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IMPROVISATION IN UNDERWATER COMMUNICATION FOR DISASTER MANAGEMENT

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Abstract

The planet is composed majorly of water which covers almost 70% of its surface.This being established humans have still paid relatively less attention to the development of underwater communications and underwater networks. This difference in exploration and speed in development arises due to the toils that obstruct the replication of wireless sensor networks (WSNs) to their underwater equivalents. Maximum underwater deployments depend on acoustics for facilitating communication along with special sensors which can withstand the extreme conditions of the ocean. This paper mainly focuses on the development of underwater sensor networks (UWSNs) and their applications in the field of disaster management and their recent deployments.

Keywords: Directed diffusion routing protocol, Remote station, Network topology, Remotely operative underwater vehicles, Optical communication, Deployment Salinity level

1. Introduction

Recent developments in technologies have led to the opportunity to do underwater explorations using sensors. An underwater sensor network (UWSN) is coming up as a technology which can break new grounds in underwater exploration. UWSN is a blend of wireless technology with micromechanical sensor technology having smart sensing, intelligent computing, and communication capabilities. UWSN is a network of autonomous sensor nodes that are spatially distributed underwater to sense the water-related properties such as quality, temperature, and pressure. The sensor nodes are connected wirelessly through communication modules to transfer information [10].Underwater communication is mainly done with a set of nodes transmitting their data to buoyant gateway nodes that dispatch the data to the nearest remote station. The paper focuses on the applications of UWSNs to help detect, predict and manage disasters.

2. Underwater Sensor Networks Architecture

Underwater Sensor Network Architecture shown in Figure (1)

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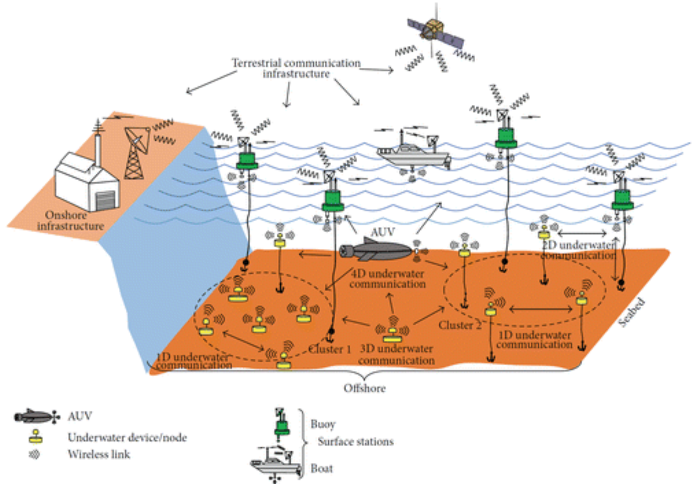

Fig.2 Underwater Sensor Network Architecture

2.1. 1D-UWSN Architecture

One dimensional UWSN (1D-UWSN) architecture is a network of sensor nodes deployed autonomously. Every node is an individual network, it can sense, process and transmit data to the remote station. In 1D-UWSN the nodes communicate using radio frequency, acoustics or optical communication and it makes use of start topology.

2.2. 2D-UWSN Architecture

TwodimensionalUWSN (2D-UWSN) architecture is a network where anassembly or cluster of sensor nodesare deployed underwater. Each cluster has a anchor node. The clusters are anchored at the underwater surface. Every node in a cluster collects data and sends it to the anchor node. The anchor node further relays this information to the surface (buoyant) nodes. In 2D-UWSN the clusters communicate using radio frequency (RF), acoustics or optical communication and it makes use of start, mesh or ring topology.

2.3. 3D-UWSN Architecture

Three dimensional UWSN (3D-UWSN) architecture, the sensors are deployed underwater in the form of clusters and are anchored at variable depths. The differentpositioning of the nodes at dissimilar heights, the communication between the sensors goes beyond the two dimensions. This architecture uses three types of communication:1. Intercluster communication,2. intracluster communication,3. anchor-surface(buoyant) node communication.All the three communication types in 3D-UWSN can communicate using acoustic, RF, or optical communication.

2.4. 4D-UWSN Architecture

Four dimensional UWSN (4D-UWSN) architecture is designed by the amalgamation of3D-UWSN and mobile UWSNs. The mobile UWSN is made up of remotely operative underwater vehicles (ROVs) to gather information from the anchor nodes and transmit the information to the remote station.As data is to be transmitted to ROV, the sensors containingbulky data and are inclose proximity to ROVs use radio links where as the sensors containinglesser data or/and are far away from the ROV make use of use acoustics links [7,8].

