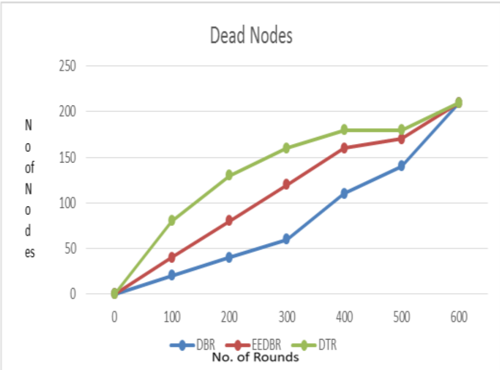

Fig.2.Dead Nodes

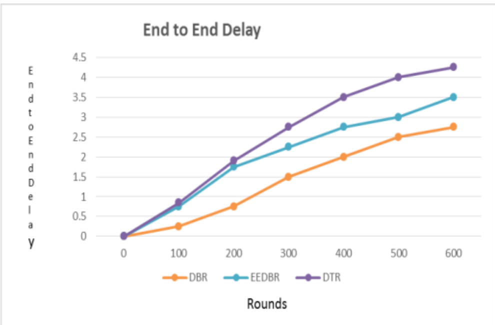

Fig.3.End to End Delay

III. CONCLUSION

In this review, various types and characteristics of location-free routing protocols have been discussed. Comparatively, Under Water wireless Sensor Networks characteristics were found very different to other wireless sensor networks. Acoustic channels were found to transfer very less amount of data but consume a large amount of energy comparatively. The forwarding of data in a stable mode is quite difficult for sensor nodes due to the flow of water. In all routing protocols, energy efficiency is considered essential. One cannot be selected specifically in the defined protocols above; to be utilized as the best as every protocol has some advantages and disadvantages. Much research on proposing a new routing protocol has to be done with respect to energy efficiency, transmission delay, propagation delay, and shortest path. These routing schemes are very much useful in prolonging the network lifetime and path selection for effective data forwarding. The specified sensors are used in various scenarios of applications and a new efficient and reliable routing protocol has to be framed. Routing in Under water wireless Sensor Networks has been a wide area of research nowadays. The underwater sensor networks field is rapidly growing, and challenges like efficient path selection, energy efficient transmission, and data retransmission need to be considered for future research work.

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