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GEOGRAPHIC AND OPPORTUNISTIC ROUTING FOR UNDERWATER SENSOR NETWORKS

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Abstract:
Underwater wireless sensor networks (UWSN), similar to the terrestrial sensor networks, have different challenges such as limited bandwidth, low battery power, defective underwater channels, and high variable propagation delay. A crucial problem in UWSN is finding an efficient route between a source and a destination. Consequently, great efforts have been made for designing efficient protocols while considering the unique characteristics of underwater communication. Several routing protocols are proposed for this issue and can be classified into geographic and non-geographic routing protocols. In this paper we focus on the geographic routing protocols. We introduce a review and comparison of different algorithms proposed recently in the literature. We also presented a novel taxonomy of these routing in which the protocols are classified into three categories (greedy, restricted directional flooding and hierarchical) according to their forwarding strategies.

Keywords: Underwater Wireless Sensor Networks, UWSN, Geographic Routing, Node position, Forwarding Strategy, Greedy, Restricted Directional Flooding, Hierarchical.

1. INTRODUCTION

The earth is a water planet, because more than 70% of its surface is covered by the sea and ocean, the remaining part are covered by human being. Several reasons attract to discover this underwater world such as the still large unexplored surface, the biological and geological wealth, the natural and man-made disasters, which have given rise to significant interest in monitoring oceanic environments for scientific, environmental, commercial, security and military fields [1]. Due to these reasons, underwater wireless sensor networks (UWSN) are very promising to this hostile environment. They have many potential applications, including ocean sampling networks, undersea explorations, disaster prevention, seismic monitoring, and assisted navigation [2]. The function of a routing protocol in UWSN is a fundamental part of the network infrastructure to establish routes between different nodes.UWSN routing protocols are difficult to design in general. It is a challenging task, caused by the aquatic environment. UWSN are significantly different from the terrestrial sensor technology. First, the suitable medium of communication in underwater networks is the acoustic waves and is preferred to both radio and optical waves because they have great drawbacks in aquatic channel [3]. Secondly, the most terrestrial sensors are static, while underwater sensor nodes may be mobile with water movements and other underwater activities. Consequently the challenge imposed by UWSNs leads to the inability to adapt directly the existing routing protocols in terrestrial WSN, so new routing approach must be implemented for UWSN. In spite of the existence of a considerable number of papers about routing protocols in UWSNs presented by we perceived a lack of a specific overview involving the geographic routing protocols. In this paper we provid e an insight into geographic routing protocols designed specifically for UWSN. In ad dition, we introduce the main challenges of using geographic routing protocols in UWSN from different perspectives and discuss some directions of future research on this field.

2. UNDERWATER WIRELESS SENSOR NETWORKS

Similar to terrestrial sensor networks, under water sensor networks consist of a variable number of sensor nodes (cabled seafloor sensors, acoustically connected sensors, moored sensors, autonomous underwater vehicle) as illustrated in Figure 1, that are deployed to perform collaborative monitoring over a given volume. The data collected by these sensors are transmitted to the surface station. The surface station is equipped with an acoustic transceiver that is able to handle multiple parallel communications with the deployed underwater sensors. It is also endowed with a long range RF and/or satellite transmitter to communicate with the onshore sink and/or to a surface sink [8]. Underwater wireless sensor network architecture has been classified into two-dimensional and three-dimensional with fixed nodes and three-dimensional with Automatic Underwater Vehicles (AUVs) [8].

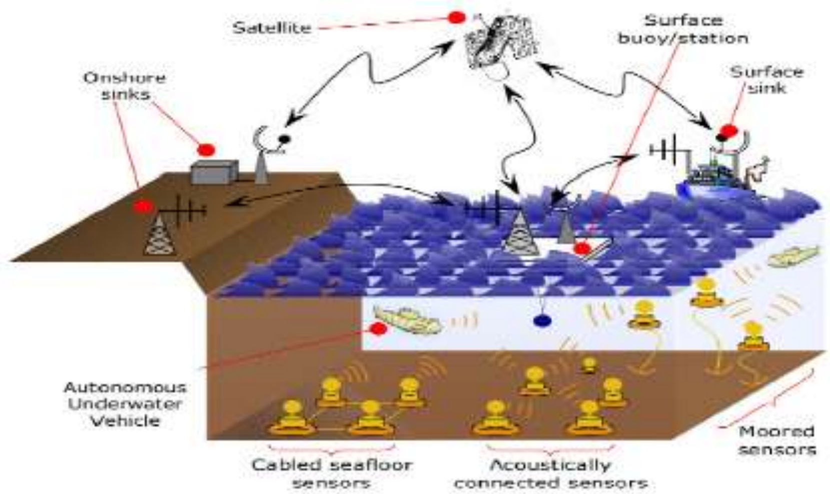

Fig.1. Different ways deployments of UWSN

This classification is based on the geographical distribution of the nodes and their mobility. The architecture deployed depends upon the application. These include networks of sensors with depth controlled by attaching each sensor node to a surface buoy, by wires of regulated length, so as to adjust the depth of each sensor node. This kind may be used for surveillance applications or monitoring of ocean phenomena (ocean bio– geochemical processes, water streams, pollution). The major characteristic of geographic routing protocols that is involves location information in routing decisions. Location based routing is very promising for packets transmission in mobile wireless ad-hoc and sensor networks particularly in hostile environments because it does not add any burden in the network design although the localization process itself in this kind of routing is an intrinsic source of communication errors [9].Although the research on geographic routing being more recent than topological routing, it has received a special attention due to the significant improvement that geographic information can produce in routing performance. Geographic routing does not require that a node performs maintenance functions for topological information beyond its one-hop neighbourhood [10]. Consequently, geographic routing is more feasible for large-scale networks than topological routing, which requires network-wide control message dissemination. Besides that, geographic routing requires lower memory usage on nodes by maintaining the information locally.

