An Improved Clustering Approach in UWSN to improve Network Life

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***Abstract*— A sensor network is the distributed network splitted in number of clusters. The major concern in this network architecture is the decision about the cluster formation as well as the selection of cluster head over the clustered nodes. The effective cluster head selection results the improved network life as well as the communication. In fixed networks this kind of decision can be taken easily by implementing the standard clustering protocol, But in case of Underwater sensor network it is also to manage the network localization and the movement of nodes over the network. In this paper, the idea is presented for a new clustering approach so that network reliability will be improved.**

***Keywords*— UWSN, Clustering, Localization, Mobility, Network Life**

I. INTRODUCTION

Underwater Wireless Sensor Networks is one of the emerging field of wireless technology that is been extensively developed in last few years. It defines the new application areas to setup a underwater network to perform the monitoring, communication by using the fixed or the mobile sensors. These kind of network also having their own responsibilities, advantages as well as the drawbacks. The architecture followed for a normal sensor network is not completely adaptive to the underwater sensor network because of the new major dissimilarities between these kind of network. In such networks basically the expensive smart sensors are used. These smart sensors are having the ability to keep the information about the neighbouring nodes. It means these smart sensors are having the memory as well as some times small processing device. The energy parameters of these networks are defined in same way as of the normal sensor network.

Now the main issue discussed here is the clustering process. Besides, the connectivity of every sensor to a CH has to be ensured at any time. Furthermore, for data to be routed from any CH to the PN (Processing Node), all CHs have to belong to a single connected graph. Hence, for sensors' states allocation to be optimal, coverage, connectivity of sensors to CHs, and routing has to be taken into account within the same global planning process.

Besides achieving energy efficiency, clustering reduces channel contention and packet collisions, resulting in better network throughput under high load.

Generally, energy conservation is dealt with on four different levels:

1. Efficient scheduling of sensor states to alternate between sleep and active modes;
2. Energy-efficient routing, clustering, and data aggregation;
3. Efficient control of transmission power to ensure an optimal trade-off between energy consumption and connectivity;
4. Data compression (source coding) to reduce the amount of uselessly transmitted data

The scope of this paper includes both the first and the second levels. We address the global problem of maximizing network lifetime under the joint clustering, routing, and Coverage constraint.

II. BACKGROUND

The clustering is one of major research concern in case of sensor networks. There are number of existing protocols that works on clustered architecture. One of such common protocol is LEACH. The lean protocol works for the multicast as well as broadcast networks. In case of clustered network, there are number of communication areas covered by different authors such as cluster formation, inter cluster communication, intra cluster communication, data aggregation etc. In this section the work done by the earlier research in the same area is presented. In this work, the leach protocol architecture is been presented.

The leach protocol is developed by Dr. Wendi Rabnir in 2002. The author uses a clustering function for the energy balancing and decreases the communication cost over the network. The work performed by leach is divided into rounds and every sensor node gives the self election of the cluster node. The basic features of Leach protocol are given as under

- Self Configuring Clustering
- Localization of nodes and the intelligent communication
- Low Energy Communication and data access
- Application Specific Data Processing

The leach provides the adaptive clustering approach for the sensor network for the cluster formation and it is responsible for the cluster formation and the inter cluster communication over the network. It can work on frequency division as well as time division based scheduling to perform the aggregative communication over the network. The system defines a base station to perform the communication and support the concept of CDMA for providing the required data.

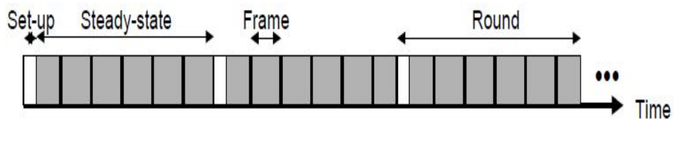

Fig 1: LEACH protocol Phases

The architecture of the Leach Protocol undergoes to the number of stages.

A. Setup Phase

In the next cluster setup phase, the member nodes inform the Cluster Head that they become a member to that cluster with "join packet" contains their IDs using CSMA. After the cluster-setup sub phase, the Cluster-Head knows the number of member nodes and their IDs. Based on all messages received within the cluster, the Cluster-Head creates a TDMA schedule, pick a CSMA code randomly, and broadcast the TDMA table to cluster members. After that steady-state phase begins. [Kay Romer and Friedemann Mattern, Eth Zurich (2000)] [Hiren Kumar Deva Sarma and Avijit Kar (2002)][M. Ibrahim Channa and Irum Memon(2001)][Michael O'Rourke (2012]

B. Steady State

In this phase data transmission begins. Nodes send their data during their allocated TDMA slot to the Cluster-Head. This transmission uses a minimal amount of energy (chosen based on the received strength of the Cluster-Head advertisement). The radio of each non-Cluster-Head node can be turned off until the nodes allocated TDMA slot, thus minimizing energy dissipation in these nodes. When all the data has been received, the Cluster-Head aggregate these data and send it to the BS [Kay Romer and Friedemann Mattern, Eth Zurich (2000)]. Here fig 2. is hsowing the basic clustering algorithm.

