International Journal of Oceans and Oceanography
ISSN 0973-2667 Volume 13, Number 2 (2019), pp. 269-276

http://www.ripublication.com

Underwater Wireless Sensor Network Based Marine Environment Monitoring System

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Abstract

Marine environment monitoring system is of great interest to the researchers since the sea is wealthy store house of natural resources. To Understand and evaluate the marine environment it is essential to collect the data continuously. Several works has been done in the past few decades which employs sophisticated information and communication mechanisms to monitor the marine environment. In this paper, we have proposed a marine environment monitoring system based on under water wireless sensor networks. Underwater Wireless Sensor Networks (UWSNs) is a structure that performs collaborative duty with the help of different types of nodes .In recent years Underwater Wireless Sensor Networks have been well thought out as capable alternative for monitoring marine environments as they have many advantages such as unmanned function, simple deployment, real-time monitoring and comparatively low expenditure. Our system is designed in such a way that it can process a large amount of data that are collected continuously.

Keywords: Marine Environment Monitoring, Underwater Wireless Sensor Networks, Nodes, Deployment

1. INTRODUCTION

Monitoring marine environment is forever a tough and fascinating process when taking into accounts its size and expansion. It is very difficult for the human beings to understand the features of the marine environment as they are complex and challenging. Marine environment plays a vital role in life of all living things on this planet. Due to changes in marine environment there is a major setback in the fishery industry, and this setback is escalating every year due to a variety of marine environmental changes.

Marine Environment is subjected to over exploitation, eutrophication and introduction of water pollutants by unswerving human activities. Coastline landscape is altered by several natural phenomenons like erosion; these changes can affect progress, scheduling and even security.

At present Light Detection and Ranging is used to find out the changes in coastline landscape. Rise in sea level and floods can have severe bang on the life of people. Currently tide stations are used to monitor the rise in sea level. There are a number of incidences by which oil or hazardous chemical are introduced into the water bodies, these spills irrespective of whether it is intentional or unintentional, affects the water animals, fishery industry, ecological diversity and at times it affects human population. Tsunami which arises in the marine environment cause huge destruction to life and property, sophisticated Real-time seismic monitoring can help us to predict tsunamis. But deep water seismic observations have been meager due to the high cost, hazard, and complexity in collecting data from subsea sensors.

Underwater Wireless Sensor Networks (UWSNs) contain a number of mechanisms such as vehicle and sensors that are deployed in a precise location to carry out joint monitoring and data collection responsibilities. These networks are used between different nodes and ground-based stations. Underwater sensor networks nodes are capable of moving from one place to another due to water currents. Since the sensor nodes are mobile the collected data by the nodes would be useful only when localization is concerned. Another key challenge that is affecting underwater sensor networks is energy saving. The energy of the sensor node would be quickly depleted as the sensor nodes are mobile.

