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LIFETIME EFFICIENT ROUTING PROTOCOL USING BUFFERS IN UNDER WATER SENSOR NETWORKS

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Abstract: *Under water sensor networks are used to detect the objects and the environmental pattern under the sea water. Some of its limiting features are high latency y, low bandwidth and high energy consumption. Some of the applications of under sensor networks are oceanographic data collection, pollution monitoring and disaster prevention. The issues which have to be resolved in the underwater sensor networks are high energy consumption and low delivery rate. Since the sensor devices are placed under the sea water it is difficult to change the batteries frequently. So maintaining the life time of th e sensor nodes is the biggest challenge. There are several methods available to overcome the issue namely VBR, Depth Based Forwarding and Focus Beam Routing protocol. In the existing system, Q-Learning based tracking technique is used to find the next forwarding node based on the residual energy of the individual node. So that number of forwarding will be reduced and energy consumption of the sensor nodes will be reduced. In my proposed work the buffer size is also considered for finding the next forwarder, so that the dropping on the packets will be reduced.*

Keywords-components: Wireless Sensor Network, Underwater sensor networks, Energy Efficiency, Life time extension, Sensors Nodes;

I INTRODUCTION

A. Underwater Wireless Sensor Network

Underwater sensor networks are used to analysis the environmental pattern of aquatics sensors. In this all the sensor devices are put into the water, after that that se nsor devices will form a topology and then they share the information to each other. Each sensor device will store the details about its neighbour nodes.

The underwater sensor network consists of sensor devices, base stations, surface station and onshore sin k. Sensor devices will sense the objects inside the water and will pass the signal to the base station. In this the sensor devices will also acts as the router. It will also receive the packets and forward the packets.

Fig 1 illustrate the basic architecture of underwater sensor network in which all the sensor nodes are connected to its respective underwater sink of that cluster. All the sensor nodes are grouped as clusters. The sensor node will send the packets to the underwater sink.

This underwater sink is used transmit the packets to the surface station which is above the sea water. And this above water surface station will transmit t he signal to the onshore sink which is in the ground level.

Usually the surface station is above the water level and it will be in the ships or in the submarine used to transmit the data to the base station.

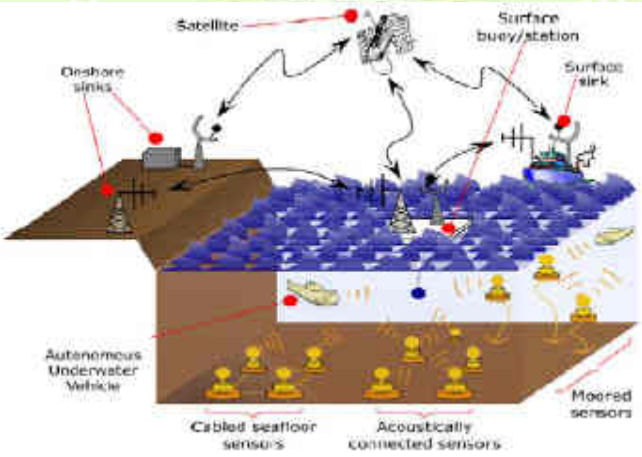

Figure 1. Architecture of underwater sensor networks

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B. Applications of Underwater Wireless Sensor Network Underwater sensor networks are envisioned to enable applications for oceanographic data collection, pollution monitoring, offshore exploration, disaster prevention, assisted navigation and tactical surveillance applications. Multiple unmanned or autonomous underwater vehicles (UUVs, AUVs), equipped with underwater sensors, will also find application in exploration of natural undersea resources and gathering of scientific data in collaborative monitoring missions.

- Environmental monitoring
- Undersea Explorations
- Disaster Prevention
- Assisted Navigation
- Distributed Tactical Surveillance
- Mine Reconnaissance

C. Characteristics Of Uwsns

Underwater sensor networks have some similarities with their ground-based counterparts such as their structure, function, computation and energy limitations. However, they also have differences, which can be summarized as follows.

- Underwater communications are based on acoustic links characterized by large propagation delays.
- Underwater channel have low bandwidth.
- Radio waves do not propagate well in underwater.
- Energy consumption is high in underwater sensor networks.
- It gets distracted by various elements like Bluetooth and infrared.

