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A Dynamic Programming Approach for Route Formation in Unstable Underwater Sensor Network

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Abstract: The communication is more challenging in underwater sensor network than any other network form. The floating mobility and the restricted node energy increasing the communication challenge for the network. In this work, a dynamic programming based model has been defined to generate the route over the network. In this work, the network is divided in smaller zones and the zone level evaluation is performed to identify the node with higher energy and lesser communication fault. The dynamic programming method is applied on these zone nodes to generate the route over the network. Further, the obtained results has been compared with existing energy adaptive routing approach and found that the method has improved the network life and communication.
Keywords: UWSN, Dynamic Programming, Architecture, Communication, Zones.

Introduction

Underwater sensor network is one of recent and the challenging sensor network in which nodes are present in the water area. These sensor nodes can be either floating on the surface or placed at fixed position in the water. Each phenomenon of network generation, communication, mobility etc. is slightly different for underwater sensor network. The environmental and the geographical constraints to this network form is considerably more challenging. As the real time network, it is used for the specialized applications such as nuclear leakage detection, oil leakage identification, water pollution evaluation etc. The geographical area to the underwater sensor network can be as smaller as a pond and can be as large as the ocean [1-2, 4-5, 6-7]. The basic geographical architecture is shown in Figure 1.

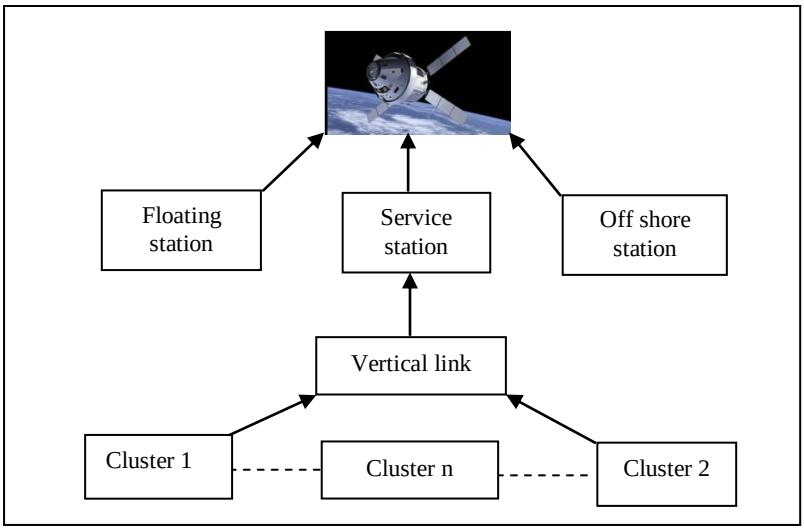

Figure 1. : Framework of underwater sensor network

The Figure 1 is showing all the components or elements related to the network are shown in the figure. The figure is showing the network composed on ocean. The smallest units of the network are the sensing devices which are present in the water area. Each group of sensor nodes present in a region are connected to the controller node called cluster head. The floating stations or the controllers are present on the surface to capture the signals from these sensing devices. At the higher level, the network is connected to the base station or the satellite for communicating to the rest of world [1-3, 7-9, 17]. The arrows are showing the communication performed between all the network components.

One of the critical challenges to underwater sensor network is the absence of the node tracking through GPS system. The location or the coverage specific method is required for tracking the region nodes and to provide the communication to the region nodes. The sensor nodes are intelligent and defined specific to the role. The nodes in the sensor network can be configured under the defined architecture. The positional updation and the topological configuration can be updated regularly based on the functional and the application specific requirement. The connectivity specific observations can be performed to identify the failure nodes and to perform the communication through these failure nodes [4-7, 9].

In this paper, a dynamic programming based effective zone node mapping method is defined to generate the effective route for underwater sensor network. The fault and energy adaptive decision parameters are considered to generate the communication route. In this section, the basic architecture of underwater sensor network is defined along with relative network components or elements. The network challenges are also discussed in this section. In section II, the work defined by earlier investigators has been discussed. In section III, the proposed research methodology has been presented. In section IV, the obtained results has been presented and discussed. In section V, the conclusion of the present work has been provided.

