Grid based Fuzzy Optimized Routing Protocol for Underwater Sensor Networks

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ABSTRACT
In Underwater Sensor Network (UWSNs) there are several problems with limited bandwidth, long propagation delay, low battery power, location problems because of having adverse environment. In Grid Based Fuzzy Optimized (GBFO) routing protocol the whole network is divided by different virtual grids. Then energy estimation of an active node with in a grid has been performed. After making sequence of active nodes, only one node is in active mode and remaining nodes will perform as sleeping node. Having multiple characteristics and packet forwarding among active nodes in fuzzy optimized active node selection phase the activeness ratio takes into account the eligible neighbor's based on link expiration time, Number of packets within a node. Active node will select from fuzzy. It will compensate loss energy of networks. Provides facilities where a node can communicate with centroid infrastructure.

Keywords
UWSNs, Activeness Ratio, GBFO, FIS

1. INTRODUCTION
Underwater sensor network (UWSNs) has been appeared as a new dimension that helps in investigating the vast area under of water and provides vital information to the surface. Consist of a variable number of sensor nodes that are deployed to perform collaborative monitoring tasks over a given area. Sensor nodes are tiny devices can sense their residing environment in various activities and communicate between themselves. With the significant progress in wireless sensor networks and upsurge in marine economic development, underwater sensors networks (UWSNs), characterized by low cost and high reliability. Our main concern is to build up a routing protocol for UWSNs that will help us to send packets from source to destination facing the challenges of underwater sensor networks. For saving energy we used unicast routing technique [1, 2]. For better performance we have design such kind of routing technique. Total network is divided into different three dimensional grids. Only one node with in a grid is selected as an Active Node, remaining nodes will in sleeping mode having their Activeness sequence. When Active node will get go to sleep message from the next sequenced node then it will go to sleep mode and next sequenced node will be Active Node. Node forwarding phase -active node from one cell will forward packets to the upper grid's active node.

2. ROUTING PROTOCOL FOR UWSNS
Routing protocols are regarded as an indictment of determining and preserving the routes. Most of the research works pertaining to underwater sensor networks have been on the issues related to the physical layer. On the other hand, routing techniques are a comparatively new arena of the network layer of UWSNs [3]. Thus, providing an efficient routing algorithm becomes a significant mission. Although underwater acoustic network has continued to be studied for decades, underwater networking and routing protocols are still at the infant stage of research. We have studied some routing protocols to shape our own routing protocol.

2.1 The Geographic Adaptive Fidelity (GAF)
- Energy-aware unicast location-based routing protocol
- Is primarily designed for networks with mobile nodes. The network region is divided into a virtual grid.

2.2 Sector-based Routing
- In sector-based routing with destination location prediction, a node knows its own location and predicts the location of the destination node where the precise knowledge of the destination's location is relaxed by it.
- The sender determines its next hop using information received from the candidate nodes. It eliminates the problem of having multiple nodes acting as relay nodes.
- It does not require rebroadcasting the request to send (RTS) every time it cannot find a candidate node within its transmitting range.

2.3 Fuzzy Logic Optimized Vector Protocol
- Use 3D architecture
- Degrade the average end to end delay occurs at vector based forwarding

2.4 Focused Beam Routing Protocol
- At draw an imaginary line from source to destination node.
- There is a finite number of increasing power levels, P1 through Pn.
- No dynamic angle for drawing beam at each stage.
- Use RTS and CTS procedure.

2.5 Optimizing Energy based Routing
- Use parabola to transmit packets from source to destination.
- Best suited node is selected at each time to forward, to optimize energy.

- Hop by hop acknowledgement process has been devised.
- Use probability for forwarding with respect to energy
- Use Request, response, acknowledgement.
- Link expiration time between two nodes

2.6 Energy Efficient and Depth based Routing

- Only the depth is used for routing process
- Balance overall energy consumption ,increase overall network life time
- Residual energy of nodes considered in the routing calculation.

2.7 In H2-DAB Routing Protocol

Sink node broadcasts a hello packet, and the sensor node that receives the packet is assigned a Hop ID by incrementing the Hop ID existing in the hello packet of sink node. The packet-receiving node broadcasts the hello packet after updating the Hop ID of the received hello packet. In this way, to forward a packet, this protocol utilizes only the hop count which is not a good indicator to forward packet because UWSN is an energy-constrained network. It does not guarantee the network living time because the same node can be chosen again and again to transfer a packet.

