https://dx.doi.org/10.22161/ijaems.4.4.6 ISSN: 2454-1311

GeoSoc: A Geo-cast-based Communication Protocol for Monitoring of Marine Environments

Mr. B. Karthikeyan[1], D. Anandhapandian[2], H. Abdulrahman[3], A. Hariprasath[4], J. Lokeskwaran[5]

[1]Associate Professor, Department of Information Technology, Panimalar Engineering College, Chennai, Affiliated to Anna University, India.
[2,3,4,5]Final Year, Department of Information Technology, Panimalar Engineering College, Chennai, Affiliated to Anna University, India.

Abstract— With the rapid development of society and the economy, an increasing number of human activities have gradually destroyed the marine environment. GeoSoc a node can take one of the following states: SINK: The master node of the whole network manager of receiving all the information that is collected by all the sensor nodes that make up the different clusters used for monitoring desired area. Cluster head: The node that coordinates a group of nodes that are part of a cluster and are responsible for the monitoring of an assigned area. Is responsible for establishing direct connection with the SINK node to transmit the information collected for all its sensor nodes. In case of losing SINK contact, can make use of a node. Gateway: A node that has connection with two Cluster head or a sensor node that does not reach its Cluster head. This type of nodes is used to increase network coverage and reduce loss connection by the nodes that make up the net.•Sensor Member: These nodes are responsible for Collect the information you want to monitor. Is the state that a node takes when it has already established Cluster head connection to a node? • Disconnected: A node has this been in two situations, 1) when it is activated for the first time and have to look for the cluster to which must be connected, 2) when it loses connection with its coordinator node and you have to perform the search for a new node coordinator.

Keywords— GeoSoc, Marine Environments, WSN.

I. INTRODUCTION

A wireless sensor network (WSN) consists of a number of dedicated sensor nodes with sensing and computing capabilities, which can sense and monitor the physical parameters and transmit the collected data to a central location using wireless communication technologies. A WSN has a number of inherent characteristics including uncontrollable environments, topological constraints, and limited node resources for energy and computational power. Generally, a WSN deploys more sensors than the optimal placement in order to improve the system reliability and the fault tolerance.

On the other hand, with the development of society and economy, more and more people have started to pay attention to the marine environment. Marine environment systems are particularly vulnerable to the effects of human activities related to industry, tourism and urban development. Traditionally, oceanographic research vessels were used to monitor marine environments, which is a very expensive and time-consuming process that has a low resolution both in time and space. For marine environment research, a WSN-based approach can dramatically improve the access to real-time data covering long periods and large geographical areas. According to Tateson *et a* , a WSN-based approach is at least one order of magnitude cheaper than a conventional oceanographic research vessel.

There have been a few literature reviews on Wireless Sensor Networks for marine environment monitoring. Albaladejo *et al.* provided a comprehensive review of the research and development of oceanographic monitoring using wireless sensor networks and pointed out the challenges and difficulties of WSNs for oceanographic monitoring. This paper is intended as an update and extension of Albaladejo *et al*'s review based on recent developments in this area during the past five years. The limitations and challenges of wireless sensor networks for environmental research were discussed in. They reviewed several WSN applications such as water ecosystems, forest monitoring, precision agriculture, wildlife observation, disaster prevention and urban monitoring.

This paper provides a comprehensive review of recent developments in the related fields, discusses major technical

https://dx.doi.org/10.22161/ijaems.4.4.6 ISSN: 2454-1311

challenges, and identifies future research directions. The rest of the paper is organized as follows: Section 2 briefly describes fundamentals of WSN-based marine environment monitoring systems. Section 3 reviews some related projects, systems, and technologies. Section 4 highlights various challenges and opportunities including oceanographic sensors protection, advanced buoy design, energy harvesting system design, and WSN-based system stability and reliability. Section 5 provides some concluding remarks.

II. OVERVIEW

This section provides an overview on the application of WSNs in marine environment monitoring, including different application areas, a common architecture of WSN-based marine monitoring systems, a general architecture of an oceanographic sensor node, sensing parameters and sensors, and related wireless communication technologies.

2.1. Application Areas

WSN-based marine environment monitoring has a broad coverage including a number of application areas: water quality monitoring, ocean sensing and monitoring, coral reef monitoring, and marine fish farm monitoring. Different application areas require different WSN system architectures, communication technologies, and sensing technologies.

