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Emerging Application of Wireless Sensor Network (WSN) (Underwater Wireless Sensor Network)

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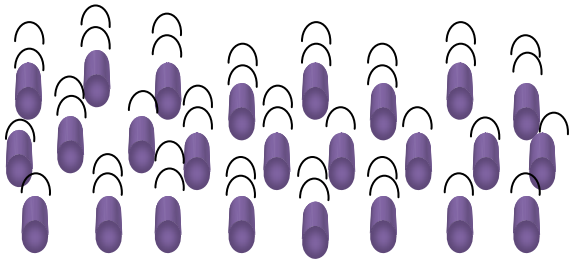
Abstract—*Wireless Sensor Networks (WSN) is an emerging area in the field of research. WSN consists of spatially distributed tiny sensor nodes, they sense and transfer the data and make it available to the sink. In this paper author has talked about a new and rare application of WSN that is Underwater Wireless Sensor Network applications*

1. INTRODUCTION OF WIRELESS SENSOR NETWORK

WSN is described as wireless sensor network, which is network of data sources distributed in nature and provides the information about the phenomenon of environment to multiple end users. WSN is a collection of several wireless sensing devices which are able to process, talk to peers and sense. They are centralized (base station or sink). [1]



The figure shown above consists of various sensor nodes (small in size) which does senses and communicates with each other without the presence of wires. These tiny nodes are capable of sensing and processing the data, they also communicate various components with each other. Data is routed with the help of sensors to one or more base stations so that communication can be performed with other nodes which are spread within our environment.

Sensor is an electronic device that detects or measures physical quantity and converts it further into an electronic signal i.e. sensors do translate various aspects of physical quantity to representation that are understandable and which are easily processed by the computers. [2]

2. VISION BEHIND THE SENSOR NETWORKS:

- Sensor nodes are embedded into the physical world.

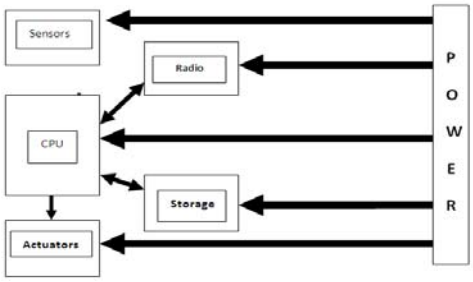
Higher level identification and tasks are performed by the network in these devices.[1]

WHAT IS SENSOR NODE?

Sensing node has three components:

- Control Processing Unit (CPU)
- Sensor Array
- Radio Transceiver

1. Nodes are powered from batteries.
1. On-board storage is seen and actuators may be present.



3. CHARACTERISTICS OF SENSOR:

While choosing a sensor the following characteristics should be kept in mind:

- Hysteresis
- Transfer Function
- Sensitivity
- Linearity
- Accuracy
- Noise
- Bandwidth
- Dynamic Range
- Resolution

Above explains the Wireless Sensor Network with the explanation, characteristics and the vision behind the Sensor network.

But our topic is Underwater Wireless Sensor Network which is used for various underwater applications, but why only underwater sensor network?

As water covers 2/3rd of the earth in the form of seas and oceans, so UWSN is came into existence.

So UWSN can be used in various applications like:

- Detection of amount of gas and oil present underwater.
- Detection of pollution
- Ocean Currents are being monitored
- Fish or any other micro organisms are being tracked.
- Seismic prediction
- Various autonomous underwater application
- Detection of undersea earthquake(natural disaster)
- Detection of pre causes of the disaster with warning

Radio waves act as communication medium, through which various sensor nodes can communicate at long distances at frequency 30 to 300 Hz for which antennas are required that are large and require power for high transmission.

Introduction of Underwater Wireless Sensor:
UWSN'S research field has grown significantly in the past few years which offer communication between various nodes and protocols for exchanging information.

Underwater environment has used acoustics for ages for communication as language; an appropriate example of the same is communication between dolphin and whales (for information exchange).

Lewis Nixon was the first one who developed sonar type for military purpose which was able to detect submarines. Later, piezoelectric properties of quartz were used for the detection of submarine which wasn't useful but laid the roots for sonar designed devices.