The major issue in the underwater sensor networks is the energy consumption. To send a signal to the base station the sensor networks usually follows the multi hop propagation since the range of each node will be very less. While forwarding the signal it will find the shortest path and will send in that path. If the node keeps on forwarding in the shortest path then the battery of the nodes which is available in that path will drain quickly when compared to others. So the life time of the sensor network will be reduced.

The main work of this paper is to find an optimized path so that the path cost is also very less and energy consumption is also less. To implement this reinforcement learning technique is enhanced. This will find the next forwarding node based on the residual energy and the buffer size. Which node has the higher optimized value of the residual energy and the buffer size is chosen as the next forwarding node, so all the nodes will not participate in the forwarding process and the dropping of packets will be reduced, which reduces the retransmission. Thus the lifetime of the network will be increased.

II. RELATED WORK

There are many protocol has been introduced to reduce the energy consumption of the sensor nodes in the underwater sensor networks. If the energy consumption is reduced there are chances for the data loss to increase, so that the mechanism has to be efficient enough to handle those two factors. Some of the protocol which is already available is discussed.

Since Energy efficiency is the major issue, a technique of energy efficiency of routing protocol [1] has been proposed, residual energy is considered here, energy efficiency is achieved efficiently.

Machine Learning Technique [2] is used to calculate the path the node not only considers the number of hops between the source and destination but also it will consider the contribution of traffic jams and the queue length of each node for finding the next hop. It also performs well under changing network topologies because it uses only the local information at each node. The traffic jam of the network is also considered in making decision to select the next hop forwarder. Because of this the dropping of the packets due to the congestion in the network is been reduced. In dual reinforcement Q-Routing [3] technique the Q value is calculated by every node to find the next forwarder. The distance between the two nodes are used to calculate the Q value. In this technique there are two propagations used forward propagation and backward propagation. In forward propagation the current node will get the details of the previous node. And during the backward propagation the current node will get the details of the next node.

Ant colony optimization technique (ACO) [4] is executes like how the ant will collect and save the food in its nest by travelling in a straight line. The ant will leave some pheromone on the path it travels so that the next ant will follow the same path. Likewise each packet will leave some pheromone in the nodes which it visited. If the next packet comes to a node it will check for the pheromone, if it is available then it will be the next forwarder. If not it will just drop the packets. Initially the sender will send forward ant packet to the receiver, that packet will travel in all direction to reach the receiver. While travelling towards the receiver the packet will

leave a pheromone in the visited packet. Then the packet coming first to the receiver will be taken and its path is chosen for the transmission, So that the receiver will update that path in its routing table. Then the receiver will send a backward ant packet to the sender in the same path, so that the sender will also update the path. Then it will start transmitting the packet in that path.

The author has proposed a technique [5] called Battery Aware Routing protocol (BAR). In this battery-aware routing protocol based on the observation, that the battery can provide more energy capacity if it is not used continuously. Sensor nodes are put into sleep mode if there are no objects to track or no data to transmit. Since the node is in sleep state the energy consumption will be less. It is observed that the life time of the battery is improving if the sensors are not in active state continuously. So if they are put into sleep state whenever it is not in use then the energy consumption will be reduced and the lifetime of a network is prolonged by allowing interleaving recovery time during battery usage. In Vector Based Forwarding (VBF) [6] technique, each packets contains three main fields while forwarding it to its neighbour they are sender, target and forwarder. In order to handle node mobility, each packet contains a range field. When a packet reaches the area specified by its target field, this packet is forwarded in the area controlled by the range field. The routing pipe is defined by the vector from the sender (with position SP) to the target (with position TP) and the radius of the pipe is defined in the radius field. When a packet reaches a neighbouring node first it checks the target field, if the node is the target then the packet reaches the destination all the transaction will be stopped. If not it will check for the forwarder field, if match occurs it will consider itself as the next forwarder and forward the packet. Otherwise it will dope the packet. This reduces the unwanted forwarding of packets in the wrong path.

