Review on Intend Adaptive Algorithms for Time Critical Applications in Underwater Wireless Sensor Auditory and Multipath Network

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***Abstract*—In the present scenario underwater wireless sensor network (UWSN) is a serious area for the research because there are many challenges still remain to be solved. UWSNs have self-powered sensor nodes and some autonomous vehicles are installed underwater, which implement associative task using acoustic link. It's becoming popular everyday due to their indispensable role in different application like pollution monitoring, ocean mapping, oil and mineral exploration, disaster prevention (like tsunami) and assisted navigation & tracking. In this paper, we analyze the basic concept of underwater sensor network, communication process, literature survey, different architecture of two dimensional and three dimensional and we also discuss the challenges and applications of UWSNs.**

Keywords—Underwater Wireless Sensor Network (UWSNs), Multipath Power-control Transmission (MPT), Autonomous Underwater Vehicle (AUV) or Remotely Operated Vehicle (ROV), Cross layer-energy, Large propagation delay, Decentralized algorithms.

I. INTRODUCTION

Our earth is covered by 75% of water including ocean and river also. Underwater wireless sensor network is a technology which performing collaborative task with the help of self-powered sensor nodes called Autonomous Underwater Vehicle (AUV) or Remotely Operated Vehicle (ROV) it's become more acceptance for observe wide area of oceans. UWSNs consist of a mutable number of sensors that are established to perform the monitoring tasks in a particular region, many disastrous earthquakes and related natural disaster like tsunamis. So, it help us to provide timely information and generate early warning system (EWS) which save lots of human life.

On the other hand, there are some other applications where the UWSNs allow continuous observed for diverse field like pollution monitoring, ocean mapping, submarine detection, oil and mineral exploration, etc.

It is an internal architecture of underwater sensor node which interfaces between the other sensors, which receive the data and save it in the memory, process it and transfer to the base station. In underwater sensor nodes are used acoustic link to communicate each other cause of high bandwidth. RF not works in underwater due to their limited bandwidth due to their limited bandwidth 5kbps and 20kbps.

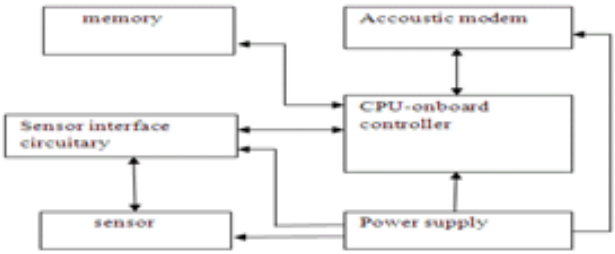

Fig. 1. Block diagram of Underwater Sensor (internal)

This paper gives the detailed information on various research challenges, application and also discuss about the architecture of UWSN.

II. LITERATURE SURVEY

Underwater Sensor Network: Application, Advances and Challenges [1]. In this paper the author summarized the applications, advances and challenges of UWSN and also discussed different communication protocols like acoustic link.

Self-Powered Wireless Ocean Monitoring System [2]. This paper designed and implemented self-powered ocean monitoring system with the help of solar energy which is renewable resources and to generated the energy at sea surface and share those energy to underwater nodes.

Research Challenges of Underwater acoustic sensor network [3]. The principal of this paper is just only for facing challenges in underwater sensor network like communication problem, limited battery power, propagation delays. Also, discuss about various architecture and characteristics of UWSNs. Enhance the Reliability of Head Nodes in Underwater sensor networks [4]. The author of this paper proposed a methodology to enhancing the reliability of head nodes in UWSN. In connected with acoustic communication network the author discusses an algorithms and methodologies for the secure communication network. Also, introduced the design of reliability in term of numeral and size of messages.

Challenges: Building Scalable Mobile Underwater Wireless Sensor Network for Aquatic Application [5]. In this paper the author proposed a new scheme known as mobi-sync. The mobi-sync in used to spatial correlation parameters

among the mobility pattern of neighboring underwater network to reduce the long propagation delay accurately.

Problem in UWSN (Study paper) [6]. The author of this paper summarized the problems and challenges of underwater sensor network. Beside this also explained the applications where the UWSN is used.

Energy Efficiency and Reliability in MAC [7]. In this paper the author discussed the different type of routing protocol for energy efficiency because the nodes are battery operated and it is the major disadvantages of UWSNs is limited battery power and low capacity also high propagation delay which results large amount of packets is loss in underwater communication.

Omni directional underwater acoustic micro modem design and implement based on low power Microcontroller [8]. This paper designed and implemented Omni directional underwater acoustic microchip modem for low power consumed. Also, designed ARM cortex-M3 for supported flexible interfaces and process a high-speed digital domain signal. Also, micro modem is inbuilt ARM cortex-M3.

