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Research and Improvement of LEACH Protocol for Wireless Sensor Networks

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Abstract—The data transfer of wireless sensor network (WSN) can not be separated with routing protocol, Energy efficiency is one of the most important factors in wireless sensor networks. In this paper based on the uneven distribution of the LEACH cluster head and the different lengths and base station communications, we present a improved LEACH algorithm which refers to remaining energy and optimal cluster heads. Computer simulation using NS2 reveals that the proposed protocol reduces the energy consumption compared with the existing LEACH protocol.

Introduction

Wireless sensor network[1] is consisted of a large number of low cost microsensor nodes deployed in the region to monitor, through wireless communication to be a multi-hop network of self-organization, the aim is to collaborate in perception, acquisition and processing of network coverage area perceived object information, and send it to the total base station console. WSN has the advantages of network flexibility, the network size variable, which have been widely used in many fields[2], WSN as one of the emerging technology can be widely used in military, industrial, transportation, and environmental protection fields which has caused people's attention. Besides wireless sensor networks can also be used on mobile node system as medical and fire which can monitor moving objects in real time and send the node’s information to the console. This paper solely considers the routing protocol of mobile nodes in wireless sensor networks monitoring.

According to the basic network routing protocols of wireless sensor networks which can be divided into flat and hierarchical routing protocols. As the flat routing protocols need to maintain large routing tables and occupy more storage space, so they are not suitable for large-scale networks, hierarchical routing protocols set out to attempt to conserve energy by means of arranging the nodes in clusters or tree structures to have some nodes transmit to a node within close proximity and to have these nodes forward this information to the base station[3]. LEACH (Low-Energy Adaptive Clustering Hierarchy) is a relatively mature representative and classical hierarchical routing algorithm. Other hierarchical routing protocols such as PEGASIS, TEEN etc. are improved upon LEACH, so LEACH is more representative. This paper mainly studies on the LEACH algorithm, but there are some disadvantages. This paper mainly on the basis of lower power consumption to improve LEACH protocol.

Leach Protocol

Description of LEACH. LEACH[4-6] protocol is a low-power adaptive clustering routing protocol which was presented by MIT's Heinzelman etc. for wirless sensor network. The main content are distributed clustering technology, adaptive clustering algorithm and cluster algorithm for the first rotation position. Among them, distributed clustering technology ensure a large number of nodes in the self-organizing behavior; adaptive clustering algorithm and the location of cluster head node rotation algorithm to ensure that all nodes bear the burden of energy consumption in fair and ultimately the survival time of the entire system can be extended.

LEACH protocol operation is carried out by round, each round contains two stages as the cluster building and stable operation. In the cluster-building stage, adaptive clustering structure formation, after the formation of cluster heads, cluster head node using TDMA schedule to organize the communication among cluster members, In steady operation stage, cluster members gather data continuously and send the data to certain cluster-heads in certain slots. The cluster head nodes fuse these data and forward them to the base station. Cluster heads are elected again in next rounds.

In the cluster building phase, a certain number of nodes are selected as cluster heads. Each node randomly assigned a number between 0 and 1, as marked by the value. If the node threshold flag value is less than T(n), then the node as the cluster head node on the current round. The size of threshold T(n) determined by Equation 1:

$$T(n)=\begin{cases}\dfrac{p}{1-p[r \bmod(1/p)]}, n \in G \\ 0,[others]\end{cases} \quad (1)$$

Where P is the percentage of the desired cluster heads; r is the current round of elections: $r \bmod(1/p)$ representatives which has been elected in this round of circulation over the number of cluster head nodes, G is a collention which is not collected to be cluster head nodes in the last 1/p rounds. And T(n) is the average probability that the first r rounds of cluster head nodes have not yet become a cluster head[7 8].

Disadvantage of LEACH. LEACH protocol is a cluster-based routing protocol, It uses random, self-organization adaptive clustering method and local control for data transmission. While using low power MAC protocol and related information processing technology to achieve the purpose of energy saving. At the same time there are also some disadvantages in it:

- LEACH protocol randomly selects cluster head at each round. Therefore, some nodes maybe exhaust energy too quickly due to being selected as cluster head many times. In this paper, our modified protocol makes the nodes with more residual energy have more chance as cluster head and this will prevent the whole network to die too early.
- The number of the cluster heads in LEACH protocol for each round is uncertain, so the number of cluster heads may not be optimize. Random numbers can only take the number of similar clusters in the best and expect the number of equal, but in fact the number of clusters in each round and the optimal value is a certain deviation, which resulted in a decline in performance of LEACH protocol[9].

