An Approach Which Maximize Network Lifetime and Provide Dynamic Coverage and Connectivity for Heterogeneous Wireless Sensor Networks

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Abstract

A Wireless Sensor Network (WSN) consists of distributed autonomous sensors to monitor physical or various environmental conditions. Wireless sensor network is a rapidly growing area for research. Coverage without connectivity is meaningless in wireless networks. Coverage and connectivity is considered as a measure of quality of service (QoS). In most of the existing work, coverage and connectivity is not provided efficiently for heterogeneous WSN. The existing method used in heterogeneous WSN to attain coverage and connectivity is static. These existing methods are not applicable for the dynamic environment of heterogeneous WSN. Coverage is not made with constraints. Energy consumption should be concentrated to maximize the network lifetime. To provide coverage and connectivity for the heterogeneous WSN, Grouping the sensors into cluster by the strategy of Dynamic Cluster Formation criteria and to identifying the minimum active set to provide k-coverage. Maximize lifetime by weighted mean method. To propose a dynamic relative neighborhood method for reachability to provide strong connectivity.

Keywords— Coverage, Connectivity, Network Lifetime, Clustering, Wireless Sensor Network.

I. INTRODUCTION

A wireless sensor network (WSN) is distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a sink (Figure 1) then to a main location.WSN applications are disaster relief operations, biodiversity mapping, intelligent buildings, machine surveillance, medicine and health care.

A wireless sensor network consists of a collection of wireless sensor nodes. These nodes will be very small in size. Battery present in the sensor supplies the power to sensor nodes with limited energy.

Coverage is important for a sensor network to maintain connectivity. Connectivity can be defined as the ability of the sensor nodes to sense the environment and share the information through the network to reach the data sink (Figure 1). One of themost active research fields in wireless sensor networks is that of coverage. Coverage is usually interpreted as how well a sensor network will monitor a quantity in a particular field of interest like temperature, pressure, sound, etc. Hence, Coverage is considered as a measure of quality of service.

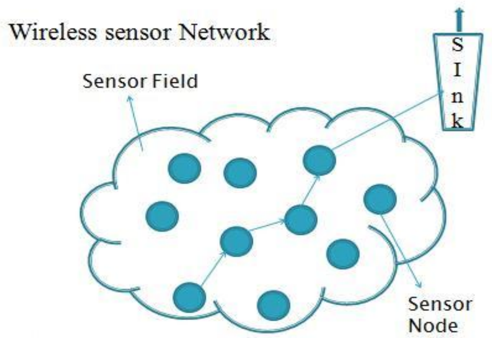

Fig 1 Wireless Sensor Network

Designing efficient algorithm becomes very important for extending the lifetime of sensor nodes and maximizing network coverage [1, 2]. Coverage is also one of the most important design goals in many applications of WSNs. A good coverage should minimize the overlap among the ranges of the clusters and cover all the sensors deployed within the monitored region [3]. WSNs are widely used in a variety of application scenarios such as surveillance and environment monitoring. In all these scenarios, a fundamental concern is the quality of sensing, which is often referred to as coverage and quantifies the collected information about the region of interest (ROI)[4]. The goal of maximizing the lifetime if a network is equivalent to finding the lowest possible transmission power levels for the nodes that suffice to make all of the network connected to the sink[5]. The existing methods for prolonging the lifetime of WSNs focus on the issues of device placements [6], data processing [7], routing [8] and topological management [9].

Only few works focus on coverage issues in WSN. The paper is organized as follows: In chapter I, we address many of the issues that factor into how coverage is determined and guaranteed. In Chapter II, related work. In Chapter III, discuss the proposed work. In Chapter IV, deals with the methodologies used to maximize coverage, increase network lifetime and dynamic connectivity. In Chapter V, we discuss the observations made from the work. Finally in chapter six, we give the conclusion of this paper. At the end of the paper is a list of references.

II. RELATED WORKS

We summarize the related works regarding coverage, clustering and network lifetime maximization. Cluster heads are elected following a three way message exchange between each sensor and its neighbours [10]. In [11], the authors propose an addressing protocol for cluster-based sensor networks. To prevent collisions, the nodes within a cluster are assigned different local IDs. Global IDs are obtained by putting together the local IDs and the IDs of the cluster heads. However, this solution has a great increment in energy cost in case of large sensor networks. Our algorithm, in contrast, assigns local unique IDs to the nodes in each cluster, and does not have increased energy cost when the size of the network increases. In [12] the authors focus on network connectivity and do not properly consider coverage. They translate the connectivity conditions into differentiable constraints on individual node motions. In [13] Complete k-coverage of a field is provided. Configuration protocols to solve the problem of k-coverage. Relationship between the communication and sensing range. In [14] Energy aware algorithm for the selection of sensor, relay node. Shortest path algorithm is used for choosing the path. In [15] ABC Based Sensor Deployment. Schedule the sensor nodes to achieve network lifetime. Target coverage is provided. Maximized coverage not provided for heterogeneous type of network.