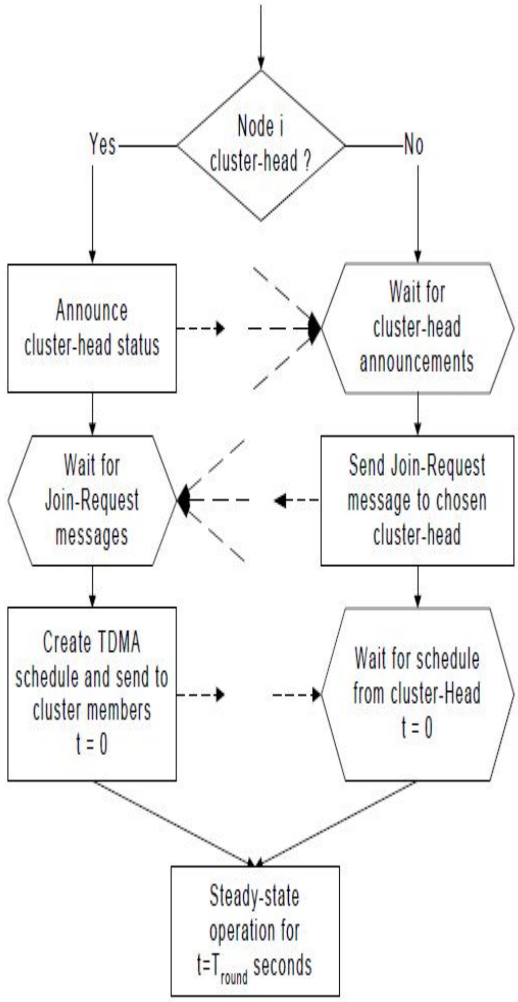

Fig 2: Clustering Algorithm [7]

III. RESEARCH METHODOLOGY

A The nodes in the sensor network could be the Next Node with certain probability and the network load is balanced, because of the Next Node randomly being selected by the LEACH clustering algorithm. In addition, there is no center node to control and coordinate the selection of Next Node, and each node decides whether to be the Next Node itself, therefore the LEACH can choose the Next Node with distributed and self-adaptive manner.

During the term of selecting Next Node, the node generates a random number range from 0 to 1, and the system generates a random threshold T (n) at the same time. If the random number is smaller than the T (n), it could be the Next Node. Then the node broadcasts that it is a Next Node now. To ensure that the node which already been the Next Node could not be the Next Node again in one round, the value of T(n) for the node will be set as 0. Otherwise the node can participate in the selection of Next Node with the probability of p, the p represents the percentage of Next Nodes in the sensor network each round. With the number of selected nodes as Next Node increasing, the threshold value T (n) of the nodes which are never being selected is also rising up. Therefore the probability of nodes generating random number is smaller than T (n) is increasing. That means the excess nodes have higher probability to be the Next Node.

However when the value of T (n) is 1, it indicates that the nodes must be the Next Node. Node which has been selected as Next Node will broadcast a message that it becomes the Next Node in this round. Then other nodes not being Next Node now can collect the information of each Next Node. According to the intensity of each Next Node's signal, one node can join the cluster which has the lowest cost to be communicated.

A. Algorithm

LEACH has two phases: the set-up and steady-state. In the set-up phase, the cluster-heads are chosen "stochastically", which is randomly based on an algorithm. A threshold is determined based on this algorithm.

- Initialize all the parameters.
- Cluster head selection:-A sensor node chooses a random number,r between 0 and 1. If this random number is less than a threshold value, T(n), the node becomes a clusterhead for the current round. This threshold value is calculated using :-

$$T(n) = \begin{cases} p\dfrac{p}{\left(1-p\left(r \bmod \left(\frac{1}{p}\right)\right)\right)} & , \quad n \in G \\ 0, & \text{otherwise} \end{cases}$$

  Where,
  p = predetermined fraction of nodes that elect themselves as CHs.
  G = The set of nodes that have not been selected as a cluster-head in the last (1/P) rounds.
  r = number of current round.

- Formation of the cluster:-calculate the distance between the cluster head and the sensor node, which have the shortest distance that node join that cluster. The second parameter is the energy and third parameter is residual Energy. As a cluster head will be selected with minimum distance and maximum energy. We will also select the Vice Cluster Head. The Vice Cluster head is that alternate head that will work only when the cluster head will die.
- Now CH receives data from Non-CH nodes and aggregates them. And send to the BS. If the distance between the CH and the BS is more than here we used multi-hopping concept, acc to this if the distance between the CH and the BS is more than one CH send data to the other CH which is more closer to the BS.
- Now energy dissipated is calculated and subtracted from the remaining energy of every node and if some nodes are having energy less than minimum than those nodes are deleted from the network and the life time close .and we get the output. Hence this round will be completed.
- If the Energy (ClusterHead) <=0 then we set the ClusterHead=Second ClusterHead. And also find the next vice cluster head as the next option.
- The process of cluster head selection criteria is different. It is on the basis of three factors i.e. Minimum distance, maximum residual energy, and minimum distance. Based on received signal strength, each non-cluster head node determine its cluster head, greater the signal strength means shorter the distance between them and if distance is small then for the transmission less energy is required .
- The proposed approach will improve the network life as never the cluster head will die. As a cluster head will die it will be replaced by its vice Cluster head.