Improved Protocol I-LEACH

Clustering Process. Based on the above shortcomings, this paper presents an improved algorithm of LEACH protocol I-LEACH (improved LEACH), mainly to optimize the process of its cluster.

Selected a cluster head node consider energy state that all sensor nodes must monitor the changes, if energy lower than the average energy level, reduce the probability of it becoming the first cluster [10]. At the same time to optimize the formation of clusters, so that the initial cluster from the base station into the cluster head high, to reduce the energy consumption of cluster head. Clustering process shown in Fig. 1:

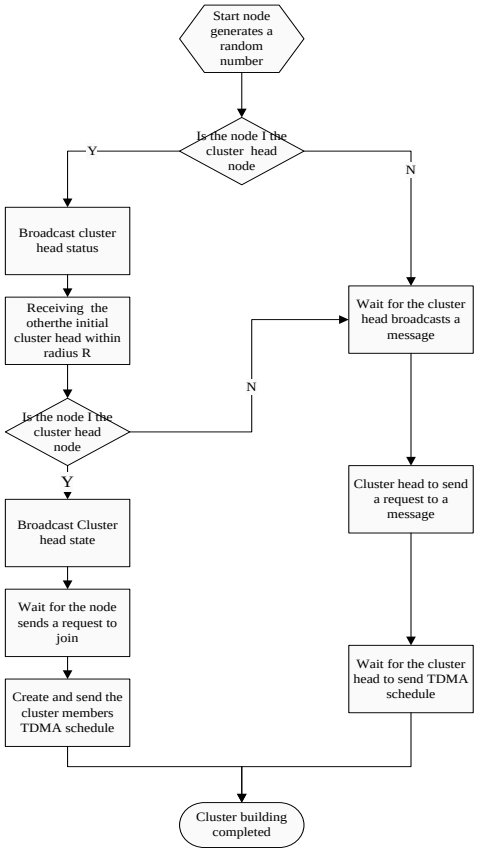

Figure 1. Flow chart

Initial Cluster Head. Here in our LEACH threshold T(n) is improved by adding the energy factor, the improved T(n) is reset as Equation 2:

$$T(n)=\begin{cases}\dfrac{p}{1-p[r \bmod(1/p)]}.\dfrac{E_{current}}{E_{start}}, n\in G\\ 0,[others]\end{cases} \tag{2}$$

Where $E_{current}$ representatives the current energy. E_{start} representatives the initial energy of nodes. The node is elected to be the cluster head when its random value is less than T(n).

Formation of Cluster Head. In addition to the different threshold with LEACH, the nodes was chosen as the initial cluster heads still on the election of cluster head selection, at this time that the initial cluster starts broadcasting its own cluster head by the radius of d_0 to start formal competition, the signal the shorter the transmission distance, the smaller the energy consumption. Here use the free space channel model and multi-path fading channel model wireless channel models. If the distance between the transmitter receives less than d_0, use the free space model, which send data from the energy loss and proportional to the square; Otherwise, use the multi-path fading channel model that is dual-path model, the sender sends data at this time of energy loss with distance is proportional to the fourth power. In order to minimize energy consumption here, so take the value of R is the radius of d_0, where $d_0=\sqrt{\dfrac{\varepsilon_{fs}}{\varepsilon_{amp}}}$, ε_{fs} is the power amplifier for free space loss, ε_{amp} is multi-path fading in the power amplifier loss.

When a node receives a broadcast, if the initial cluster head is elected, then the number of nodes to compare the weights W(W is the distance between the base station node) to choose the least W as the cluster head node. Other initial node to become non cluster head node. This reduces the distance between cluster head to the base station, as to saving energy. After determining the cluster heads, the cluster head node begins to broadcast its formal state in the cluster. The clustering of non-cluster head node start to send join message, When the cluster heads receive all the added messages, based

on the number of member nodes to TDMA mode for each non-cluster members of the allocated time slot, and sent with a broadcast to all cluster nodes, This will ensure that each node within the cluster in the corresponding data transmission, while in other times into hibernation, reducing energy consumption. Nodes begin to transfer data when they knows its time slot. while the cluster head of the energy required to be turned on all the time.