3. PROPOSED ROUTING PROTOCOL

In this part we present our Grid Based Fuzzy Optimized (GBFO) Routing Protocol in detail

3.1 Underwater Network Architecture

Here the total 3D network area of underwater is at first divided into many virtual grids. Like DBR it also take the advantages of the multiple –sink underwater sensor network architecture. An example of such network is shown in figure 1. In this grid based Multiple-sink underwater sensor network architecture, the water surface nodes of different grids that are called sink nodes are equipped with the modem that is capable of capturing both radio frequency and acoustic signal. The nodes that send receive only acoustic signals are deployed in the underwater environment. Underwater sensor nodes with acoustic modems are placed in the interested 3D grid, and each one of such nodes is assumed likely to be a data source. They can collect data and also help relay data to the sinks. Since all the sinks have radio frequency (RF) modems, they can communicate with each other very efficiently via radio channels. Hence, if a data packet arrives at any sink, we assume it can be delivered to other sinks or remote data centers efficiently. This assumption can be easily validated by the fact that sound propagates (at a speed of 1.5×103 m/s in water) five orders of magnitudes slower than radio (with a propagation speed of 3×108 m/s in air).

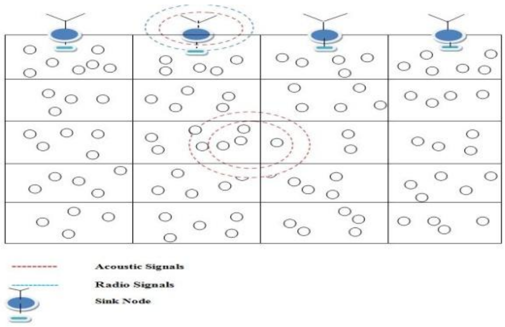


Fig.1 Grid based multiple-sink underwater sensor network architecture.

3.2 Overview of the GBFO Routing Protocol

Our proposed GBFO routing protocol is divided into several phases named as active node, active node selection phase, Link expiration time measurement phase, no. of packets measurement of phase, fuzzification of link expiration time and no. of packets phase, sequence of nodes according to their activeness ratio measurement phase and packets forwarding phase.

3.2.1 Active Node

Only one node with in a grid is selected as an active node according to activeness ratio. The other remaining nodes will in sleeping mode having their Activeness sequence. At a time there is only one active node of each grid.

3.2.2 Active Node Selection Phase

At first we have to determine the residual energy of each reliable node of each grid. Then we can measure the no packets that a node can forward. For active node selection it is needed to complete the determination of no of packets measurement phase, link expiration time measurement phase and fuzzification of link expiration time and no. of packets phase.

3.3 Algorithm for Active of GBFO Protocol Node Selection

```
Initialize j, temp ← True
while(true)
  loop j<NoOfNode
    if ActRatio [j-1] < ActRatio [j] then
        temp ← ActRatio [j-1]
        ActRatio [j-1] ← ActRatio [j]
        ActRatio [j] ← temp
    end if
    J ← j+1
  end loop
end while
return Sequence of ActRatio
```

3.4 Illustration the Number of Packets Of Each Node

Actually no. of packets of each node is generated on their residual energy. The no. of packets of each node can be illustrated as follows:-

Total Energy of a node N1,

ET(N1)=ET(N1)-[Ep (N1)+Ea];