IV. CONCLUSIONS

In case of sensor networks energy efficiency is one of the main challenges in the design of protocols for WSNs. The ultimate objective behind the protocol design is to keep the sensors operating for as long as possible, thus extending the network lifetime. In this paper we have surveyed and summarized recent research works focused mainly on the energy efficient hierarchical cluster-based routing protocols for WSNs. As this is a broad area, this paper has covered only few sample of routing protocols. The protocols discussed in this paper have individual advantages and pitfalls. The proposed work will increase the network lifetime with some intelligent cluster selection approach.

REFERENCES

[1]. S. Madden, M.J. Franklin, J.M. Hellerstein, and W. Tag Hong, "A Tiny Aggregation Service for Ad-Hoc Sensor Networks" SIGOPS Opemting System Review 96, SI (December 2002), pp. 131-146.

[2]. G.J. Pottle, and W.J. Kaiser, "Embedding the Internet: Wireless Integrated Network Sensors" Communications of the ACM 43,5 [May 2000], pp. 51-58.

[3]. A. Depedri, A. Zanella, R. Verdone, An energy efficient protocol for wireless sensor networks, in: Autonomous Intelligent Networks and Systems (AINS 2003), Menlo Park, CA, June 30–July 1, 2003.
[4]. W. Heinzelman, Application-specific protocol architectures for wireless networks, Ph.D. thesis, Massachusetts Institute of Technology, 2000.
[5]. W. R. Heinzelman, A. P. Chandrakasan, H. Balakrishnan, An application-specific protocol architecture for wireless microsensor networks, IEEE Transactions on Wireless Communications 1 (4), pp. 660–670, 2002.
[6]. G. Smaragdakis, I. Matta, A. Bestavros, SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks, in: Second International Workshop on Sensor and Actor Network Protocols and Applications (SANPA 2004), 2004.
[7]. Q. Li, Z. Qingxin, and W. Mingwen, "Design of a distributed energy efficient clustering algorithm for heterogeneous wireless sensor networks," Computer Communications, vol. 29, pp. 2230-7, 2006.
[8]. M. Veyseh, B. Wei, and N. F. Mir, "An information management protocol to control routing and clustering in sensor networks," Journal of Computing and Information Technology, vol. 13, pp. 53-68, 2005.
[9]. S. Lindsey, C. Raghavendra, K.M. Sivalingam, Data gathering algorithms in sensor networks using energy metrics, IEEE Transactions on Parallel and Distributed Systems, vol. 13 (9), pp. 924–935, 2002.
[10]. H.O. Tan, I. Korpeoglu, Power efficient data gathering and aggregation in wireless sensor networks, Issue on Sensor Network Technology, ACM SIGMOD Record, Vol. 32, No. 4, pp. 66–71, 2003.
[11]. A. Manjeshwar, Q-A. Zeng, D. P. Agarwal, “An Analytical Model for Information Retrieval in Wireless Sensor Networks using Enhanced APTEEN Protocol”, IEEE Trans. Parallel and Distributed Systems, vol. 13, no. 12, pp. 1290-1302, Dec. 2002.
[12]. N. Thepvilojanapong, Y. Tobe and K. Sezaki, “HAR: Hierarchy-Based Anycast Routing Protocol for Wireless Sensor Networks,” Proc. IEEE Symposium on Applications and the Internet, Trento, Italy, pp. 204-212, 2005.
[13]. Y. H. Wang, C. H. Tsai and H. J. Mao, “HMRP: Hierarchy-Based Multipath Routing Protocol for Wireless Sensor Networks”, Tamkang Journal of Science and Engineering, Vol. 9, No 3, pp. 255-264, 2006.
[14]. Y. Yang, H.-H. Wu, H.-H. Chen, Short: Shortest hop routing tree for wireless sensor networks, in: Proceedings of IEEE ICC-2006, 2006.
[15]. O. Younis, S. Fahmy, Heed: A hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks, IEEE Transactions on Mobile Computing, vol. 3(4), pp. 366–379, 2004.
[16]. C. Y. Wen and W. A. Sethares, "Automatic decentralized clustering for wireless sensor networks," EURASIP Journal on Wireless Communications and Networking, vol. 2005, pp. 686-97, 2005.
[17]. C. Yongtao and H. Chen, "A distributed clustering algorithm with an adaptive backoff strategy for wireless sensor networks," IEICE Transactions on Communications, vol. E89-B, pp. 609-13, 2006.
[18]. C. Li, M. Ye, G. Chen, J. Wu, An energy-efficient unequal clustering mechanism for wireless sensor networks, in: Proceedings of the 2nd IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS’05), 2005.
[19]. S. Fang, S. M. Berber, A.K. Swain, “An Overhead Free Clustering Algorithm for Wireless Sensor Networks”, IEEE GLOBECOM-2007, pp. 1144-1148, 2007.