A water quality monitoring system is usually developed to monitor water conditions and qualities including temperature, pH, turbidity, conductivity and dissolved oxygen (DO) for ocean bays, lakes, rivers and other water bodies. An ocean sensing and monitoring system is used to monitor ocean water conditions and other environmental parameters. A coral reef monitoring system is normally installed to monitor coral reef habitats using an autonomous, real-time and *in-situ* wireless sensor network. A marine fish farm monitoring system is developed to monitor water conditions and qualities including temperature and pH, and accurately quantify the amount of fecal waste and uneaten feed for a fish farm.

2.2. Common WSN Architecture

Figure 1 shows a common wireless sensor network architecture for monitoring marine environments, which consists of sensor nodes, sink nodes, a base station, a server and user terminals. Sensor nodes can sense and monitor the *in-situ* environmental parameters such as water temperature, salinity, turbidity, pH, oxygen density and chlorophyll levels, and transmit the collected data to sink nodes via wireless communication using ZigBee or some other communication protocol. Communication between sensor nodes and a sink node is usually point-to-point. A sink node collects data from a group of sensor nodes, and transmits the collected data to the base station via the GPRS network. The server stores and processes the received data from the base station. The user terminals connect the server over the Internet.

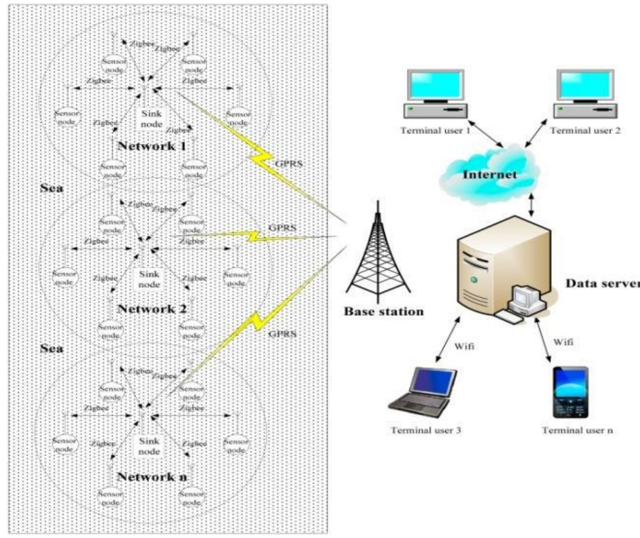

Fig.1: Common architecture of WSN-based marine monitoring systems.

The design and deployment of a lasting and scalable WSN for marine environment monitoring should carefully take into account the following factors: the hostile environment, the network topology, communication protocols, the number of nodes, buoys, mooring systems, oceanographic sensors, energy supply, and so on.

2.3. General Sensor Node

Figure 2 shows an architecture of a general sensor node in a marine environment monitoring system. It usually includes a buoy device in order to protect electronic devices of nodes against water. A marine monitoring sensor node normally consists of the following four main modules:

- A sensing module for data acquisition
- A central processing module for local data processing and storage;
- A wireless transceiver module for wireless data communication;
- A power supply module for energy supply.

https://dx.doi.org/10.22161/ijaems.4.4.6 ISSN: 2454-1311

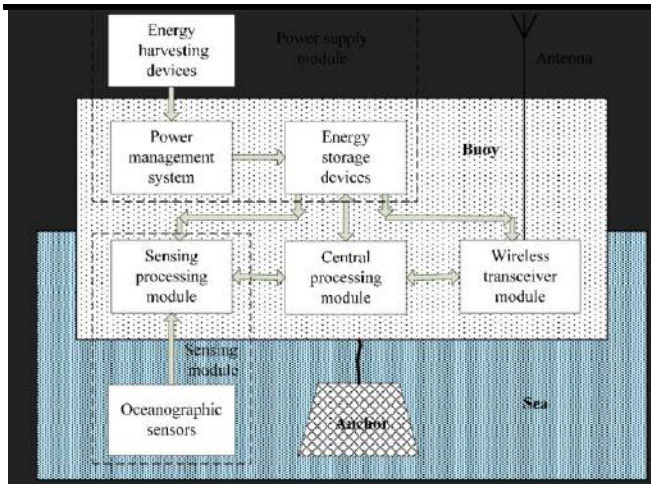

Fig.2: General architecture of an oceanographic sensor node.