Here Ep =Energy Cost Per Packet Send/Receive

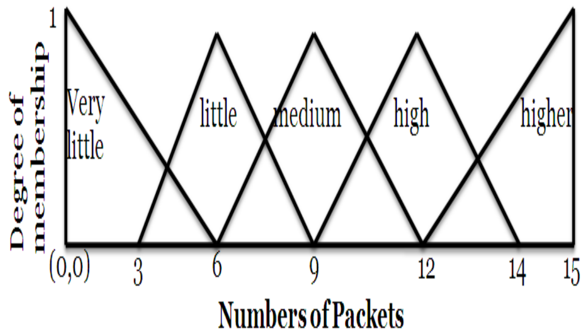
Ea =Energy Cost Per Hour Activation

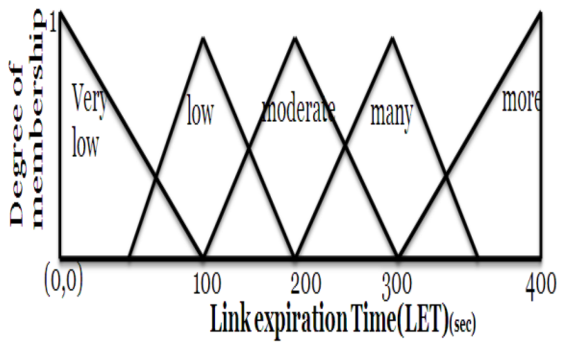
3.5 Fuzzification

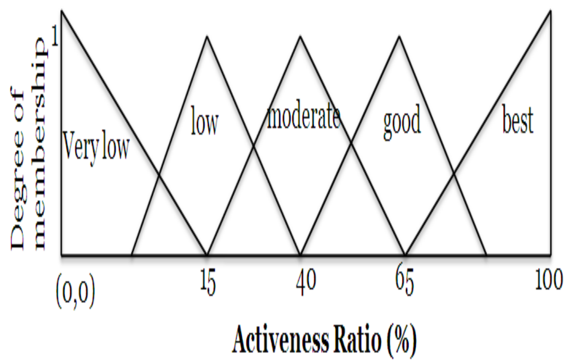
We choose fuzzy logic to get more reliable Activeness Ratio of different nodes that helps in selection of active node from the activeness sequence.

Link Expiration Time (LET), Number of packets (NOP) of a node is used to measure activeness ratio of each node.

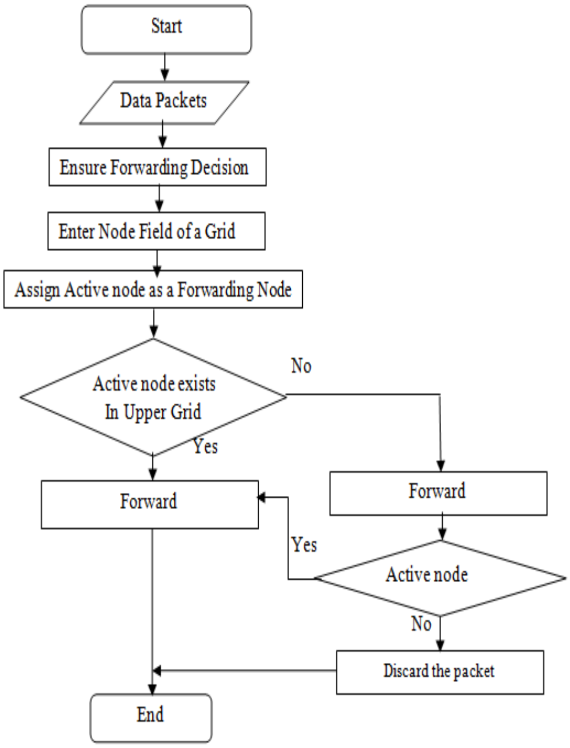
The input and output variables are mapped into fuzzy sets using appropriate membership function. Membership functions are







3.6 Flow Chart for Packet Forwarding Technique of GBFOR Protocol



4. RESULTS AND DISCUSSION

4.1 Summary of Simulation with Fuzzy Inference System

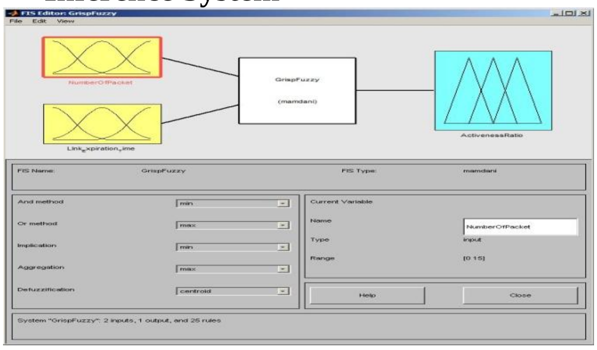


Fig. 2 Fuzzy Inference System

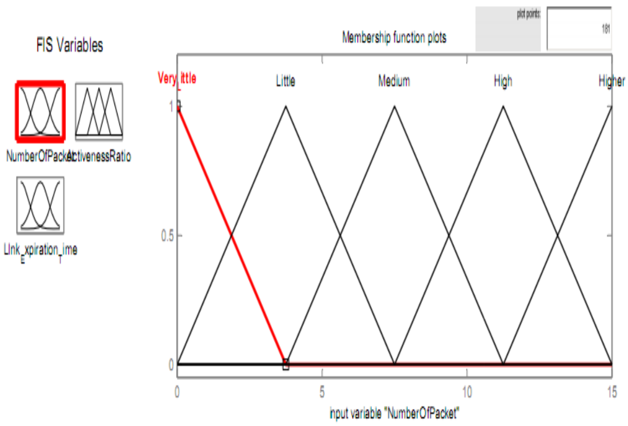


Fig.3. Fuzzy Inference System Input (NOP)

