A Proposal to Reduce Energy Consumption for Wireless Sensor Network

Tran Cong Hung, Phan Thi The

Abstract—**A wireless sensor network may contain tens to thousands of wireless sensor nodes to monitor the area and they are used in many applications such as security, surveillance, climatic-change studies, and structural health monitoring. These nodes process, store and send the information to other nodes in the network. To transmit data sensor nodes require battery power. if a node does not have sufficient battery power then it cannot transmit data. So power optimization is a major issue in wireless sensor network. An efficient routing algorithm is required to utilize power of nodes and extend the lifetime of wireless sensor networks. In this paper, we study to selection a ClusterHead and use Dijkstra's algorithm to find the shortest path to Cluster Headers to Base Station (Sink)**

Keywords: **Cluster Head, Dijkstra, Leach WSN**

I. INTRODUCTION

A sensor network can be made callable by assembling the sensor nodes to clusters. Every cluster has a leader called clusterhead (CH). A CH may be elected by the sensors in a cluster or preassigned by the network designer. The cluster membership may be fixed or variable. A number of clustering algorithms have been specifically designed for WSNs for scalability and efficient communication. The concept of cluster based on routing is also utilized to perform energy efficient routing in WSNs. In a hierarchical architecture, higher energy nodes (cluster heads) can be used to process and send the information while low energy nodes can be used to perform the sensing. Some of routing protocols in this group are: LEACH (Heinzelman 2000) [1, 2], PEGASIS (Lindsey 2002) [3], TEEN [4] (Manjeshwar 2001) and APTEEN [5] (Manjeshwar 2001). Most of the recent energy efficient protocols designed for heterogeneous networks are based on the clustering technique, which are effective in scalability and energy saving for WSNs.

Manuscript received 1 Sept, 2015. Accepted: 6 Oct, 2015

Tran Cong Hung, Ph.D. is with the Post and Telecommunications Institute of Technology, Vietnam (e-mail: conghung@ptithcm.edu.vn).

Phan Thi The, lecturer. is with Thu Duc College, Vietnam (e-mail: phanthithe@gmail.com).

In order to optimize energy consumption and maximize the life time of the WSNs [6], balanced sensor deployment as well as cost-lowest path is found by Dijkstra's algorithm in [7]. Dijkstra's algorithm will find the cost-lowest path based on the path distance, while we propose to apply the energy model to the Dijkstra's algorithm to select the optimized path to Cluster Head. So it is reasonable to have uniform energy consumption. In this paper, we study to class the Cluster Header and use Dijkstra's algorithm to reduce power consumption.

This paper is organized as follows. Section 1 is introduction, Section 2 is Related Work which describes Leach Protocol for wireless sensor networks and present a survey of proposal clustering algorithm for saving consumption energy in wireless sensor networks.. Section 3 is Simulation which simulate about proposal algorithm and lastly, Section 4 presents the Conclusion and Future Work

II. RELATED WORK

Saving energy is an extremely important factor in sensor networks. In the original LEACH protocol [1], the probability corresponds to the number of desired Cluster Head (CHs) in the network. It has following design goals: random placement of nodes, self-configuring and adaptive cluster formation, local control for data transfers and low-energy. LEACH protocol has different rounds and each round has two phases, a setup phase and steady state phase. In the steady state phase transfer of data takes place and in set up phase it provides cluster formation in an adaptive manner. Cluster heads (CH) are used to perform data aggregation and/or data fusion before forwarding information onto the Base station (BS). Sensor nodes form clusters and elect CHs which are then responsible for transmitting data to the BS. Nodes within the cluster achieve energy savings by transmitting only to the CH.