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3. CLASSIFICATION OF GEOGRAPHIC ROUTING PROTOCOLS IN UWSN S

In geographic routing protocols the key information is the current position of the destination, so the sender must be aware of this important information, which can be obtained by a location service. In this category the node forwards the packet to a single node as a next hop which is located closer to the destination than the forwarding itself. Greedy protocols do not create and maintain paths from source to the destination; as an alternative, a source node includes the approximate position of the receiver in the data packet and selects the next hop according the optimization, To ensure the packet delivery from a source to a destination this kind of routing broadcast periodically small packets (beacons) to advertise their position and allow other nodes to maintain a one-hop neighbor table. The greedy routing can well scale with the size of network also are flexible to topology changes without using routing discovery and maintenance. The sender will broadcast the packet (whether the data or route request packet) to all single hop neighbors towards the destination. The node which receives the packet checks whether it is within the set of nodes that should forward the packet (according to the used criteria). If yes, it will retransmit the packet. Otherwise the packet will be dropped. In restricted directional flooding, instead of selecting a single node as the next hop, several nodes participate in forwarding the packet in order to increase the probability of finding the shortest path and be robust against the failure of individual nodes and position inaccuracy. It is based on TBF (Trajectory based forwarding) protocols which use the source and Cartesian routing. VBF is a geographic routing protocol which requires a full localization. The position of each node is estimated with angle of arrival (AOA) technique and strength of the signal, the location information of the sender, the forwarder, and the target are carried in the packet. The path transmission is specified by a vector from a sender to a destination, and this vector is located in the center of a pipe routing, the entire nodes in this pipe are candidate for packet transmission. When a node receives a packet, it firstly calculates its position with (AOA) technique, if the node determines that it is included in the pipe, it continues transmission of the packet otherwise it discards the packet.

4. RESULT STUDY

In order to minimize the energy consumption each protocols aims to limit the number of candidates relay that are qualified by the packet transmission. These protocols used different shape for this purpose, for example in VBF and HH-VBF a pipe routing is used but in HH-VBF a pipe routing is created in each hop, also REBAR uses a specific domain. In case of FBR the forwarders are restricted in a transmitting cone. The robustness of an approach is considered to be high if the failure (or absence due to mobility) of a single intermediate node does not prevent the packet from reaching its destination. It is the case in VBF, HH-VBF, and REBAR, we find that VBF is robust against packet loss and node failure in that VBF uses redundant paths to forward the data packets. Some of these paths are interleaved, some are parallel. However HH-VBF is more robust than VBF especially in sparser networks, it can find more paths for data delivery compared to VBF, by using the hop-by-hop vector for packet forwarding. Similar to VBF, REBAR robustness is high since the packets are delivered in redundant and interleaved paths. We can determine the scalability performance of the protocol with an increasing number of nodes in the network. It can be classified as follows: high scalability, when a network grows as much as it needs and the approach is still able to maintain a good performance. As the case of the three greedy routing protocols VBF, HH-VBF, and REBAR because they do not need routing discovery and maintenance. Moreover, they have a low packet overhead due to the small number of small-size packets and reduction of the use of control messages. LCAD uses a clustering approach which is a favorite to large scale networks. The rest of protocols have a medium scalability because that can handle networks with a reasonable size, but may have problems if it grows. Since all the position-based routing protocols are scalable compared to topology-based ones, all the discussed protocols have at least medium scalability. It is considered to be low, medium or high depending on whether the position of a given node will be inaccessible upon the failure of a single node, the failure of a small subset of the nodes or the failure of all nodes, respectively. Hence, in the proposed protocols, a given node will be inaccessible upon the failure of a subset of nodes. Thus their location services robustness is regarded to be medium.

The void problem is addressed by several studies in terrestrial sensor networks which aimed the stationary and two-dimensional wireless networks. However these techniques are not suitable for underwater sensor networks because the underwater void is characterized as three dimensional spaces. In addition, the mobility of most underwater nodes makes the void mobile that can also result from the surrounding environment. For example, when a ship navigates over the underwater sensor network, it blocks communications in the nearby area and thus generates a void that moves along with the ship. The characteristics of underwater sensor networks make it more difficult to manage the three-dimensional and mobile voids in such networks. Only a few geographic routing protocols take in account the void problem in their design, so we should give more importance to this challenging problem.

CONCLUSION

The design of any routing protocol depends on a specific goals and requirements. Development of a geographic routing protocol for the aquatic environments is regarded as a vital research area, which will make these networks much more reliable and efficient. In this paper we have conducted a comprehensive survey of various geographic routing protocols in underwater wireless sensors networks. We classified the geographic routing protocols according to their forwarding strategies into three categories: greedy, restricted directional flooding and hierarchical approaches. We presented a performance comparison of the most relevant routing protocols in terms of forwarding strategy (type, shape region, robustness, scalability, packet overhead), location service (type, robustness), design goal (density, mobility, handling void and destination mobility.

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