The above research papers discussed about various applications and challenges of underwater wireless sensor nodes and some energy efficient routing protocol.

III. System Architecture

UWSN architecture can be classified in large number of underwater sensor nodes that are used for forwarding and receiving acoustic waves. UWSN architecture is divided into two-dimensional and three-dimensional in which 2D architecture cover ocean floor which is also most common UWSN architecture and the 3D architecture have includes depth as a dimension is 3D space. 3D space are those space when the sensor node are deployed and to cover the ocean bottom into the ocean surface and to create an column which have to maintain their position, because different type of waves hit the nodes and the nodes is moving from one point to another.

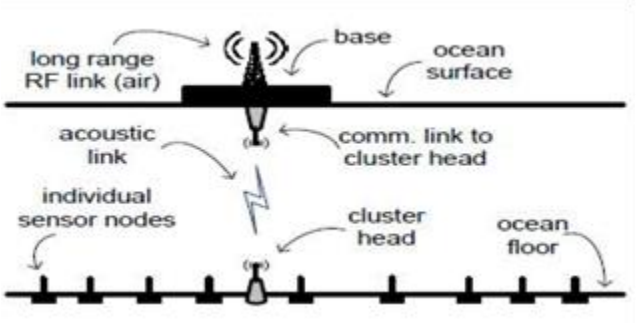

Fig. 2. Common underwater sensor network architecture (2D)

In 2D UWSNs all the nodes connected to the ocean floor. The underwater sink collects the data from the sensor nodes by horizontal transceiver and then send the information to a surface station by the vertical transceiver. However, the RF signal is used to communicate the surface station to onshore and surface sinks. [9]

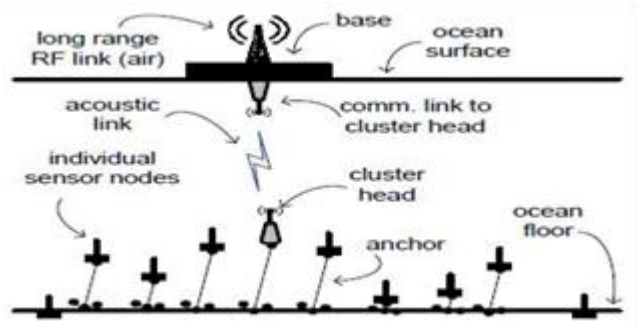

Fig. 3. Three-Dimensional underwater sensor network

However, In 3D UWSNs all the nodes are connected to a buoy by a cable which can transmit data between each other. Apart from this by using RF the collected data is transmitted to the central station. For data harvesting Autonomous Underwater Vehicles (AUVs) play a vital role. AUVs contain more energy and it considered as super node.

AUV- Autonomous Underwater Vehicle is a robotic device which deploy underwater and moving autonomously because it is free from external control. AUV drop in to mobile robotics sector and its present scenario while commercial and military requirements. Working of AUV is deploying in water by a propulsion system, controlled and piloted by onboard system. So, the AUV have move around in their environment and are not fixed to one physical location.

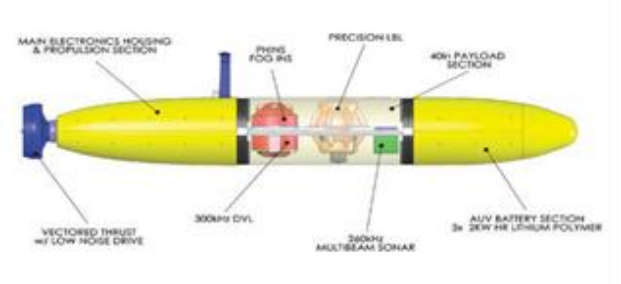

Fig. 4. Autonomous Underwater Vehicle (AUV)

ROV- Remotely Operated Vehicles (ROV) is non-autonomous which is used to controlled by an operator which provide data under the water and the operator using remote controller, where the pilot is not in the vehicle (self-constrained, integrated system). Besides, there are different types of ROVs either large in size like a truck or small in size which have only a camera 40 to 50cm long. Also, they both are remotely operated vehicles which operate by an operator and transfer data to the surface station or buoy. It can used in a various field like scientific research, oil & gas drilling support, reconnaissance, telecommunications, security, etc.

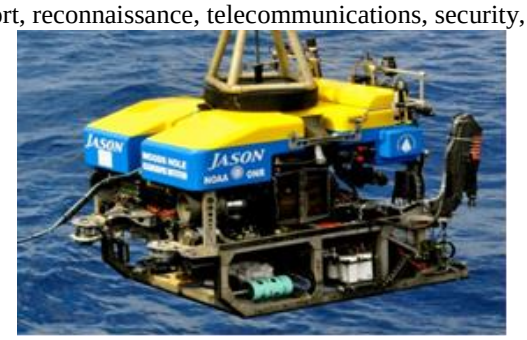

Fig. 5. Remotely Operated Vehicle (ROV)

IV. Communication Requirements

Communication is the process of passing information from one place to another, in UWSN we review the different type of physical fundamental efficient communication.

