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FLOODING BASED ROUTING TECHNIQUES FOR EFFICIENT COMMUNICATION IN UNDERWATER WSNS[1]

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ABSTRACT: *UW-WSNs have many challenges with respect to design and routing. UW-WSNs differ from terrestrial networks in many aspects. Many design issues like limited bandwidth, high bit error rate with losses of connectivity and high propagation delay make out-of-water routing techniques unsuitable for underwater environment. In this article, routing techniques which are based on flooding will be discussed keeping in mind all the major challenges which we are not facing in terrestrial networks.*

KEYWORDS: UW-WSN, Flooding, Vector, Restricted Zone, UW Vehicle.

INTRODUCTION

Many sensors and vehicles in underwater networks are deployed to achieve collective monitoring jobs within an assumed area. In future, underwater sensor networks are proposed for enabling various applications. Underwater WSNs will be helpful in disaster prevention, pollution monitoring and assisted navigation in near future. To make these applications feasible and practical, it is required to permit underwater devices regarding communication between them. For the communication point of view, wireless underwater networking will be the enabling technology. Sensor nodes will be able to manage their tasks by exchanging configuration, location information and movement information. When we talk about the communication perspective in underwater wireless sensor networks, it has been trialled in 1945 by developing a telephone to communicate with submarines. But underwater networking has not been explored as underwater communication [1].

UW-WSNs have major challenges regarding *network design* and *routing techniques*. As we have strictly limited bandwidth, high propagation delay in underwater, high bit error rates with losses of connectivity and most importantly having limited battery power, it is not easy to design underwater sensor network. Underwater environment is not suitable as terrestrial environment, where even we cannot take advantage of solar energy. Keeping in mind the underwater environment, which routing technique will be suitable for this environment is a big challenge. The existing routing protocols have been categorized as *Proactive*, *Reactive* and *Geographical routing* protocols.

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Proactive protocols maintain up-to-date routing information between all nodes, which helps to minimize the message latency by route discovery method. This is basically a control message which comprises of updated routing information. But after modification in network topology due to mobility or failures, it causes a large signalling overhead. So while propagating updated information to all nodes, it is necessary for each node to establish a path to any other node within the network. This is basically not needed in UW-WSNs.

Like proactive protocols, *Reactive Protocols* are also experience signalling overhead and unsuited for UW-WSNs.

Geographical routing protocols establish paths between source and destination by taking advantage of localization information. But question is, can we obtain accurate localization information in underwater environment? Because localization requires strict synchronization between nodes. So due to variable propagation delay in underwater, these protocols are also not suitable for UW-WSNs [2].

In this work some flooding based routing techniques will be discussed dealing with challenges for efficient communication in underwater sensor networks.

RELATED WORK

In [1], authors discussed several important aspects of underwater communications. For the development of efficient networking, the main challenges are highlighted. And a cross layer approach is mentioned by the authors. Existing routing protocols for terrestrial sensor networks are discussed briefly with arguments on unsuitability of these existing routing protocols and virtual circuit routing techniques are suggested for underwater sensor networks.

The comparison of major existing underwater routing protocols can be found in [2]. Authors underlined the several drawbacks of traditional approaches in underwater wireless sensor networks. Underwater communications characteristics are discussed as well as with practical aspects. Authors argue that underwater wireless sensor networks are wide ranges networks having no single and complete solution.

The analysis of certain underwater routing protocols can be found in [3]. Existing underwater routing protocols like VBF, DBR, QELAR etc. are discussed by the authors. Each protocol design have certain goals i.e. low energy consumption, enhancement in communication delay, scalability achievement etc. Authors examine the major challenges regarding design and implementation of underwater sensor networks.

In underwater sensor networks, each protocol executes different kind of jobs. In [4] authors gave brief overview of existing underwater routing protocols. Some different issues in design and implementation of underwater networks like high bit error rate, limited bandwidth etc. are also discussed by authors.

In last recent years the study of underwater wireless sensor networks has been major research field. For efficient communication in underwater wireless sensor networks multiple proposals has offered. In [5] authors made discussion on some of the protocols designed for underwater wireless sensor networks.