In the late 90's researchers were aware of various features underwater communication was able to provide us with like search for various geological resources like gas, oil etc, detection and tracking of banks of fish and archaeology of submarine including connections that were multipoint in nature were capable of translation of networked communication technology to underwater environment. UWSN have confronted us with various applications like:

- Offshore exploration
- Pollution Monitoring and the other would be discussed further.

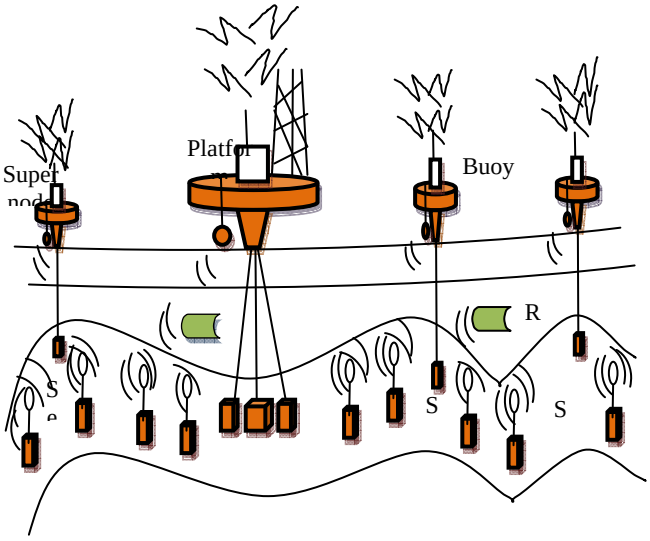
The architecture of UWSN differs from the terrestrial ones, due to the characteristics provided by the transmission medium (sea water) and signal which are employed while transmission of the data (acoustic ultrasound signals) (Akyilidiz et al, 2006). [3]

Architecture of underwater sensor network system

The diagram below shows the general architecture of underwater sensor network which describes the capabilities of UWSN's architecture. The diagram considers the capabilities of a sensor node situated underwater, its interaction with the environment, other adjacent nodes and various applications.

Four various nodes are seen in the diagram:

- At lowest layer there are large numbers of nodes present (the small circular nodes-transparent) responsible for data collection due to the presence of sensors, also these sensor nodes are responsible for communication with other adjacent nodes, by, acoustic modems which have short range of transmission. These sensor nodes are moderate in price, power of computing and capacity of storage. Batteries are present, but long term operations are spending asleep.



- At top layer control nodes are present which are either connected to the internet or are operated by human-beings. These nodes may be positioned on an off-shore or on-shore platform. The control nodes are expected to have large capacity of storage for buffering of data and also access to ample power of electrical. Communication of the control nodes with sensor node is done with the help of relay node whereas the connection of sensor node with underwater acoustic medium further connected to a control node is wired in nature.

- Third type of node is Super nodes which are able to access networks of high speed. Two implementations are considered here:

1. First, nodes are attached to tethered buoys which are capable of communicating with the base station, with the help of high speed radio communication.
2. Second, these nodes are placed on the sea floor, connected to the base station with the help of fiber optics.

Despite these, super nodes provide rich connectivity of network, also helps in creating various points of collection of data for underwater acoustic network.

- Finally, the green objects named robots provide various services to the platform.

The nodes discussed above vary in power i.e. from 8-bit to 32-bit embedded processor.

Power of battery and careful monitor of consumption of energy is very essential sensor node. Each layer present in system architecture should be able to minimize consumption of energy. For optimizing: *placement of sensors* which are good and *coverage of communication*, tethers are used to ensure that the nodes are positioned where they are expected to be roughly. A tiered deployment is anticipated where greater resources are present with some of the nodes. Some nodes are expected to be mobile while others to be wired. Also mobile nodes are expected to recover from various failures or these failures can be replaced by humans. Nodes move autonomously, while some nodes are tethered to one location and are expected to move due to anchor's drift or external effect's disturbance.
For inter node communication various networking protocols are required, which allow self configuration and coordination of underwater nodes. Certain assumptions about the application which does match the design are:

- Application benefit is achieved from data storage which is temporary in nature and local processing, where the storage is used to buffer data that manages communication (low speed).
- Also nodes do benefit from pair wise computation and communication. [4]

4. CHALLENGES IN UWSN:

- Maintenance of underwater device is required due to periodical corrosion and fouling which leaves an impact on its lifetime.
- To develop less expensive, robust, sensors that are stable and are based on nano technology.
- High bit error rates.
- Memory availability is low as compared to other technologies.
- Power and batteries are limited.
- Characterized by high cost as extra protective sheaths are required for sensors.
- Limited bandwidth.
- Due to multi path and fading the channel of underwater is impaired.
- New integrated system is required for synoptic sampling of chemical, biological and physical parameters for the improvement of understanding the marine system processes.
- Delay in propagation of underwater is five order magnitudes higher than Radio Frequency (RF) terrestrial channel.