Two phase resilient protocol [7] in which two phases of path finding will be carried out in two phases. This is mostly used in the long-term underwater monitoring application. In first phase initially the shortest path will be found for sending the packet, and that path will be used for the data transaction. The path also will be stored in the backup file for future reference. While transferring the data if any link breakage occurs or any node in-between source and destination then the transmission may fail. Then it will check for the backup file if there is any alternate path available for that destination, if so then it will choose that path an forward it in that path. Depth Based Routing protocol (DBR) [8] a technique in which the base station will be above the sea water. The sensor nodes will be put into the sea water and acoustic modems are deployed at the water surface. Each node will know its own distance from the water level. If a node wants to send a packet to the modem, it will attach its depth or the distance between the node and the modem in the packet. Then it forwards the packets to its neighbor. To reach the base station the packet has to travel through multiple hops. So the sender node will just transmit the packet to all its neighbor nodes, which comes inside its transmitting range. The packet will contain the details about the sender and its distance between the sea level and the node. After receiving the packet the node will compare its depth with the sender's depth. If the depth of the sender is larger than the depth of the receiver then it decides that the current node is above the previous node. So it will consider itself as the next sender and forwards the packet Focused Beam Routing protocol (FBR) [9] is a method in which first an imaginary line is drawn between the sender and the receiver. Using that imaginary line the angle between the sender and the receiver will be calculated. Then using the angle of variation and the distance D from the source to destination the transmitter's cone was drawn. The sender will send control packets to all the nodes which is inside the transmitter cone. If it receives any acknowledgment from a node then it assumes that node as a next forwarder and forwards the packet. If it does not receive any acknowledgment then it changes the distance D into 2D then construct a new bigger cone. And it will again send the control packets to the nodes present inside the transmitting cone. If it receives any acknowledgment it will forward the packet to that node, because of this no need for us to send the packets for all nodes. So the energy consumption of the overall network is improved. There will be two estimations available to update the details, the newly calculated estimation and the old estimation. To calculate the Q value the newly calculated estimation is subtracted by the old estimation. If a particular node found a path is the shortest path then it will update it in the Q value, then after finding some other path better than the current path then it consider itself as the newly estimated value then it will reduce from the old value and will update the Q value. Energy efficient routing protocol [10] is a technique in which all the sensor devices are fixed in the bottom of the ocean with floating buoy that can control the depth of the sensor. Because of this the movement of the node will be restricted.

And the protocol can only be used to the static nodes. The network is layered and sink is in the surface of the ocean. Nodes Calculate only communicate to the one in the neighbour layer which is the only issue in this. QELAR [11] is the protocol which operates by Q learning technique. In this the value is calculated for finding the next hop for forwarding. This Q value will be calculated by considering the residual energy of that node and also the successful delivery of that node. After calculating the Q value, which node has the highest Q value will be chosen as the next forwarder. Then that node will calculate the Q values for its forwarder and forward. If forwarding the packets to the next forwarder failed, it will retransmit the packet. There will be a max_trans

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value for each node. So before retransmitting it will decrement the max_trans value by 1. When the max_trans value becomes 0 the retransmission will be stopped and the second highest Q value node will be chosen and will be considered as the next forwarder.

III. PROBLEM DEFINITION

The main issue in the underwater sensor networks is the energy consumption. To reduce this, there are many sleep wake mechanisms, but residual energy of the node is not balanced in those mechanisms. Residual energy is an amount of energy available in each node. If we follow the shortest path algorithm the amount of energy consumed will be reduced, but still there is a major issue in that, the nodes which comes in between the shortest path will be used more frequently. The balancing of the residual energy will leads to longer lifetime of the sensor network. So while finding the next forwarder the sensor node considers only the residual energy, because of that the lifetime of the sensor network is increased but the packet drop ratio will be high. If a node contains high residual energy all the packets will be sent to it, so it contains many packet in its buffer, because of this the buffer overflow will happen. When the buffer of the node is full then the dropping of the packets will be done, that will increase the transmission rate of the network. And the retransmission will consume high energy.

IV. PAPER OVERVIEW AND CONTRIBUTION

Extending the life time of the sensor networks not only depends on the energy of the network, but also it depends on the retransmission of the packet. The residual energy of the network but also it depends on the number of retransmission since the energy consumption is high while retransmitting. The technique used for identifying the optimized path is reinforcement technique. In our simulations, for typical marine science applications where the maximum velocity of nodes driven by water is 2-3 knots (1-1.5 m/s) [10], QELAR is able to achieve high energy efficiency and long lifetime.