A method used in heterogeneous WSN to attain coverage and connectivity is static and not applied in the dynamic environment. Coverage not made with constraints. Problem in node connectivity due to failure of nodes without energy. Complexity in choosing the active node. Hence, it needs an efficient approach for coverage and connectivity in HWSN.

III. PROPOSED WORK

To provide efficient coverage and connectivity for the dynamic environment of heterogeneous WSN. Grouping the sensors into cluster by the strategy of Dynamic Cluster Formation criteria. Choosing the cluster head from the group of sensors. Identifying the minimum active set to provide k-coverage and maximize lifetime by weighted mean method. Minimal active set is identified to say which node should be active and which should be in sleep state. Weighted mean method dynamically identify the active set by few criteria. This will change the cluster head of the cluster with respect to power. To propose a dynamic relative neighborhood method for reachability to provide strong connectivity. (FIGURE 2)

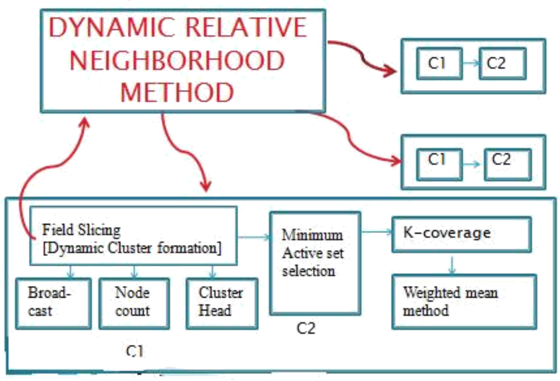

Fig 2 System Architecture

Maximized coverage and connectivity provided for the Heterogeneous WSN. Lifetime of sensor node should be maximized by energy consumption. Coverage and Connectivity is applied in the dynamic environment by the proposed methodology. Sensor field should be covered with minimum active set.

IV. METHODOLOGY

- Field Slicing

The sensor nodes are scattered randomly in a field region of interest. Clustering is a key technique used to extend the lifetime of a sensor network by reducing energy consumption. The node in the network makes decision independently. Clustering is completely distributed. Each node only interacts with a small set of sensor nodes within the transmission range. Field Slicing Splits the Field into small small regions. Sensor network can be made scalable by Dynamic Cluster Formation

- Dynamic Cluster Formation

At the beginning all the nodes are unclustered. We define different messages to be used in clustering process like update message, state message and join message.

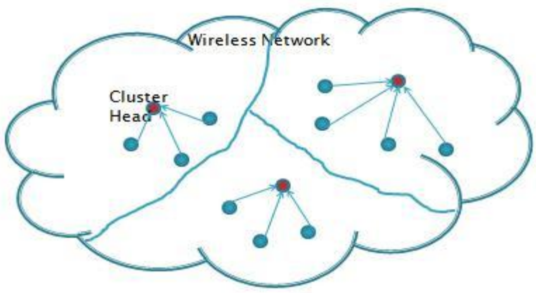

Fig 3 Dynamic Cluster Formation

Initially, all the nodes are awake. After receiving an initialization command from the base station, each node broadcasts an update message to all its neighbours at time Tm to indicate its existence (FIGURE 3). Every node calculates its nodecount (FIGURE 2) according to the number of received update messages. Sends nodecount message to neighbour between Tm and Tm+Ts, Ts is the delay time of the node.

$$Ts = Ce^{1/nodecount} \quad ,C\text{-Constant}$$

Each node has to wait for the expiration of its delay time before deciding whether or not it should declare itself as a cluster head. If during the delay time a node does not here a cluster head message from any other node whose nodecount is larger than its own, then, upon the expiration of its delay time it will announce itself as a cluster head (FIGURE 3). Thus, at the end of this cluster will be formed and cluster head will be identified.

- Minimum active set selection

Coverage efficiency depends on the number of active nodes. Constructing a connected sensor K-cover, wherein each point in the region is covered by at least K active sensors. The active nodes must guarantee the sensor field is k-covered. Minimum active set selection made by Weighted Mean Method

- Weighted Mean Method

The weighted mean of a sensor is calculated with the residual energy {X1, X2 ..., Xn} and with weights {W1, W2 ..., Wn}. Weighted Mean calculated as follows,

$$\bar{x} = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i},$$

The sensor node who's weighted mean with respect to residual energy and weight is going to be high will be considered as active set. Thus helping all sensors deplete and use their energy as slowly and uniformly as possible while guaranteeing K-coverage of a field.

- Dynamic Relative Neighborhood Method

To preserve connectivity, the distance covered by the node is constrained by the connectivity of the node to its neighbours in a connected method called the dynamic relative neighborhood method.