A sensing module is usually composed of several probes and sensors (with associated amplifiers and A/D converters) to sense and monitor the physicochemical parameters of marine environment as mentioned above. A central processing module normally includes a CPU and memory to process and store the collected data. A wireless transceiver module mainly consists of a RF transceiver and an antenna to send the collected data and receive instructions from the sink node. A power supply module usually contains energy storage devices (rechargeable batteries), power management system and energy harvesting devices (solar panel, wind energy, tidal power, seawater generator, *etc.*). Finally the buoy has an anchor device in order to prevent it from moving (due to waves, marine currents, wind, tide, *etc.*).

The energy options for sensor nodes usually include batteries, capacitors, heat engines, fuel cells, and energy harvesting. Sensor nodes are normally battery powered in most application systems. However, the use of a battery in sensor nodes has a number of disadvantages:

As sensor nodes increase in number and size, the replacement of depleted batteries is wasteful and time-consuming.

It is therefore necessary to explore an alternative power supply for sensor nodes. Harvesting energy from their ambient environment is a promising power supply for sensor networks with lower cost and long life. Energy harvesting methods include photovoltaics, fluid flow, temperature gradients, pressure variations and vibration harvesting. In terms of their efficiencies and realisability, the most outstanding energy harvesting at the moment is photovoltaics. This issue will be further explored in Section 4.3.

2.4. Sensing Parameters and Sensors

The operating principle of sensors is to respond to changes in their environment by producing an electrical signal in the form of voltage, current, or frequency. Sensors can commonly be divided into physical sensors and chemical sensors. In a marine monitoring system, physical sensors are used to measure some physical parameters, such as temperature, humidity, pressure, wind speed and wind direction, and chemical sensors are used to sense various chemical parameters (salinity, turbidity, pH, nitrate, chlorophyll, dissolved oxygen (DO), *etc.*) as shown in Table 1.

Table.1: Common marine environment monitoring sensors.

Sensors	Monitoring Parameters	Range	Accuracy	Power Supply
SBE 16plus V2	Temperature	−5 to +35 °C	±0.005 °C	9–28 V
GT301	Pressure	0 to 60	< ±0.5% of FRO	24 V
SBE 16plus V2	Conductivity (Salinity)	0–9	± 0.0005	9–28 V
OBS-3+	Turbidity	Mud: 5000–10,000 mg/L Sand: 50,000–100,000 mg/L	0.5 NTU	15 V
PS-2102	pH	0 to 14 pH	±0.1	N/A
YSI 6025	Chlorophyll	0 to 400 μg/L	0.1 μg/L	6 V
ISUS V3	Nitrate	0.007 to 28 mg/L	±0.028 mg/L	6–18 V
SBE 63	Dissolved oxygen (DO)	120% of surface saturation in all natural waters	0.1	6–24 V; 35 mA

The right choice of marine environment monitoring sensors depends on the user requirements of deployment area, measurement range, accuracy, resolution, power consumption, and intended deployment time.

2.5. Wireless Communication Technologies

WSN physical topology and density are entirely dependent on the applications, so the design and deployment of a WSN should consider its environment and application. A number of sensor nodes are densely deployed to improve data accuracy and achieve better system connectivity. However, a dense deployment of sensor nodes has some disadvantages: high energy consumption, data collisions, interferences, *etc.* . WSN nodes normally have three typical kinds of network topologies: star topology, cluster/tree topology and mesh topology, as shown in Figure 3.

https://dx.doi.org/10.22161/ijaems.4.4.6 ISSN: 2454-1311

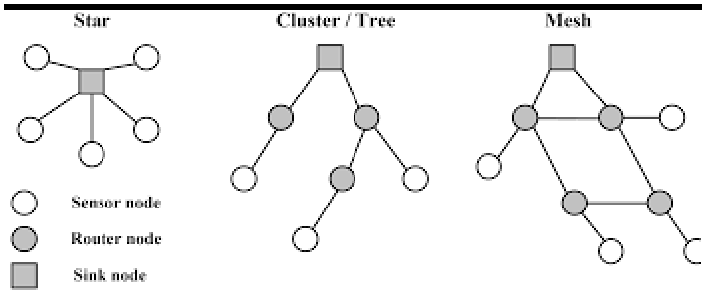

Fig.3: General WSN network topologies.

Star topology: A star topology is a point-to-point single-hop architecture in which each sensor node connects directly to a sink node. It potentially uses the least amount of power among the three topology architectures.

Mesh topology: A mesh topology is a one-to-many multi-hopping architecture in which each router node connects to multiple nodes. Its advantages over a star topology include a longer range distance of transmission, decreased loss of data, and a higher self-healing communication ability. However, its disadvantages are at the cost of higher latency and higher power consumptions.