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Most of the routing protocols for underwater sensor networks or even for terrestrial networks, a separate packet is being used by routing protocols for control information and data transmission. In [6], the information carrying based routing protocol proposed for energy efficient, real time and scalable routing. The most significantly, location information of nodes are not required by this protocol but a small portion of the nodes are get involved for the process of routing.

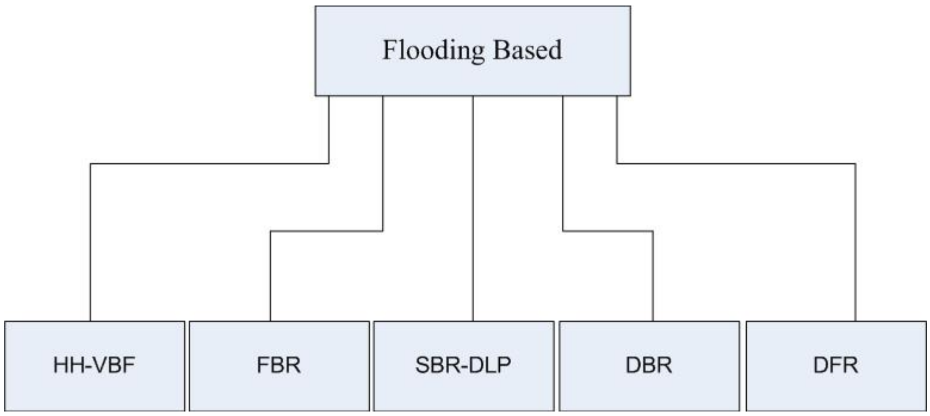
A number of broadcast messages or queries are seems to be a load on the network, if having no prior information about location of the nodes. This will obviously reduce the actual expected throughput. In [7], authors give an idea in order to reduce this redundant flooding. Focused Bream Routing Protocol is proposed by the authors for underwater sensor networks. The assumption of this routing technique is that each node in the network contains location information but its own. This technique is based on another assumption that the destination location is known by the source node. Author argues that there is no need to get information of location of other nodes, while each node contains its own location information and also destination node location information if it is a source node.

In [8], a new idea for efficient routing has been given by the authors for underwater wireless sensor networks. The features of data packets and depending on the condition of network, routing decision are made. Different parameters like packet emergency level, packet age and the battery level of the node are used to put priorities on each packet. All these elements except emergency level of the node are variable, which make the protocol flexible according to the network condition.

METHODOLOGY

The routing protocols for underwater wireless sensor network based on various approaches i.e. flooding based, multipath based and cluster based approach. Figure 1 is showing the classification of routing protocols for underwater sensor networks.

Figure 1.



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A. Protocols Based on Flooding

Flooding involve the transmission of a packet to all other nodes which are in transmission range. This approach does not require wide knowledge of the network. Flooding approach is in fact a very simple approach having one major limitation of redundant packets. Identical packets require more energy to transmit [9]. The under mentioned routing protocols employ flooding based approach in underwater wireless sensor network environment.

HH-VBF

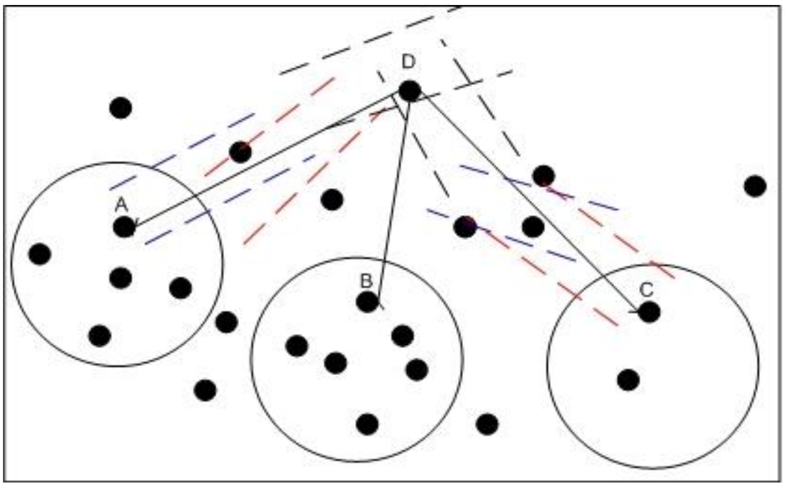
Hop by hop vector-based forwarding (HH-VBF) is the replacement of the well-known underwater sensor network protocol, VBF (vector-based forwarding). Figure 2 is showing the HH-VBF scheme. A virtual routing pipe is used for flooding in vector-based forwarding protocol having fixed radius. A virtual line between source node and destination node is representing a vector. A node can only take part in routing when it is closer to the vector [9].