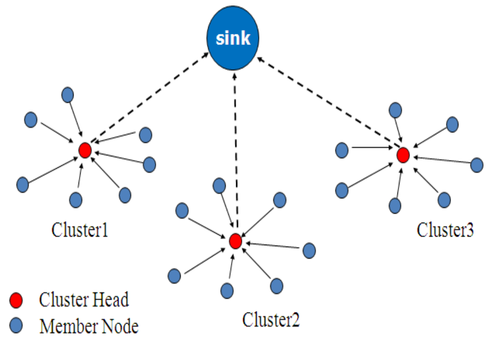

Fig 1. Clustering in LEACH[1]

LEACH then rotate CHs to distribute energy requirements among all the sensors. Additionally, LEACH performs local computation at each CH (data aggregation) to reduce the amount of data that must be transmitted to the BS. This saves both energy and bandwidth. However, random election also has many limitations. The biggest drawbacks is the random election making the high-energy nodes have the same probability of becoming cluster as lowenergy nodes.

The CHs functions have sensing as normal nodes. In addition, CHs also receive data from the nodes in the cluster, aggregate data and transmit data to the BS, so that CH consumes more energy than normal node. If low-energy nodes becomes CH, it will consume more energy at the result, the low-energy nodes will quickly stop working.

We propose a strategy to re-organize the sensors by themselves. Our solution is order sensor nodes to be cluster heads at first. The second step is to find the cost-lowest path according to Dijkstra's algorithm which is based on the energy consumption model. Finally, the path weight will be changed dynamically based on the energy model.

A. Selecttion Cluster Head

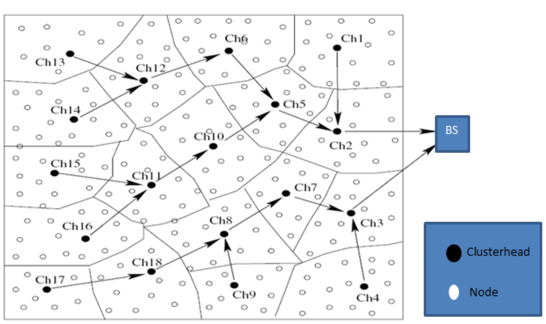

Fig 2 Dividing Node to Cluster

The division of network and selecting a proper cluster head also affects the overall performance of the network. The division of network is based on the calculation that according to the position information node belongs to which grid. The proposed protocol is known as Dynamic-division Geographical Adaptive Fidelity (DGAF)[8]. In this algorithm, we want to find the optiminal position of the cluster head which should be selected near the centre of their region because it consumes less energy in comparison to cluster head situated at the border of the region. The area is divided into grids as hexagons or as squares named. This protocol works in two steps which are as following:

Step 1: Dividing into virtual grids[9]. Every node knows its position in the network. By the help of calculations node get the information to which grid it belongs to also its distance from the centre of the grid.

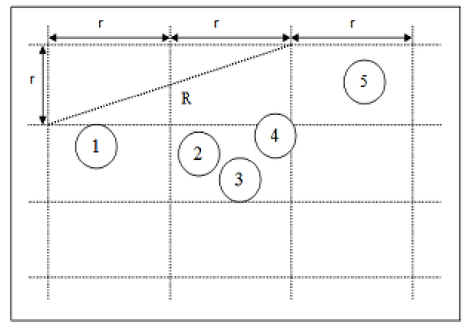

Fig 3. Dividing into virtual grids[9]

Assuming coordinate of node X_i is (X_x, X_y) with sensor radius Rx, and coordinate of Y is (Yx,Yy), then the distance beetween node X_i and Yi is $d(X_i, R)=\sqrt{(\mathrm{Xx}-\mathrm{Yy})^2+(Xy-Yy)^2}$

Step 2: Selecting cluster head Selection of cluster head is done by the help of "Cost" factor[9]. The node having lowest cost within the grid is selected as cluster head. Cluster heads are connected to each other for data transmitting.

$$\mathrm{Cost}_i=\frac{E_i}{d_{ik}} \qquad [1]$$

- Ei: Residual energy of node
- d_{ik}: distance from its grid's centre.

B. Find Optimal Path between subset of ClusterHead

In order to optimize energy consumption and maximize the life time of the WSNs, balanced sensor deployment as well as cost-lowest path is found by Dijkstra's algorithm [7] . Dijkstra's algorithm will find the cost-lowest path based on the path distance, while we propose to apply the energy model to the Dijkstra's algorithm to select the optimized path from subset of CHs.