Simulation Analysis

Simulation Parameters Setting. Simulation parameters setting at the beginning, using the 100 nodes randomly distributed in (100,100) of space, The base station location (50, 175) where all nodes are static, the bandwidth is set to 1 Mbps, data length is 500 bytes, each node has an initial power of 2 J.

Simulation Results. The following results of the analysis to compare the two protocols:

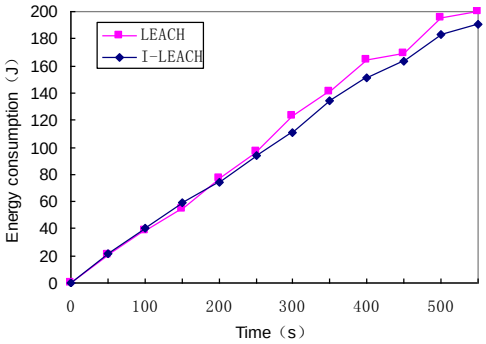

Figure 2. Energy consumption

Fig. 2 shows the two routing protocol nodes consuming energy over time. As the chart shows, after 250s I-LEACH routing protocol has less energy consumption than LEACH routing protocol at the same time which due to better overall utilization of energy.

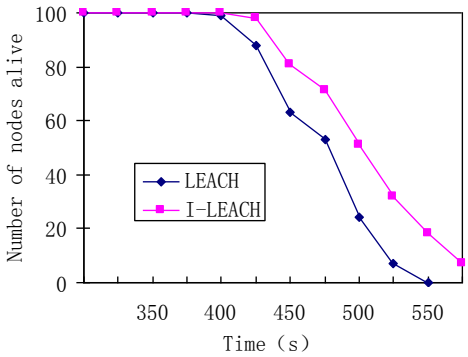

Figure 3. Number of nodes alive over time

Fig. 3 shows the network number of nodes in the survival over time. From the simulation data, LEACH protocol appears the first node death at 400s, while the I-LEACH protocol begins at 420s. The improved protocol saves the energy, so as to shorten the time of death of nodes. So the lifetime of the entire network is prolonged.

Conclusion

This paper has studied and simulated he traditional classical LEACH algorithm. And improved it. The residual energy of node LEACH algorithm is one of the factors affecting cluster head election. And optimize the cluster nodes, reducing excess energy consumption of cluster head nodes. Through the simulation, the improved algorithm to a certain extent improved the survival rate of the network

nodes and extended network lifetime. Energy consumption on the network has reduced. In this paper, considering the improvement of the clustering stage, but did not take into account the cluster head to the base station transmission problem, therefore, the cluster head to the base station data transmission is an important issue to study in the future.

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References

[1] F. Akylidiz.W. Su, Y Sanjarasubramaniam and E. Cayirci, A Survey on Sensor Networks, IEEE Communication Magazine, August 2002, pp.102-114.

[2] Sun Limin, Li Jianzhong, Chen Yu, Wireless Sensor Networks, Tsing-hua publishing company Beijing, 2005.

[3] Shin E, et a1 Physical Layer Driven Protocol and Algorithm Design for Energy-Efficient Wireless Sensor Networks[j]. Proc ACM Mobi−Com’01, Rome, Italy, 2001, 23(7)：72-86.

[4] W R Heinzelman, A Chandrakasan, H Balkarislman. Energy efficient communication Protocol for wireless sensor networks[C]. Proceedings of the 33rd Annual Hawaii International Conference on System Sciences, Hawaii, USA, 2000：1-10

[5] W R Heinzelman, A Chandrakasan, H Balkarishnan. An Application−specific Protocol Architecture for Wireless Microsensor Networks[J]. IEEE Transactions on Wireless Communications, 2002, 1(4)：660−670

[6] Mhater V Rosenberg C Homogeneous VS heterogeneous clustered sensor networks : acomparative study[J]. Communications 2004 IEEE International Conference on Volume6, 20-24 June 2004, 3646· 3651

[7] Wang Wei, Study on Low Energy Grade Routing Protocols of Wireless Sensor Networks”, Dissertation, Hang Zhou, Zhe Jiang university, 2006.

[8] Mo Xiaoyan, “Study and Design on Cluster Routing Protocols of Wireless Sensor Networks”, Dissertation,Hang Zhou, Zhe Jiang university,2006.

[9] 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 2002, pp.195-202.

[10] Zhang Li, LI Layuan. LEACH clustering of wireless sensor network routing protocols to improve and simulation [J]. 2009

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