A. Reinforcement Technique

The reinforcement learning is a one using that the system can learn automatically [2] based on the events done and the experiments. The reinforcement learning satisfy the markov property is called Markov Decision Process (MDP). In this the *tuple (S,A,P,R)* are used, In which S for State, A for Action, P for transmission probability and R for rewards.

In this the Action selection is used to select the action which has to be done in the environment. State sensing is used to sense the changes occurred in the environment for the respective action done. Then the policy improving is used to optimize the action which has to be done by for action state depending upon the environmental patterns sensed by the sensing state.

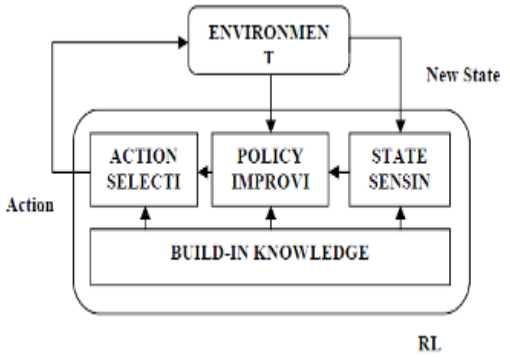

Figure 2. An example of model based Q-value

Figure 2 shows the Q-Learning technique model. Build-in-knowledge will be connected to all three sections and will administrate it's working.

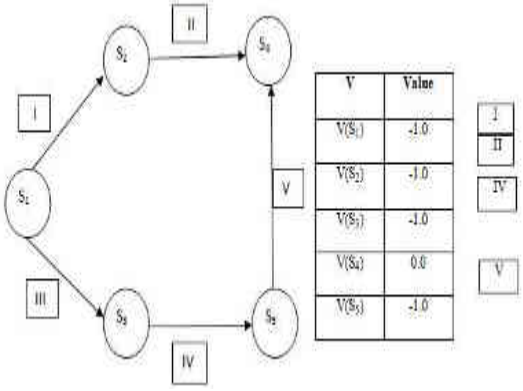

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Figure 3. An example of model based Q-value

Initially the *V value* of all the nodes is set to -1.0 which is one hop away from the source as shown in figure 3. After that packet is forwarded to its neighbour node[11], because of that residual energy of that node will be reduced. Again the *V value* is calculated since the residual energy will be reduced the new *V value* will also be reduced. The source will choose some other node as the next forwarder, so all the nodes will participate in the forwarding equally. Because of this the lifetime of the network increases. And the ranking systems are explained in combined cluster based ranking protocol [12].
To do this there are two types of process they are,

- Aware Reward Function
- Transmission Failure

1) Aware Reward Function

By using Q-learning Learning Technique each node will calculate *V value* for its neighbors, which will considers the residual energy, hop count, distance and the buffer size of the next forwarder. In this if the buffer size increases the *V value* are also increases. By using reward function and this *v value* each node will elect its next forwarding candidate to make lifetime extended routing[10].
In this to calculate the V Valve is calculated. E_f denotes the Free Energy, E_t denotes the total battery capacity. B_f denotes the free buffer size and B_t denotes the total buffer size. Thus the V value is the optimized value of the free buffer space and the available residual energy.

2) Transmission Failure

All the nodes are listening to the traffic. One node can get to know whether a packet is successfully delivered to other nodes or not by analyzing the outgoing traffic of the receiver node. After a node sends a packet, it stores the packet in the memory rather than removes it from the buffer immediately. If the next forwarders (not the destination node) successfully receive the packet, they will forward the packet further along the next hop, and the returning packet heard by the previous forwarder will be taken as an acknowledgment.
The main reason behind the dropping of the packets is due to less available buffer size. To minimize the dropping of the packets the next hop should be chosen such a way that the node should have enough buffer size to handle the packet. While calculating the value for finding the next hop this buffer size parameter is also added so that the dropping of the packets will be reduced. Then we choose the node containing the highest value as a next hop, the residual energy is balanced and thedropping of the packet and the retransmission is reduced so that the energy consumption is reduced.

V CONCLUSION

In the existing system the residual energy is considered for finding the next hop, So that the average energy of the node will be increased. And the life time of the network is increased. In this dissertation we proposed a method through which the dropping of the packets are reduced because for forwarding based of the buffer space. Since we forward the packets to the node which contains enough buffer space the node doesn't need any retransmission. So the energy consumption will be very low.

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