The computation of routing vector from each transmitter towards the destination is the main difference of HH-VBF with VBF. Node calculates a vector from sender node to itself, after receiving a packet. A distance between the calculated vector and node itself is also computed by the node. Node will be a forwarder if the calculated distance is smaller than the virtual routing pipe distance. A packet which is going to be transmitted holds by a transmitter/forwarder for a specific time. This time is depends upon the distance between transmitter and receiver [10].

FBR

Focused beam routing protocol (FBR) is also a flooding based technique in order to transmit packets. In FBR [11], transmission power is the main factor which forces flooding. For the purpose of minimization in energy consumption, various transmission power levels are used by this flooding technique, having range from P1 to PN. In FBR scheme, every

Figure 2. HH-VBF



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Node has knowledge about its own and the destination location. That is why it is also known as location based scheme. Transmitter sends Request-to-send (RTS) packet to each node within its range initially with a power level P1. RTS packet includes the locations of source and destination as mentioned above. The nodes which are in transmission range P1 will response with clear-to-send (CTS) packet. In case of receiving more than one CTS, transmitter will choose suitable forwarder which depends on the distance of that node to the destination. In case of receiving not even a single reply, the transmission power level is increased by the transmitter. Transmitter will continue to increase transmission power level until a CTS response receives at transmitter end.

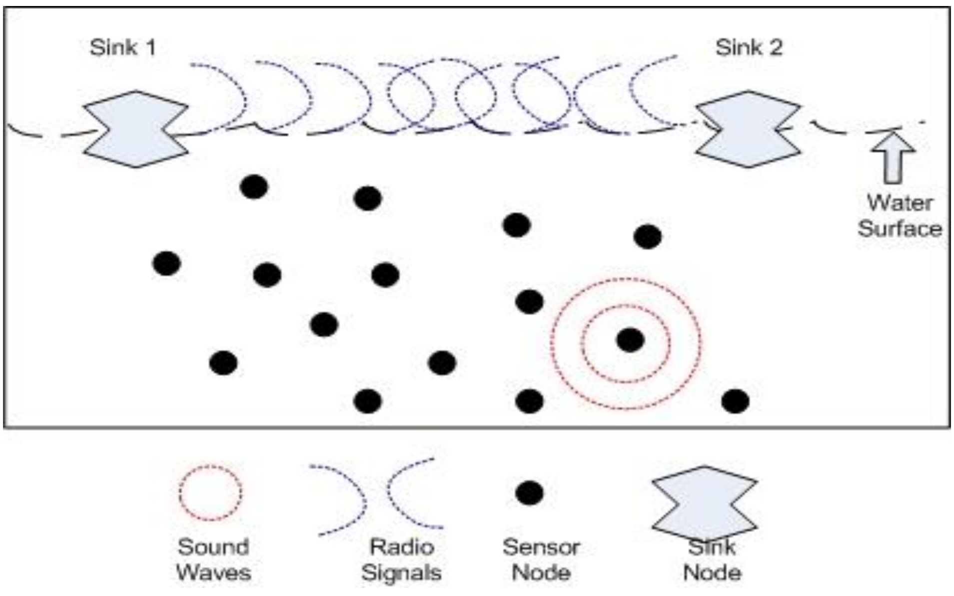
Achieving maximum power level and receiving no reply, transmitter will follow the same procedure again for power level P1 to PN by shifting itself to right or left.

