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Survey of Routing Protocols in Underwater WSNs for Mine Detection

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Abstract. Acoustic technology is a specific technology which can provide strong communication under the water for military and non military applications. In recent years, the underwater wireless sensor networks have a considerable growth. These networks can be applied for monitoring environments, underwater exploring, preventing unexpected events, tactical supervising and mines detection under the sea. On the other hand, there are numerous unsolved issues for UWSN in a very large scale, Such as reliable transportation, Routing, MAC, Localization, Limited Bandwidth, high and Variable propagation Delay, Defective underwater Channels, low battery power and, etc. Autonomous or Unmanned Vehicles under the water (UUV, AUV), equipped with some sensors, which can detect natural resources under the sea and collect the scientific data. In this article, we try to review UWSN routing and introducing some challenges and issues relevant to these networks, after that a comparison between routing protocols, which are proposed until now, is represented. The aim is that to find a proper protocol for underwater mines detection application

Keywords*:* Acoustic Communication, Geographic Protocols, UWSN, Ground Sensor Networks, Routing

1. Introduction

Acoustic Communication based on acoustic waves in Frequency, Time, Phase, Domain, or the situation of the data placement direction in voice. In many years, Underwater Acoustic communication is used in military applications. In comparison with Radio frequency waves which cannot be used under the water because of their attenuation ,Acoustic has a higher propagation attribute and low bandwidth under the water[1], these specifications are the main reason to apply acoustic in underwater networks. These networks are used for monitoring and controlling military, business or environmental devices. [2]

According to mobility and outspreading implementation, these networks can easily divide to some parts. For this reason, a constant and stable path between source and destination may not exist. In these cases traditional routing protocols may not operable, because when there is no path, all packets will be lost. Furthermore, for continuing connection, it is need to produce different packets according to applicable requirements of underwater networks [3].therefore it is necessary to design intelligent routing protocols to responsible these different requirements. There are a lot of routing protocol for responding these challenges ,however, some of them assume that all local information about all sensor nodes in networks , is defined in the previous process of routing [1].

With respect to this issue that providing scalable and efficient routing services in UWSNs[1] is controversial, in this article we try to review and compare the different routing protocols in underwater wireless sensor . second section an introduction about some specific properties of underwater wireless sensor networks is provided. Then in the last part these routing protocols of underwater sensor networks is compared with each other.

[1] Underwater wireless sensor networks

2. Underwater Routing Protocols

2.1 VBF[2]

In [5] the authors have proposed VBF. This protocol addresses the node mobility issue in a scalable and energy-efficient way. In VBF, each packet carries the positions of the sender, the target and the forwarder (i.e., the node which forwards this packet). The forwarding path is specified by the routing vector from the sender to the target. Upon receiving a packet, a node computes its relative position to the forwarder by measuring its distance to the forwarder. Recursively, all the nodes receiving the packet compute their positions. If a node determines that it is close to the routing vector enough (e.g., less than a predefined distance threshold), it puts its own computed position in the packet and continues forwarding the packet; otherwise, it simply discards the packet. Therefore, the forwarding path is virtually a routing "pipe" from the source to the target: the sensor nodes inside this pipe are eligible for packet forwarding, and those outside the pipe do not forward.

2.2 HH_VBF [3]

In [8] the authors indicate that in large-scale networks the cost of energy consuming optimization with HH-VBF is lower than VBF protocol, so it can be said that the efficiency of this protocol in large networks is higher than VBF.

The performance of these protocols in the face of routing vector is totally similar to VBF protocol.
The HH_VBF protocol could overcome two drawbacks of VBF protocol:

1. Too sensitive with radial border of routing pipe
2. Low speed in transferring information in large-scale networks

2.3 DBR[4]

In [1] the authors propose a depth based protocol. This protocol same as others has an algorithm which try to address information packets from source to destination. DBR does not need full-dimensional location information .Instead; only local depth information of each node is required in packet forwarding.

The information receivers are usually located on the surface of the water, so DBR addresses the information packets based on the depth of each sensor to the surface of the water receivers. So it doesn't need general information of the network..

2.4 FBR[5]

In [9] the FBR protocol is introduced. From figure 3, assume that the packet is transferred from node A to node B. To do so, node A will issue a RTS[6] to its neighbors. This request is a short control packet that contains the location of the source node (A) and of the final destination (B). Note that this is in fact a multicast request.

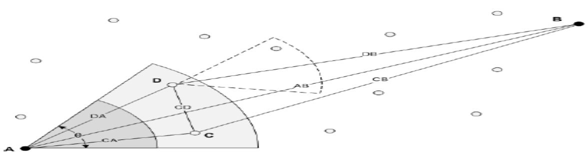

Fig.1 Illustration of the routing protocol: nodes within the transmitter's cone θ are candidate relays.