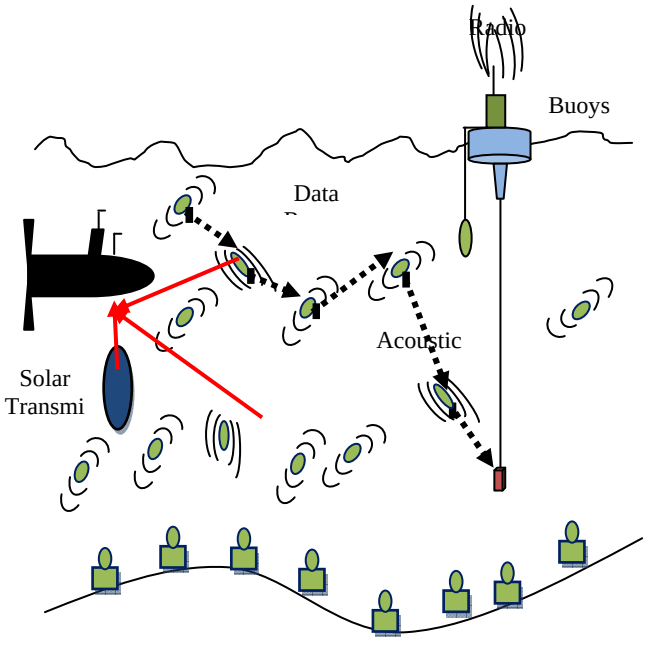
5. ADVANTAGE OF UWSN:

- Sensors are deployed in hostile environment with minimum maintenance which fulfils the need of real time monitoring, especially in remote and hazardous scenarios.

Application of Underwater Wireless Sensor Networks:

Huge potential is seen in the field of underwater domain that does monitor river's and marine's environment health, monitoring which is quite difficult and costly; so regulation of drivers in hours and the depth at which they work, also require boat on surface which is costly to operate and is subjected to weather conditions.

Fig Anti-submarine warfare



Above figure shows anti-submarine warfare which is the branch of naval which does use aircraft, surface warships or

other submarines which tracks/deter other submarines or to find or destroy/damage enemies' submarine.

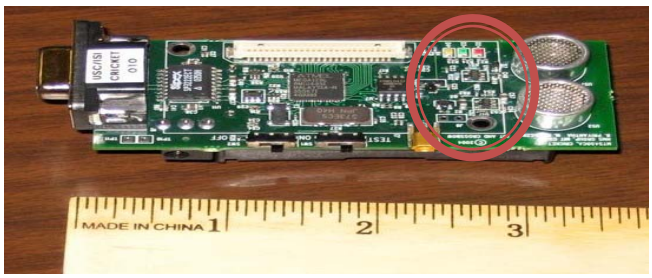
As shown above in the figure the sensor network is spread underwater that is able to monitor variables that are physical in nature like pollutants present in water, pressure, temperature, conductivity and turbidity.

The underwater network is able to track various pollutants after that does monitors them and then using the acoustic signals and passing on them further to the platform as sensor report.

Further various other applications of UWSN are as follows:

- Pollution monitoring i.e. presence of pollutants underwater, oil that spills from broken ships or boats that causes harm to marine animals is monitored with the help of UWSN.
- Ocean currents and winds can also be monitored with the help of UWSN, which further provide us with better weather broadcast details, climatic changes, tracking of fishes etc.
- Oceanic environment is being detected with the help of UWSN.
- Detection of underwater field of oils or reservoirs, routes for cables i.e. undersea exploration is possible due to UWSN.
- UWSN consist of sensor nodes which are able to detect seismic activity that can provide tsunami warnings or is able to study the effects of the same.
- Navigation i.e. detection of seafloor hazards, rocks or route is provided by UWSN
- Underwater robots are grouped and co-ordinated with the help of UWSN.
- Sensor that is distributed in nature and also is mobile can monitor surveillance area, can detect or recognize an intruder.