In this algorithm we propose that a subset of CHs is selected to broadcast. Once broadcast CHs are determined, we must determine the paths that traffic takes to reach the BS's CH. A source node with traffic to send always transmits to its CH. More specifically, communication paths are established between CHs and not individual sensor nodes. The path from source node to the BS's CH contains other CHs. To establish routing paths, we use Dijkstra's routing algorithm. Dijkstra's algorithm is an algorithm that finds the lowest cost path from a source to a destination. Dijkstra's algorithm finds the shortest paths from a given source node to all other nodes by developing paths in order of increasing path length. Dijkstra's algorithm uses link costs to determine viable paths.

Step 1: all CHs determine the energy required to transmit data to the base station, then each transmits a setup message at a predetermined power level. This setup message contains the node's available energy and the amount of energy required for it to reach the base station by direct transmission. Any CH receiving a setup message from another CH lists that CH as a neighbor, since it was within a given range corresponding to the predetermined power level of the setup message. The CH can determine the distance to neighboring CHs based on the power level of the received setup message. All CHs log their neighboring nodes with the information sent in their respective setup message.

Pseudo code

```
For each CH  in {1, 2, · · · , NCH }
Each CHi node of the CH
List of CH is neighbor of CHi
Computes distance, Energy Cost between CHi and
neighbor(CHi) to store in Table
```

Step2: Using energy cost(EC) table to initialize all CHs. This table is the weighted value for a CH (i) to transmit data to another CH (k) or the base station (bs) based on energy available at that CH(i). Each CH(i) then logs a total energy cost for each possible path to the base station. The shortest paths (using Dijkstra) are to send a data message to the base station directly, or through a neighbor's CH.

The Total energy for CH (i) to send directly to the base station is equal to its Energy Cost for the same path, while the Total of Energy for indirect paths is the Energy Cost from CH (i) to CH (k) plus the Energy Cost of node (k) to the base station. The route with the lowest TEC will be the route each node chooses when sending a data message.

If a node finds that the TEC for multiple routes is the same, which includes the route directly to the case station, then it will transmit directly to avoid clogging the network and wasting energy. If the routes with equal TEC values are all to neighboring CHs, the choice will be arbitrary.

This steady state continues until nodes run out of sufficient energy to send data across any path.

Pseudo code

```
Foreach CHi in CHs
  Use Table EC to initialize CHs
    Each CHi
      With Neighbor's CHi
        If (Path between CHi and Neighbor is Shortest)
          Send Message From CHi to Neighbor
                    Send Message From CHi to BS
```

The resulting path is the most energy efficient route through the WSN without factoring in the additional cost of the broadcast CHs, Its efficiency is also directly related to the predetermined distance of its neighbors. While greater distance provides more neighbors and more paths, it also increases energy usage to reach neighboring CHs.

For further details on Dijkstra, We implement Dijkstra's algorithm at each CH to determine the least cost path to the sink node's CH. We used Euclidian distance as the cost between two CHs in Dijkstra's algorithm. Implementing Dijkstra's algorithm carries a high initial energy cost due to the ommunications overhead necessary to establish the routes; however, our repeated use of the resulting least cost path yields energy savings that justify the upfront cost. The savings are obtained because all of the network traffic takes the least cost path when it is routed.

III. SIMULATION

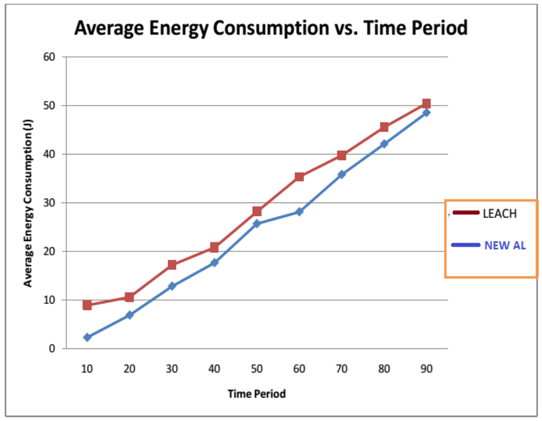

Fig 4. Energy consumption of LEACH and NEW AL

In the above figure the red line and blue line indicates the avg energy consumption in the LEACH protocol and the NEW AL protocol respectively. That means my protocol NEW AL is more efficient than LEACH protocol. Results of experimental energy consumption has been decreased about 21 % and in this proposed protocol the first node death times 5 times longer in comparison with leach protocol.