RF (Radio Frequency or Radio waves): Radio waves are those which propagation underwater at extremely low frequencies (30hz – 300hz) and required large antennae or high transmission power. [10]

Acoustic waves: Acoustic waves are those which are used underwater acoustic communication and help us while sending or receiving messages. Acoustic waves have a large propagation and also known as sound waves which have high data transmission rate and best way of communication underwater. Its frequencies about (20hz – 20000hz) approximately. [11]

Optical waves: Optical waves are those which do not suffer much attenuation but are affected by scattering, it can potentially exceed 1gbps. [12]

V. Methodology

Underwater wireless sensor network using many routing protocol for data forwarding from source nodes to a sink. There are some routing protocols are as follow:

Flooding based routing protocol: It is used to transmitting the data or packet to all other node within transmission range. [13] However, flooding based routing protocol have a many protocol based on this family like.

- Depth Based Routing Protocol (DBR)
- Focus Beam Routing Protocol (FBR)
- Hop-by-Hop Vector Based Forwarding Protocol (HH-VBF)
- Sector Based Routing with Destination Location Prediction (SBR-DLP)

Multipath Based Routing Protocol: Multipath routing protocol is the best way to find the path in which more than one path are establish from source node to destination node [14] and also it is beneficial to load balance and network robustness. Apart from this, a multipath scheme is energy-efficient because it involved multiple paths via nodes.

Cluster Based Routing Protocol: Cluster based routing protocol are the group of nodes and there are two types of nodes firstly, cluster head node and secondly, cluster member. It includes minimum cost clustering protocol (MCCP) and distributed underwater clustering scheme (DUCS).

Miscellaneous Based Routing Protocol: In miscellaneous based routing protocol include adaptive, information carrying based routing protocol (ICRP).

In this section, we discuss about the different type of routing protocol which is used to find the fastest way to collect the data or information.

VI. Applications of UWSN

In this section, we focus on the number of application are as follow:

Ocean Mapping: Ocean mapping means the boundaries of the ocean, in which the AUV is moving the 3D coastal ocean environment and arranged the sensor in different depth.

Disaster Prevention: [15] In UWSN the disaster prevention is related to early warning system because the natural disaster are unavoidable also water based disaster are more dangerous like floods underwater volcanic eruptions, earthquakes, tsunamis. So, UWSN offers a large area of monitoring and preventive mechanisms.

Assisted Navigation & Tracking: Assisted navigation is help us to navigate the boats, ship, vessels because underwater environment is extremely unexplored, random and dark with increasing depth. Target tracking is another application of UWSN in which we can use in Surveillance, Submarines detection and Target localization.

Environmental Monitoring: [15] Environmental monitoring is most important application of UWSN, which including pollution monitoring, temperature, oxygen levels, ocean current, etc.

Oil & Mineral exploration: Oil and mineral exploration is another application of UWSN in which the sensor node is also helping for detects oil and minerals in offshore.

Mine Reconnaissance: Autonomous underwater vehicles which are free from external control and can operate the task simultaneously also sensors help to perform immediate response and mine detection in deep.

VII. Challenges of UWSN

Underwater sensor network have various challenges are still remain unsolved. In this section, we review some UWSN challenges.

Propagation delay: [16] In UWSN the propagation delay is the major problem in which the acoustic channels of underwater have large propagation delay.

Communication: UWSN needed high power for communication and it contains more energy because the data transmission process is done in underwater. So, it requires more batteries power while exchanging the data packets.

Limited battery power: [17] Limited battery power is major challenge in underwater sensor network because the battery has limited power and charging or replacement of battery is not so easy task.

Cost effective: The underwater sensor devices are more expensive in term of deployment, maintenance and equipment also it is not easily available in market because these type of devices are only part of research oriented activity.

Limited bandwidth: [18] Limited bandwidth is the biggest challenge facing UWSN, because data transmission rate (bit per second) in underwater have contain large bandwidth.

Multipath and Fading: Underwater sensor network facing multipath and facing due to impaired channels.

High bit error rates: It is another problem in UWSN high bit error rates (Shadow zones) and connectivity loss, usually used in vast ocean areas.

VIII. CONCLUSION

In this paper, we review of underwater sensor network overview including their architecture design, communication process, research methodology and also review their applications and challenges of UWSN. Apart from this, there are number of research challenges still remain to be solved. We needed to be continuing our research in UWSN. In future we expect some routing protocols which trying to solve these major challenges of UWSN and also improve the network security. Related research studies are in progress.

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