3. Disasters and UWSN applications to manage them

Natural disasters are inevitable and therefore they can't be overlooked. UWSN offers a large variety of applications for the management of such disasters; it relates to the observation of events that worsen a disaster's after effect. Therefore, UWSN monitoring methods for disaster management are developed into a large range of applications like floods, underwater volcanic eruptions, underwater earthquakes and their ensuing tsunamis, and oil spills that cause above-the-water and underwater ecological fluctuations.

3.1 Floods

The consequences of floods have resulted in the development of a timely flood alert system. The alerts needn't solely be placed on urban shores and thus need remote preparation. UWSN helps develop solutions for underwater device deployments with over-the-water relay agents.

3.1.1.A flood monitoring and alarming system developed with the assistance of UWSNs consists of a sensory module, observatory module, and transponder module. The sensory module is answerable for observing water and gathering water conditions like level, thrust, and intensity of water as flood indicators. the data is transmitted to the remote station for additional observations. The aim of the observatory module is to look at the data and predict the flood. The transponder module is employed for relaying the data just in case of a flood. The designed system is simulated and tested in perspective of its potency by varying the number of nodes deployed versus the time delay. The system is additionally tested for its localization error and also the space of coverage [1].

3.1.2. Another monitoring system like an acoustic UWSN system can be used for flood observation in rivers can be used. This system is based on a 4D-UWSN design that consists of underwater deployed sensors, AUV (Autonomous underwater vehicle), and a remote station. The device relays the data acoustically to the AUV that collects the data and transmits the data to the remote station. The designed system is tested on a 5000 m by 200 m wide river bed [2].

3.2 Seismic Activities

Calamities like earthquakes and volcanic eruptions will occur anytime and anyplace over the surface of Earth and are even a lot more devastating if they occur underwater. Thus, it's vital to supervise such conditions.

3.2.1. With the help of 4D-UWSN system we can generate early warnings just in case of any risky event. It includes multicarrier communication and OFDM (orthogonal frequency-division multiplexing) for underwater communication in such situations. An efficient architecture for detecting tsunamis could be s sensor-based architecture that utilizes seismic pressure sensors to indicate the tsunami underwater and send the data through the directed diffusion routing protocol. The system works on the sense and response mechanism. As of now, only a few real deployed systems are present for tsunami and earthquake detection [3].

3.2.2. Another very efficient architecture for detecting tsunamis can be used, a sensor-based architecture that utilizes seismic pressure sensors to foresee the tsunami and transmitdata by

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directed diffusion routing protocol. The architecture functions over the sense and response mechanism. This system has a number of applications and they have been tested in a testbed environment [4].

A survey by Lloret, J. brings up that underwater natural disaster monitoring applications are abundant in number but only few have a complete design which can be deployed; hence a lot of work is still needed to achieve and improve underwater communication systems.

3.3 Oil Spill

Manmade pollution is an essential aspect to consider when talking about the deteriorating situation of aquatic life. Aquatic life is vastly affected by oil spills and this is why UWSNs have made it possible to find out the area affected the oil spills and their viscosity which can speed up the cleaning procedure.

3.3.1. An ad hoc UWSN that senses ocean contamination is developed, this system is built using vivid sensors, it has asynchronization algorithm, routing protocols, and a complete protocol stack. This improves the QoS (quality of service) [5].

3.3.2. Another system which focuses on designing a sensor that is able to sense, course, and relaydata relating to the viscosity and site of the oil spill. This applicationproposes two algorithms Light Sensor Array and Conductivity Array in order to find out the viscosity of the spill this can further be linked to a simulator that plots real-time data on a map, revealing the location of the spill [6].

Flood applications tend to use RF in combination with 2D architectures this is done to maximize the area of coverage by deploying systems in clusters. This leads to low coverage UWSNs using RF communication patterns. Applications associated with volcanoes, simulation and analytical models are a more practical way to approach these problems. For oil spills applications and, analytical, simulation, and testbed models with the use of RFs and acoustics can be thought of with 2D, 3D, and 4D architectures.

Table 1. Comparison of UWSN disaster applications

Application	Architecture	DSL	Operable depth	Sensor type	Number	Communication Type	Implementation
3.1.1	2D	Canals	Few meters	Water level, thrust, intensity	Many	RF	Simulation, test bed
3.1.2	4D	River	Kilometers	Depth	Few	Acoustic	Test bed
3.2.1	4D	Sea	Kilometers	Pressure	Many	Acoustic	Analytical
3.2.2	3D	n/a	n/a	Pressure	Many	n/a	Simulation
3.3.1	3D	Sea	50-500 meters	n/a	n/a	n/a	Simulation

4. Conclusion

This paper uses literature review of UWSN applications and their classification. Along with their application in managing disasters. If these applications are correctly used and catered to, a lot of lives, money and time will be saved. Although UWSNs has seen an amazing quantity of growth within the past few years, there's still space for plentiful contributions, notably within the physical deployments of the systems on a giant scale.

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