IV. CONCLUSIONS AND FUTURE WORK

In this paper, we study to an energy efficient routing algorithm based on Selection CHs and Dijkstra Alogrithm Consumption. This algorithm presents a shortest path between ClusterHead and neighbor, which ensures that this algorithm provides low cost communication and low power consumption because transmitted power. New algorithm is reduced as a way of clustering that considers about distance to BS, and distance to CHs and energy of nodes.

Our main aim is to reduce the power consumption among the sensor nodes in wireless sensor network.

In the furthure, we also continue considering to routing algorithm to save energy comsumption for nodes in the WSN.

REFERENCES

[1] Pooja HA, CNE, CMRIT, Karnataka, India, Achieving Enhanced Life-time of Wireless Sensor Network using Dual Hop Clustering Algorithm over Leach Protocol, 2015

[2] Mortaza Fahimi Khaton Abad, Mohammad Ali Jabraeil Jamali, Modify LEACH Algorithm for Wireless Sensor Network, International Journal of Computer Science Issues, Vol. 8, Issue 5, No 1, September 2011

[3] S.Lindsey, C.Raghavendra, PEGASIS: Power- Efficient Gathering in Sensor Information Systems, IEEE Aerospace Conference Proceedings, Vol. 3, 9-16 pp. 1125- 1130, 2002

[4] A. Manjeshwar and D. P. Agarwal, TEEN: a routing protocol for enhanced efficiency in wireless sensor networks, In 1st International Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing, 2001

[5] A.Manjeshwar and D.P.Agarwal, APTEEN: A hybrid protocol for efficient routing and comprehensive information retrieval in wireless sensor networks", Parallel and Distributed Processing Symposium, Proceedings International, IPDPS, pp. 195-202, 2002

[6] Trong Thua Huynh, Hong-Nhung Phan-Thi, Anh-Vu Dinh-Duc, Cong Hung Tran- Prolong the Network Lifetime by Optimal Clustering based on Intelligent Search Algorithms in Wireless Sensor Networks- The 2014 International Conference on Advanced Technologies for Communications, 2014

[7] Bartosz Musznicki, Mikołaj Tomczak and Piotr Zwierzykowski- Dijkstra-based Localized Multicast Routing in Wireless Sensor Networks- 8th IEEE, IET International Symposium on Communication Systems, Networks and Digital Signal Processing, 2012

[8] Jitender Grover,Mohit Sharma, Study of Geographic Adaptive Fidelity Routing Protocol in Wireless Sensor Network, IOSR Journal of Computer Engineering (IOSR-JCE0), October 2014

[9] Sinchan Roychowdhury and Chiranjib Patra, "Geographic Adaptive Fidelity and Geographic Energy Aware Routing in Ad Hoc Routing", Special Issue of International Journal of Computer and Communication Technology (IJCCT), Volume 1, Issue 2, pp. 309-313, August 2010.

TRAN CONG HUNG was born in Vietnam in 1961 He received the B.E in electronic and Telecommunication engineering with first class honors from HOCHIMINH University of technology in Vietnam, 1987. He received the B.E in informatics and computer engineering from HOCHIMINH University of technology in Vietnam, 1995. He received the master of engineering degree in telecommunications engineering course from postgraduate department Hanoi University of technology in Vietnam, 1998. He received Ph.D at Hanoi University of technology in Vietnam, 2004. His main research areas are B – ISDN performance parameters and measuring methods, QoS in high speed networks, MPLS. He is, currently, Associate Professor PhD. of Faculty of Information Technology II, Posts and Telecoms Institute of Technology in HOCHIMINH, Vietnam.

Phan Thi The was born in Vietnam in 1982. She received Master Data Transmission and NetWork in HOCHIMINH PTIT, Vietnam, 2012. Currently, She is a lecturer in Thu Duc College