Pseudocode for DRNG

```
‣ Identify all sensor nodes
‣ Check the communication range (R) of the nodes
‣ Identify the longest vertices distance of the sensor nodes in the whole network
for(each sensor node)
  {
  find neighbors of each sensor node
      }
for(each sensor node)
  {
      check R and compare with neighboring sensor node
      if (R>lowest distance)
      {
        maintain the connectivity of the sensor
      }
  if(find long distance)
      {
        remove the connection
      }
   }
```

It is a graph reduction method. Initially, identify the cluster and minimum active set. Then check the communication range(R) of the nodes. Identify the longest vertices distance of the sensor nodes in the whole network. For each sensor node, find the neighbours of each sensor node by cluster formation method. Check the communication range(R) and compare the range with the neighbouring sensor node. If the communication range(R) is greater than the lowest distance then, connectivity of the sensors will be maintained. If not remove the connectivity, when the distance is higher than R. Thus, to preserve dynamic connectivity. This will remove the longest edge of each sensor. The connectivity of the two sensors is removed if there exist another node with minimum distance. This will reduce the scalability issue and preserves connectivity.

V. CONCLUSION

Maximized coverage and connectivity provided for the Heterogeneous WSN. Lifetime of sensor node should be maximized by energy consumption. Coverage and Connectivity can be applied in the dynamic environment by the proposed methodology. Sensor field should be covered with minimum active set.

REFERENCES

[1] K.Romer, F. Mattern, and E. Zurich, “The design space of wireless sensor networks,” IEEE Wireless Commun., vol. 11, no. 6, pp. 54–61, Dec. 2004.

[2] T. D. Raty, “Survey on contemporary remote surveillance systems for public safety,” IEEE Trans. Syst., Man, Cybern., Part C, vol. 40, no. 5, pp. 493–515, Sep. 2010.

[3] S. Yi, J. Heo, Y. Cho, PEACH: power- efficient and adaptive clustering hierarchy protocol for wireless sensor networks, Computer Communications 30 (14–15) (2007) 2842–2852.

[4] X. Li, H. Frey, N. Santoro, and I. Stojmenovic, “Strictly Localized Sensor Self-Deployment for Optimal Focused Coverage,” IEEE Trans. Mobile Computing, To Appear, 2011.

[5] YS Yun et al, “Maximizing the lifetime of WSN with mobiles in delay tolerant applications”, IEEE Trans. Mobile Computing, 2010.

[6] C.-Y. Chang, J.-P. Sheu, Y.-C. Chen, and S.-W. Chang, “An obstacle-free and power-efficient deployment algorithm for wireless sensor networks,” IEEE Trans. Syst., Man, Cybern., Part A, vol. 39, no. 4, pp. 795–806, Jul.2009.

[7] F. Marcelloni and M. Vecchio, “A simple algorithm for data compression in wireless sensor networks,” IEEE Commun. Lett., vol. 12, no. 6, pp. 411–413, Jun. 2008.

[8] S. Yang, H. Cheng, and F. Wang, “Genetic algorithms with immigrants and memory schemes for dynamic shortest path routing problems in mobile Ad Hoc networks,” IEEE Trans. Syst., Man, Cybern., Part C, vol. 40, no. 1, pp. 52–63, Jan. 2010.

[9] H. Chen, C. K. Tse, and J. Feng, “Impact of topology on performance and energy efficiency in wireless sensor networks for source extraction,” IEEE Trans. Parallel Distrib. Syst., vol. 20, no. 6, pp. 886– 897, Jun. 2009.

[10] A.Chamam, S. Pierre, A distributed energy-efficient clustering protocol for Wireless sensor networks, Computers & Electrical Engineering 36 (2) (2010) 303–312.

[11] H. Liu, X.H. Jia, P.J. Wan, X.X. Liu, F. Yao, A distributed and efficient flooding scheme using 1-hop information in mobile ad hoc networks, IEEE Transactions on Parallel and Distributed Systems 18 (2007) 1–14.

[12] Tahiry Razafindralambo,” Connectivity Preservation and Coverage schemes for Wireless Sensor Networks”, IEEE Trnsactions on automatic control, vol 56, no.10, oct 2011.

[13] Habib M.Ammari et al,” Centralized and Clustered k-Coverage Protocols for Wireless Sensor Networks”, IEEE Transactions on computers, vol.61, no.1, jan 2012.

[14] Fatemah Mansour Kiaie et al,” Coverage problem in heterogeneous wireless sensor network”, European scientific journal, vol.9,no.27, sep2013.

[15] S. Mini, Siba K. Udgata et al,” Sensor Deployment and Scheduling for Target coverage Problem in Wireless Sensor Networks”, IEEE sensors journal, vol.14, no.3, Mar2013.