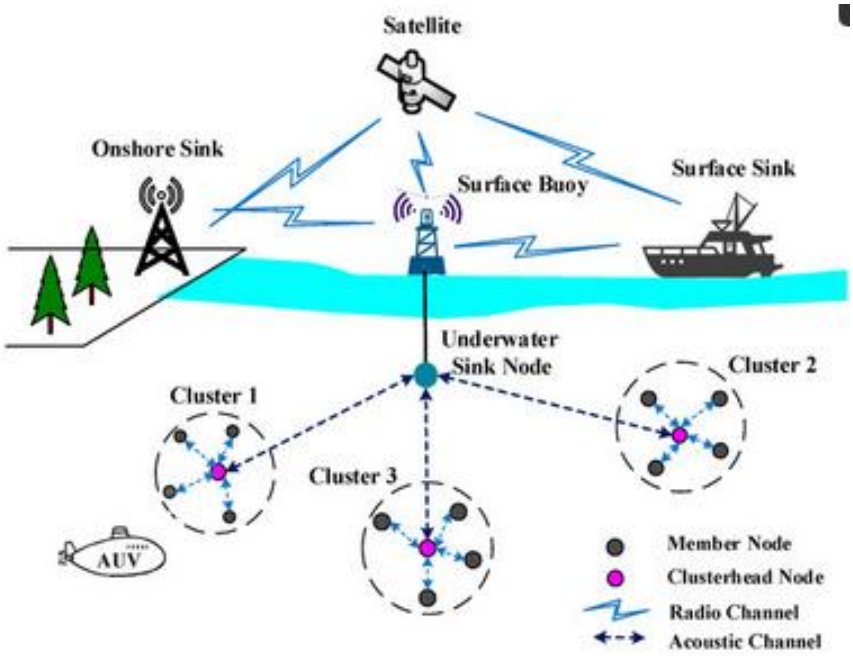

Fig1: Underwater Wireless Sensor Network Architecture

Fig1 shows the architecture of underwater wireless sensor network [1]. It consists of sink node at onshore and under water, buoy located at the surface and sensor nodes placed underwater. Sensing and communication can further be enhanced by using autonomous underwater vehicles (AUVs) and satellite. The sensor nodes which are placed under the water senses various physical quantities like temperature, pressure, turbidity etc and passes it on to the cluster head. The cluster head in turn aggregates the received information from its sensor nodes and passes it on to the surface buoy via underwater sink node. The data from surface buoy is passed on to sink nodes located at onshore or at the surface.

UWSNs can be implemented using any one of the three architectures. In a static two dimensional architecture the sensor nodes are clamped to the ocean floor. Cluster heads uses a horizontal transceiver to communicate with underwater sink node. Vertical transceiver is used by the underwater sink node to communicate with surface buoy. In a static three dimensional architecture the sensor nodes are clamped to the ocean floor and fixed out with hanging buoys. In a three dimensional architecture AUVS are used to enhance the sensing and communication range.

The paper is presented as follows section 2 deals with the related work that has been carried out in marine environment monitoring, while section 3 clearly describes the proposed architecture and finally we conclude in section 4

2. RELATED WORK

WSN system was proposed in [2] to attain ecological classification behavior of coral which are marine invertebrates. The node was configured to gather information about the coral by appropriately configuring its hardware. The images that were captured by the sensor node were transmitted to the central base station for further processing. Experimental setup was setup based on this prototype along the coastal area of Japan to determine and examine the dependency of reef building coral. In [3] an overview of possible applications of different modern tools and their approaches to estimate their usability to marine environment monitoring with unique focus on three different categories, i) Assessment of marine biodiversity beginning from microbes to macro fauna based on molecular approaches. This work provided a sequence of strategy for the application of Meta bar coding for macro invertebrate monitoring. ii) Monitoring of marine abiotic and biotic variables by using novel system for in situ technologies.iii) Acoustic monitoring, where the problem of photic disturbance or restriction are solved using passive acoustic technologies. Acoustic Complexity Index (ACI) was suggested to be a capable tool to examine marine soundscape removing out noises and biological sounds.

[3] Specifies a marine environment monitoring and protection system using IoT which involves a five layered model, where layer 1 includes GPS sensors and energy

harvesting devices, layer 2 provides instruction for the actuators to do a particular task. Data mining technology is utilized in layer 3 to process the data received and to provide necessary indication based on the predefined protocol. Layer 4 can be tailor made based on the application. The management of the entire IoT environment lies with the topmost layer. Here the information that is collected by the sensor node is transmitted using Zigbee technology.

[4] Presents a outline of marine environment monitoring which are used for various applications, most of these projects were used for water quality monitoring, the communication technology that was employed was based on zigbee technology and most of them were a prototype which were tested in a pool, pond or lakes.

One of the ongoing researches in the field of wireless sensor network is the lifetime maximization [5] suggests some mechanism to maximize the sensor network life time, the sensor node is made to close down the power expenditure when idle.

Further the network performance was improved using smack sets an algorithm to maximize the number of sleep nodes. It also made use of number of mobile sink nodes where the nodes with little residual energy are put into sleep state. Genetic algorithm based approach is used to increase the lifespan of wireless sensor network [6].

An enhanced error node regaining algorithm is used to prolong the lifetime of the network which uses a feature called as sparse or compressive sensing. This idea is excellent for wireless sensor network application designed for providing coverage for smaller areas. [7] Proposes an aerial wireless sensor network for oceanographic monitoring. An electronic module named motes is incorporated into the model which houses a RF transmitter, power supply regulation system, amplification module and mechanism to communicate with sensors.