Related Work

Underwater sensor network is the critical network form in which lot of work is already provided to generate the communication route, observe the network configuration and to utilize the network features. In this section, the algorithmic approach or methods provided by the researchers to improve the network communication and routing are discussed. Author [1] has defined distributed sensing based method to utilize the network resources and to generate the effective network path. The author used the spectrum specific network features and to observe the switching communication between the nodes. The level specific assumptions were analyzed by the author to formulate the network path. The conditional observation and the schematic routing were provided in this work. Author [2] has used the energy based node processing method to identify the potential features of each sensor node. The environment specific observations are taken to improve the communication in sensor network. The protocol level improvement was provided to increase the communication throughput. Author [3] has provided a work to generate the energy adaptive routing method for underwater sensor network. The neighbor selection for hierarchical routing was provided to improve the operational strength of the network. The cluster framed network is defined where the cluster head is placed at the surface and the sensor nodes are defined in the water area. The energy adaptive assessment was provided on neighboring nodes to identify the next communicating hop. Author [4] also used the clustered communication method to utilize the network limitations and to provide the communication for the longer distance. The routing method is defined for the dense network and to improve the phase adaptive communication. The resource adaption under the TDMA is provided to generate the effective network architecture. Author [5] has used the game theory modeling to generate the trustful path over the network. The optimal cluster head selection and route formation for periodic trust modeling was defined by the author. The packet loss based observation was taken by the author for generating the safe communication against the malicious node attack.

Author [6] has used the energy adaptive model to utilize the network features and to provide the balanced communication in the network. The multi-assistant based communication method was defined by the author to utilize the features of cluster network. The inter-cluster and intra cluster based communication modeling is provided in this work. Author [7] has used the energy effective routing and scheduling for under water sensor network. The aggregative and the clustered protocols are implied in this work for network improvement. The structured chain formation with grid size and the energy adaption was provided in this work. The effective data transmission and node selection method is also provided in this work. Zone controller adaptive network communication with grid size and energy parameter specification is provided in this work. Author [8] has used the distance adaptive route formation so that the energy adaptive will be performed. The energy efficient routing is provided using automata integration to the network. The performance adaptive route formation is provided in this work. Author [9] has used the compressive and balanced routing for spatial measure and for physical quantities of the network. The environmental features were used in the algorithmic model to generate the communication matrix. The mathematical rule specific route formation is defined to optimize the communication link between the node pair. Author [10] has used the dynamic adaptive method for level specific route selection. The priority driven scheduling and routing method is provided in this work to analyze the communication variation and route formation. The method is defined to adjust the operational communication and route formation in the adaptive network. The reactive routing method was defined with energy specific adaption to improve the quality of sensor network. Author [11] has defined a heuristic communication method to improve the communication throughput for under water sensor network. The global network is defined to resource utilization and route adaption using A* algorithm to generate the physical characterization based route. Based on this evaluation, the route is generated and the communication is optimized in this network.

Author [12] has improved the multihop communication in sensor network by enabling the distance and energy mapping. The work is defined homogenous network to apply the relative scheduling under TDMA

vector. The signal strength observation was performed to identify the effective path node for the sensor network. Author [13] has used the latency and energy based communication in the sensor network. The communication parameter based analysis was defined to identify the node with lesser delay and maximum throughput. The method is applied on real time network to improve the network communication. Author [14] has used the data collection method under energy value consideration. The network parameters such as density, residual energy and depth are considered by the author to improve the network life. The node level validation is defined for potential usage of sensor network. The coverage ratio adaptive balanced network is defined for network life and communication optimization for underwater sensor network. Author [15] has used the geographical routing for sensor network under channel level consideration. The protocol level derivation and the energy adaptive evaluation were provided to achieve the maximum utilization of the network. Author [16] has used the backbone tree method for optimization of the communication for clustered sensor network. The routing method is defined to utilize the node request and to improve the network communication.

Author [18] has proposed a reliable routing protocol to analyze the network structure and energy parameter to optimize the network communication. The structural analysis was defined to observe the communication and physical characteristics to perform effective election of next node. Author [19] has achieved the balanced energy based routing using the circular field division. The directional analysis was defined on the distributed communication to optimize the network communication. Author [20] has proposed a delay sensitive and environmental condition based distributed communication in underwater sensor network. The mobility analysis was defined to track the nodes and to adapt the communication impact on the network. Author [21] analyzed the mobility pattern to provide the cooperative communication in underwater sensor network.

Research Methodology

The underwater sensor network is more critical and challenging form of sensor networks. The major challenge of this network is the floating sensor devices in the network. As the GPS not work in such situations so there is a requirement of more adaptive method to track the sensor devices. The sensor devices are more intelligent and capable of storing neighbor information and to take the routing decisions. The routing and the communication in this network are one of the critical challenges as the route change dynamically as the node positions modify. In this present work, an intelligent zone adaptive and stability preserved method is presented to generate the aggregative route in underwater sensor network. The work will be divided into three main stages. On first stages, the network observation will be done under stability and the density criteria. Based on these criteria, the network will be divided to the N regional zones. In second stage, the route formation in individual zone will be done using dynamic programming approach. In final stage, the route from each zone will be combined to generate the aggregative route. The presented work will be implemented in MATLAB environment. The work is here defined to optimize the network communication and network life.