Cluster/tree topology: A cluster/tree topology is a hybrid star–mesh architecture. It takes advantage of the low power consumptions and simple architecture of a star topology, as well as the extended range and fault tolerance of a mesh one. However, there probably exists some latency.

The right and reasonable choice of network topology depends on the amount and frequency of data to be transmitted, transmission distance, battery life requirements and mobility of the sensor node. It should be noted that a WSN physical topology may change due to available energy, position variations of nodes, malfunction, reachability (due to noise, severe weathers, moving obstacles, *etc.*), and task details of sensor nodes.

A sensor node normally incorporates a radio module for wireless communication. The transmitted distance of wireless communication can be anywhere between a few meters (Bluetooth, ZigBee, WiFi, *etc.*) and thousands of kilometers (GSM or GPRS radio communication). Wireless communication has various standards and technologies including Bluetooth, ZigBee, WiFi, GSM, GPRS and WiMAX. Table 2 provides a summary and brief comparison of these communication technologies. Usually, two or more wireless communication technologies are used in a real wireless sensor network. In particular, underwater acoustic communication technologies can be a good choice for data collection and exchange among underwater sensors.

Table.2: Wireless communication technologies.

Technology	Standard	Description	Throughput	Range	Frequency
WiFi	IEEE 802.11a; 802.11b/g/n	System of wireless data transmission over computational networks.	11/54/300 Mbps	<100 m	5.8 GHz 2.4 GHz
Bluetooth	IEEE 802.15.1	Industrial specification for WPAN which enables voice and data transmission between different devices by means of a secure, globally free radio link (2.4 GHz).	v. 1.2: 1 Mbps v. 2.0: 3 Mbps UWB: 53–480 Mbps	Class 1: 100 m Class 2: 15–20 m Class 3: 1 m	2.4 GHz
ZigBee	IEEE 802.15.4	Specification of a set of high-level wireless communication protocols for use with low consumption digital radios, based on WPAN standard IEEE 802.15.4.	250 Kbps	<75 m	2.4 GHz
WiMAX	IEEE 802.16	Standard for data transmission using radio waves.	<75 Mbps	<10 km	2–11 GHz

Generally, the longer the range a radio module must transmit, the more energy consumption a radio module will have. The choice of a wireless communication technology depends on the amount and frequency of the transmitted data, transmission distance, and amount of available energy

III. CONCLUSIONS

During the last decade, monitoring of the marine environment has attracted a great deal of research and development attention. Wireless sensor networks are a highly promising technique for monitoring marine environments because of their advantages of easy deployment, real-time monitoring, automatic operation, and low cost. This paper presents a state-of-the-art survey of applications of wireless sensor networks in marine environment monitoring. It first describes fundamentals of WSNs-based marine environment monitoring, including application areas, a common WSN architecture, a general sensor node architecture, sensing parameters and sensors, and wireless communication technologies. Then, it reviews the related literature according to different projects, systems, applications, network routing mechanisms, algorithms, approaches and techniques on marine environment monitoring based on wireless sensor networks. From this survey, it is evident that there are still a few interesting challenges and opportunities on development and deployment of wireless sensor networks for marine environment monitoring, including oceanographic sensors protection, advanced buoy design, energy harvesting system design, and system stability and reliability.

ACKNOWLEDGMENTS

This work was financially supported by the Guangdong Ocean University scholarship council, and the Guangdong Ocean University Projects (E09174) to establish Ph.D. graduate programs.

https://dx.doi.org/10.22161/ijaems.4.4.6 *ISSN: 2454-1311*

REFERENCES

[1] Li N., Zhang N., Das S.K., Thuraisingham B. Privacy preservation in wireless sensor networks: A state-of-the-art survey. Ad Hoc Netw. 2009;7:1501–1514.

[2] Cardei M., Wu J. Energy-efficient coverage problems in wireless ad-hoc sensor networks. Comput. Commun. 2006; 29:413–420.

[3] Lee H.C., Banerjee A., Fang Y.M., Lee B.J., King C.T. Design of a multifunctional wireless sensor for *in situ* monitoring of debris flows. IEEE Trans. Instrum. Meas. 2010;59: 2958–2967.

[4] Perez C.A., Jimenez M., Soto F., Torres R., López J.A., Iborra A. A system for monitoring marine environments based on Wireless Sensor Networks. Proceedings of the IEEE Conference on OCEANS; Santander, Spain. 6–9 June 2011; pp. 1–6.