DBR

Depth based routing (DBR) utilizes the depth information relevant to each sensor node to perform flooding. The advantage of multiple sink underwater sensor network can be taken by DBR. Figure 3 is showing the example of such networks. In multiple sink underwater sensor networks, sinks are deployed with having both radio frequency (RF) and acoustic modems at the water surface. Nodes having acoustic modems are data sources, while they collect data forward to other sinks. Nodes having RF modem can share information to each other using radio channels.

Furthermore, a node distance from underwater surface to node itself is basically depth information of this node. The assumption is that each node has knowledge about its depth information. Practically a depth sensor can be used to get depth information. In contrast, it is much difficult and might be expensive to having knowledge for full dimensional location. DBR is based on greedy algorithm to transmit a packet from

Figure 3. Multiple-Sink UWSN Architecture



Source to destination. When a node is a forwarding node, its depth declines while packet moving towards the destination. By declining the depth of forwarding node in each step, packet can be delivered to the water surface. When a node receives a packet, depth of the preceding node d_p is calculated by the receiving node. A packet contains the depth information of the preceding node. After comparing the d_p with its own depth d_c , node will take the suitable decision. If $d_c < d_p$, it means node is much closer to surface than d_p , so node will involve itself in forwarding . Otherwise node will simply drop the received packet by thinking that the preceding node is closer to the surface i.e. $d_c > d_p$.

DFR

In DFR (Directional flooding-based Routing), flooding is done within an assumed area for transmission of packets. Each node in a flooding zone has two vectors: one vector is between the receiver and the sender and one vector is from reliever to sink node. These two vectors make an angle by which the flooding zone is decided. An assumption in DFR protocol is that each node has knowledge about the geographic information. Here geographic information includes the location information of each node within its range and the location information of sink node. Moreover, it is also assumed that each node can amount the link quality of neighboring nodes [13].

Working of DFR

A data packet is broadcast by source node having its location information and one parameter. [13] This parameter contains an angle known as BASE_ANGLE. BASE_ANGLE has a certain threshold value and initially set to a min value. When a packet is received by a node, it involves itself in computing an angle between two vectors: from source node to itself and from itself to sink, as mentioned above. This computed angle is called CURRENT_ANGLE. If CURRENT_ANGLE<BASE_ANGLE, the received packet will be discarded by the node. In case of having greater CURRENT_ANGLE, receiving node will update the BASE_ANGLE parameter with in data packet.