In this present work, an improved model is defined to optimize the communication in underwater sensor network. The work will be defined as the three stage model to perform the analysis and to generate the optimize communication. The work stages associated to the work are given below in Figure 2.

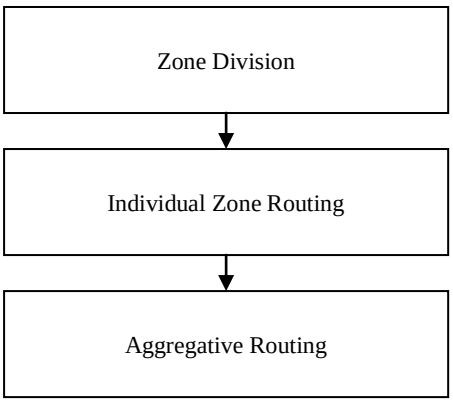

Figure 2. : Present Work

In this present work, a three stage model is presented to improve the communication in underwater sensor network.

A. Zone Division :

In this division, the network will be divided in smaller zones based on the stability and the connectivity parameters. The zones will divide the network in sub regions under geographical observations.

B. Individual Zone Routing :

At this stage, the individual zones will be processed separately and in parallel to generate the effective route. The dynamic programming based back analysis method will be defined to generate the route for individual region.

C. Aggregative Routing :

At the final stage, the aggregative route formation will be done between these zones to generate the communication over the network.

Results

In this work, a dynamic programming adaptive zone adaption method is provided for route formation in underwater sensor network. The work simulated on a random network with floating node movement. The network nodes are energy nodes and defined in the fixed geographical area. The evaluation of the work is done in terms of number of alive nodes after communication and the packet communication in the network.

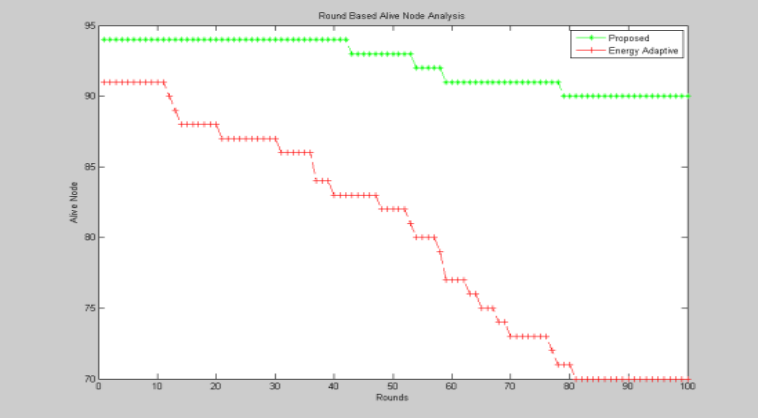

Figure 3. Alive Node Analysis

Figure 3 is showing the number of alive nodes in the network in case of energy adaptive and proposed approach. The figure shows that the numbers of alive nodes in case of proposed approach are much more than energy adaptive approach. It shows that the proposed model has improved the network life.

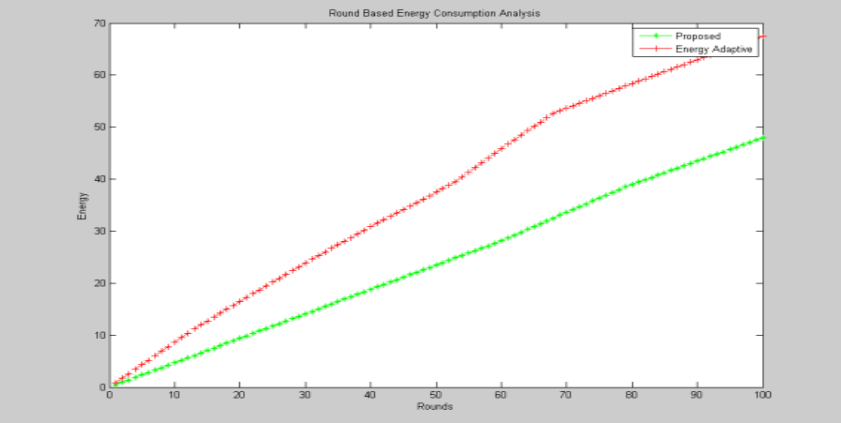

Figure 4. : Energy Consumption

Figure 4 is showing the energy consumption based comparative analysis between the energy adaptive and proposed approaches. The Figure shows that the energy consumption in case of energy adaptive approach is much higher than proposed approach. The proposed dynamic programming has reduced the energy consumption and improved the network life.

Conclusion

In this paper, a dynamic programming based and zone adaptive routing method is defined for underwater sensor network. The model is defined to utilize the network resources where the restricted coverage range is available for the network. The results show that the method has improved the network life and reduced the energy consumption.

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