All the nodes that receive A's multicast RTS first calculate their location relative to the AB line. The objective in doing so is to determine whether they are candidates for relaying. Candidate nodes are those that lie within a cone of angle ±θ/2 emanating from the transmitter towards the final destination. If a node determines that it is within the transmitter's cone, it will respond to the RTS. Those nodes that are outside the cone will not respond.

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2.5 MPR[7]

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2 Vector-Based Forwarding
3 Hop – by – Hop Vector-Based Forwarding
4 Depth-based Routing
5 Focused beam routing
6 Request to send
7 Multi-Path Routing

In article [10] the MPR protocol is proposed .this protocol has three phases: (1) the information dissemination delay phase (2) the intermediate node selection phase (3) the relay node selection phase. In the first phase, when the path is defined by dissemination delay, the source node must have some information about the delay between two hops from itself to neighbor node and from neighbor node to next hop node. in the second phase ,the node use some information about the dissemination node to select the intermediate node and Finally, the resource node review all relay node to understand whether a collision occur between them or not.

2.7 DCB[8]

This protocol which is indicated in [11] , is based on multi sink architecture and all packet which are received from each sink means that they are delivered successfully in the destination.

In this architecture, they used two types of nodes as shown in figure 4. First, ordinary sensor nodes, from water surface to sea bed at different depth levels with the buoyancy control. The number of ordinary nodes required depends on the nature of application and the depth of the area we are deploying them. For better power usages, the communication range of every node can be 300 to 500 meter. Although, acoustic communications can support up to the range of 5 km, but it is not preferred as long distance communications will drain more energy and it can decrease the network life. For this, they defined the acoustic communication range of sensor nodes.

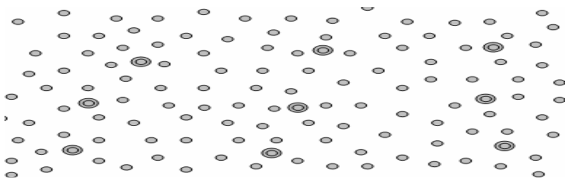

Fig. 2 Nodes Deployment

Other than these ordinary nodes, they use Courier nodes for collecting data from the whole network. These Courier nodes are equipped with some piston module, which helps to push the node inside water at different defined depths and then pull back to the ocean surface. Equipped piston can do this by creating the positive and negative buoyancy.

Regarding that one of the prominent issues for military application is, detecting mines under the sea, the use of an efficient protocol in underwater sensor networks, which has an optimized routing algorithm is very important.

The mines detection under the sea needs some floating buoys which perform as a sink and must be able to communicate with each other by radio frequencies. On the other hand, the distribution of mines under the sea either in a dense form or spars is a kind of challenge because the routing protocol must cover any kind of distribution networks. Furthermore not only the information must deliver rapidly, but also the selected protocol must manage the power of network nodes.

According to afore-mentioned features, the DCB protocol can be used in Underwater Mines detection application. In the next section, this protocol is compare to others from the design.

3. Comparison Between Routing Protocols in UWSN

In this section, routing protocols in underwater sensor network are represented in the following table with their properties:

TAB 1: comparison between routing protocols in underwater wireless sensor network

Protocols	Efficiency	Sparse networks	Dense networks	Mobility support	Information need
DBR	Dense networks: low end to end delay, high data delivery, high energy consuming	Bad. The efficiency is low	Good	Constant sink and mobile nodes	Local depth of each node
VBF	Low mobility, low data delivery, end to	Good	Not very good	efficient	Need multi dimension

[8] Dynamic Cluster-Based

	end delay				information
HH-VBF	Sparse networks: low cost energy	Good	Good	Not as efficient as VBF	Need multi dimension information
FBR	Sparse network: low energy consuming	Good	Not very good	Static and dynamic nodes	Source nodes know destination node and its location.
MPR	Dense network: good data delivery			Yes	Reverse distance paths
DCB	Dense network: good data delivery , low latency and energy consuming,	Good	Good	Stable sink and mobile nodes	Doesn't need

4. Summaries

In conclusion, regarding to different requirements of underwater wireless sensor networks, a lot of routing protocols are proposed .although, a protocol cannot be used for all application. One of the prominent application for these networks, is the underwater mines detection, because a low cost and trouble maker system in naval war, is mines which detection of those is one of the sailors concerns. All acoustic sensors under the sea can help them so sensor networking in the defined area can simultaneously gives information about the environment status for rapid decision making. among protocols, DCB is the most efficient protocol which can be used in mines detection operation, because this protocol not only perform when mines are scattered sporadically but also but also has a good efficiency in dense area.

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