Ongoing Implementation



The above device which does consist of two ultrasound transducers marked in red circles are also known as ultrasonic sensors or transceivers as they both receive and send, and do have their working similar to sonar or radar which evaluates their target's attributes by echo interpretation from sound or radio waves. These transducers do generate sound waves with high frequency and does evaluate the echo received by the sensor which does measures the interval of time between receiving the echo which determines the distance to an object and sending the signal.

6. CONCEPT OF THE ABOVE TECHNOLOGY:

- With the help of in-air acoustics (acoustics in an interdisciplinary science which deals with waves which are mechanical in nature in liquids, solids and gases and further also includes topics like sound, vibration, infrasound and ultrasound) it does simulate underwater acoustics.
- The propagation is 5 times slower than underwater which is further very helpful for the system as it does allow emulation for underwater at longer distances.
- Hardware required for in-air stand-in test bed is "Cricket node" which is developed at MIT which further consist of transducers based on ultrasound which consist of the same software platform as that of – mica2 which further has 128kb memory of program , ChipconCC100 (CSMA/FSK)of 40 kHz ultra sounders .
- It does consist of the following challenges:
  - Has bandwidth which is very low that is unable to modulate data over the channels which are acoustic in nature, which can be solved by combining radio frequency with acoustic.
  - Has ultrasound which is of short range in nature i.e.12m in air
  - Ultrasound is unreliable
  - Unreliable time-stamping of radio frequency. [5]

7. RESULTS OF VARIOUS CURRENT RESEARCHES:

- "State-of-the-Art in Protocol Research for UWSN" believes that the environment of underwater particularly does require cross layer design solution (where cross layer defines the way by which the network can achieve sharing of the information, which basically shows the co-operation among various layers that helps in combining the resources and create a highly adaptive network) which does enable the use of scarce resources that are available in an efficient manner.
- "Research Challenges and Applications for underwater sensor networking" suggested focusing on

communication which is short range in nature that would avoid challenges of long-range transfer. “Mobicom workshop WuWNet07”Analysis of reliability of relay for multi-hop underwater acoustic communication proved that multi-hop is very helpful for acoustic networks in shallow underwater.

- Drift-Tolerant Model for management of data in sensor networks of ocean does uses real experiment which proves that fleet of various drifters monitoring models is practical as long as deployment periods, initial drifter location, deployment locations are well designed. [6]

8. FUTURE TREND

UWSN provides us with various advantages along which it does require various development in its technology which would leave a great impact on the industry. Following are some of them:

- Bandwidth use should be best which can be achieved by the improvement in the physical layer.
- Error rate should be reduced with the help of forward error correcting codes.
- Power and energy consumption by each sensor node should be kept in mind i.e. power and energy consumed by the device should be less. Sensor nodes should be adaptable to the environmental condition which would help in saving energy.
- Routing protocols should be discovered which are able to determine the position of the nodes geographically.
- Cross layer communication between the layers would be helpful in information sharing amongst the nodes.

9. CONCLUSION

UWSN are growing rapidly and is seen following path of radio frequency as in terrestrial networks, while there is presence of several research field where UWSN can be applied.

The above paper discusses wireless sensor network, how a sensor node works, then a short description on underwater sensor network, its architecture, challenges, applications and ongoing implementations. We here have presented an overview of UWSN that explains the development and incorporation of this technology which leads it to the development of various commercial products and solutions that underwater network can provide us with.

REFERENCES

[1] The Basics of Wireless Sensor Networking and its Applications Daniele Puccinelli

[2] Wireless Sensor Networks: Past, Present and Future -Heinzelman University of Rochester

[3] Modelling Underwater Wireless: Sensor Networks Jesús Llor and Manuel P. Malumbres *Universidad Miguel Hernández de Elche Spain*

[4] Underwater Sensor Networking: Research Challenges and Potential Applications-USC/ISI Technical Report ISI-TR-2005-603; John Heidemann Yuan, Li Affan Syed, Jack Wills Wei Ye - *USC/Information Sciences Institute*

[5] Wireless Sensor Networks: From Terrestrial to Underwater* A talk by: Affan A. Syed, GRA USC/ISI with John Heidemann

[6] Underwater Acoustic Sensor Networks (UW-ASN): Xiong Junjie - 2009.2.10