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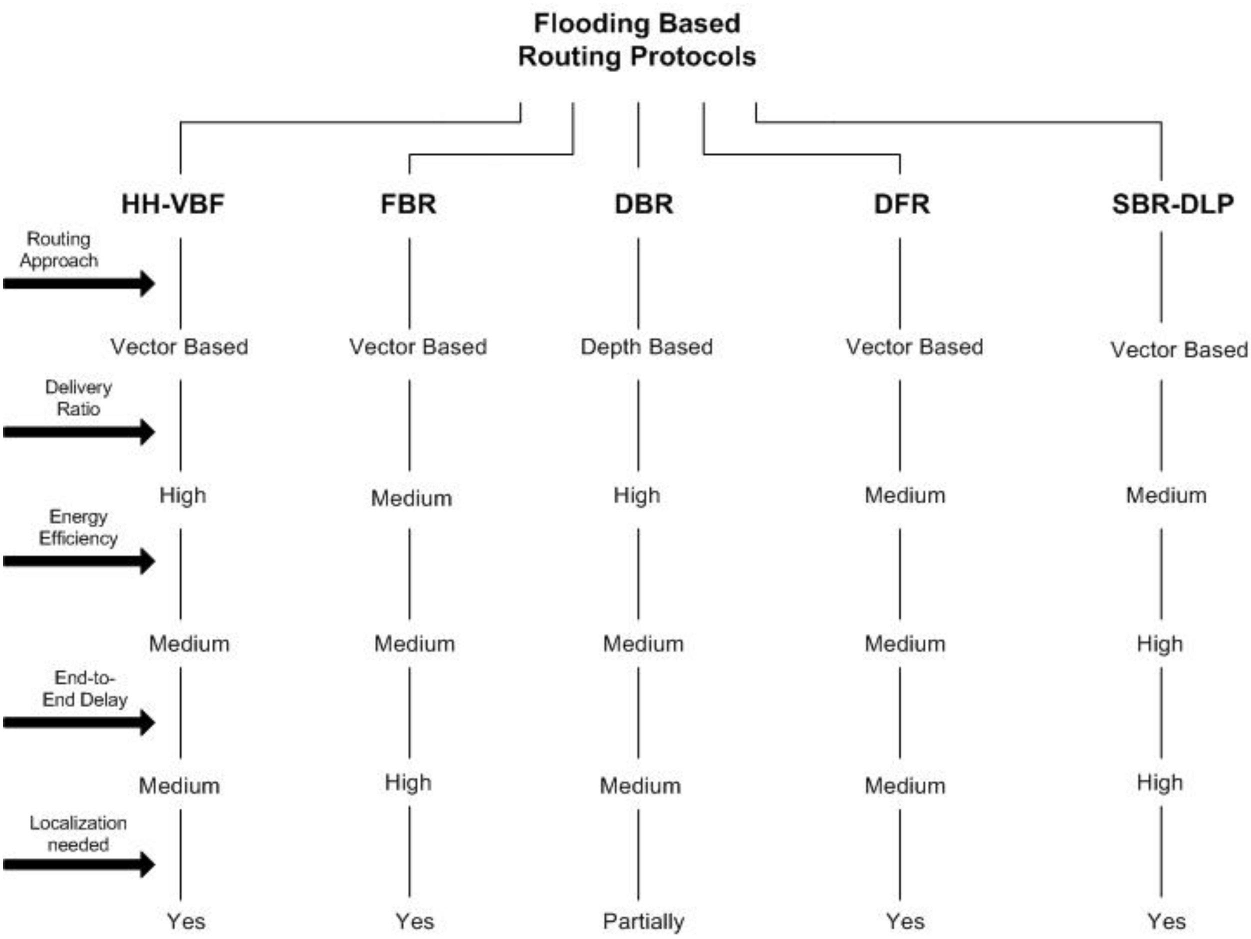
Characteristics Comparison of Flooding Based Routing

Table 1.



This change is on the basis of link quality of neighboring nodes. Two conditions must be satisfied by each node within flooding zone to declare its link quality: neighboring node's CURRENT_ANGLE must be larger than the forwarding node's CURRENT_ANGLE and the distance of neighboring node to sink must be less than the distance between forwarder and sink. No node will involve itself in transmission of packets if it does not fulfill these two conditions. This change is on the basis of link quality of neighboring nodes. Two conditions must be satisfied by each node within flooding zone to declare its link quality: : neighboring node's CURRENT_ANGLE must be larger than the forwarding node's CURRENT_ANGLE and the distance of neighboring node.

SBR-DLP

In sector based SBR-DLP (routing with destination location prediction) [14], the flooding is performed within the sector. Transmission zone is divided by this protocol in multiple sectors. A sector which is closer to sink as compare to others will be selected to initiate flooding.

A mobile destination node is considered in SBR-DLP and all the sensor nodes are considered to be mindful of the preplanned developments of the mobile destination node. At whatever point this node strays from its planned development trajectory, the destination node transmit a notice with in a packet called notification (NTF) to its one jump neighbors. The proposed protocol working is as follow:

Preceding the information transmission, a node with a pending packet broadcast a Chk_Ngb packet holding its present area. Upon accepting the Chk_Ngb packet, the getting nodes will register their separations towards the mobile sink. The nodes which are closer to the destination node send a Chk_Ngb_reply packet to the sender of the packet. The Chk_Ngb_reply packet additionally holds the sector number where the nodes dwell. A node begins to name also spot the first sector guaranteeing that the segment is bisected by a vector SD. The vector SD is a virtual line from the source S towards the destination D, the remaining sectors are named and prioritized as per their contrasts from the vector SD.

CONCLUSION

In this research work, Routing techniques are described for underwater environment precisely. In contrast with flooding based approaches, different approaches exist like multipath based and cluster based. The simulation of these approaches and the analysis of multipath and cluster based approaches will be our future work. So that the performance of these protocols can be measured closely.

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