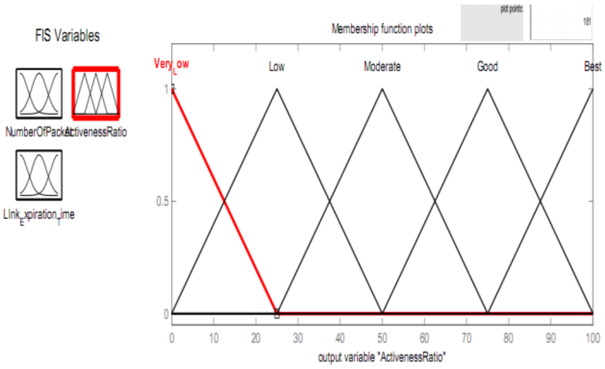
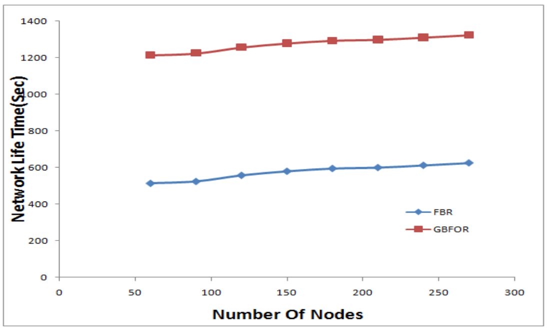


Fig.4. Fuzzy Inference System Input (LEP)

4.2 Performance Metrics

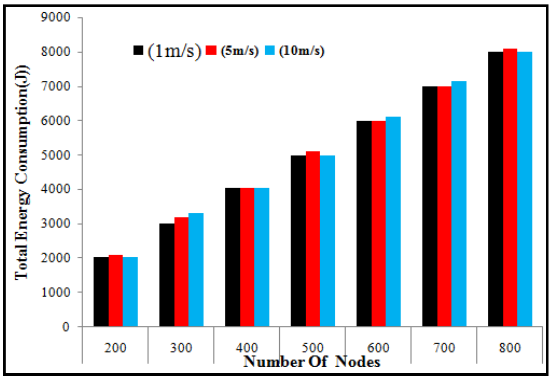
The following metrics are indicated to get the performance of the proposed routing protocol.

4.2.1 Network Life Time

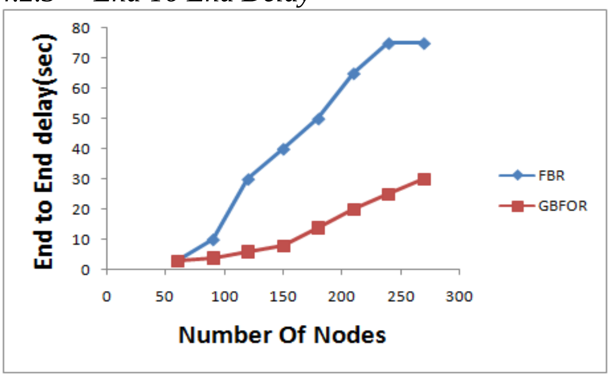


4.2.2 Total Energy Consumption

Input: Link Expiration Time



4.2.3 End To End Delay



5. CONCLUSION AND FUTURE PLAN

GBFOR protocol has been designed keeping in mind the challenges involved in energy consumptions and REQ, RES procedure in underwater conditions. As fuzzy optimized easy to work with different quality nodes and network life time high. The protocol guarantees that the maximum level of network life time and end-to-end delay. There different ways to adopt detour mechanism to avoid the void of zone and to develop better mobility handle method. In future work involves several refinements and extensions, as well as validation of the system performance in different scenarios. In particular, issues which should be considered are additional cost metrics in the candidate selection process.

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