[8] Proposes an algorithm where the cluster head is elected based on the residual energy. It employs a relay node to aggregate information from cluster heads and relay it to the base station whenever the cluster heads are located far apart.

3. PROPOSED SYSTEM

The proposed system architecture of underwater wireless sensor network based marine environment monitoring system is given in the Figure 2. Its functionality includes water quality check, seismic monitoring and marine environment monitoring. In the proposed system we employ a static two dimensional architecture.

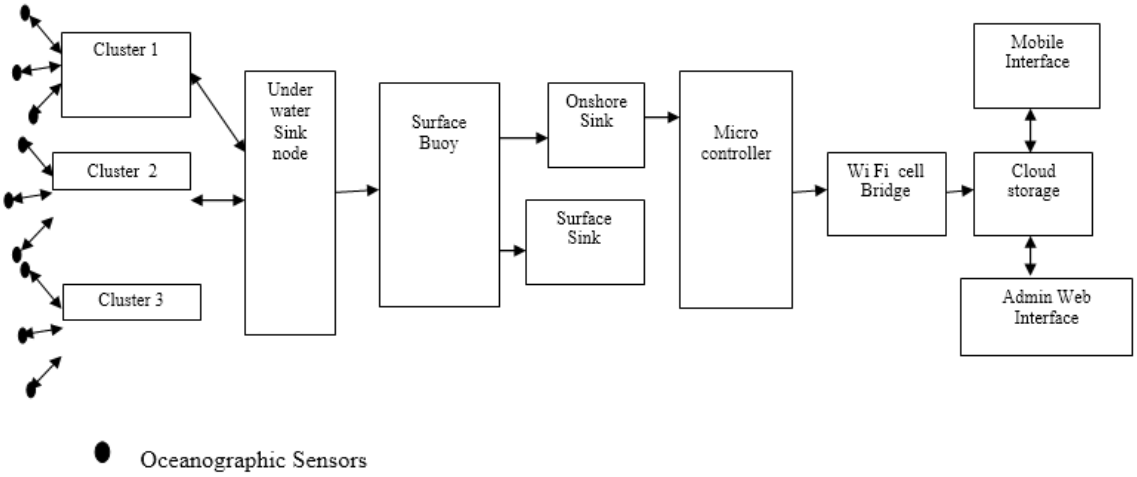

Fig 2: Proposed System Architecture

The proposed system includes oceanographic sensors like temperature sensor, pressure sensors, turbidity sensor, PH sensor, conductivity sensor, dissolved oxygen sensor, seismic sensors. The sensors that we deploy should have high resistance to water as their operation is from underwater. The sensors are grouped into clusters and cluster head is chosen by using High energy first clustering algorithm. The topology that we use for deployment is mesh topology because as per our algorithm the cluster heads are not fixed they are chosen based on the residual energy level. The sensed data collected by cluster heads is forwarded to underwater sink node.

As energy is the main constraint of wireless sensor networks, the sink node is made to shut down when it is idle. The communication between underwater sink node and sensor node is through acoustic channel, underwater sensor node in turn makes use of wired link to communicate with the surface buoy. Communication between underwater sensor node and surface buoy is point to point. The surface buoy communicates via radio channel with onshore sink and surface sink. The collected information is passed to the microcontroller MSP430, where the sensed values are processed and compared with the standard values. The information from the microcontroller is uploaded into the cloud using Wi-Fi module. The information that is store in the cloud can be retrieved and necessary action can be taken.

4. CONCLUSION

In this paper, we have presented underwater wireless sensor network based marine environment monitoring system, the oceanographic sensors measures the various parameters and based on the measured values we can alert the nearby residents when there is a possibility of tsunami which could save the life of millions of people and would help the department of ocean development to know whether the particular water body is contaminated, information about the salt level etc. based on these

information appropriate action can be carried out to help the fishery industries located close by. This project can be further enhanced to monitor the rise in sea level and melting of sea ice.

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