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The Energy Efficiency of Improved Routing Technique Based on The LEACH

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Abstract

As WSN is energy constraint so energy efficiency of nodes is important. Because avoiding long distance communication, clustering operating in rounds is an efficient algorithm for prolonging the lifetime of WSN and its performance depends on duration of a round. A short round time leads to frequent re-clustering while a long round time increases energy consume of cluster heads more. So existing clustering schemes determine proper round time, based on the parameters of initial WSN. But it is not appropriate to apply the round time according to initial value throughout the whole network time because WSN is very dynamic networks nodes can be added or vanished. In this paper we propose a new algorithm which calculates the round time relying on the alive node number to adapt the dynamic WSN. Simulation results validate the proposed algorithm has better performance in terms of energy consumption of nodes and loss rate of data.

Keywords: *WSN, LEACH, Energy Model, Energy Efficiency*

1. Introduction

WSN is a network that composed with numerous sensors on a field. The improvement on subminiature electric device system technique has allowed in the effect of cost cutting. The sensors are consisted with memory, data handling, sensor unit, wireless communication unit and battery. This sort of WSN has hierarchical structure where the end user connects the base station by going through at least one step and this do not connects the network directly [1].

Due to the attribute of WSN, it mostly operates in an intensive condition. The sensor nodes have limited resources like a battery power and small memory capacity when operating. So the sensors that are applied in

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the field face the difficulty to charge or replace the battery. Therefore, the sensors consume battery power on data detection, handling data and transmit-receive operation. The largest energy consumption is shown when communicating data. As the life expectancy of WSN depends on sensor nodes, energy efficiency is the most important issue.

The clustering technique is an excellent method for WSN energy efficiency [2]. A separation from one network to several independent clusters is the clustering method where each cluster collects at least one cluster head and surrounding data. The sensor nodes are exists to send collected data to head. In order to minimize the amount of data, the head fuse data and transmit the fused data to the base station. After all, the clustering is an energy saving method by reducing the distance between the sensor nodes. This allows sending data to closest located head rather than sending to a station located at a distance. As the head has more works, the limited battery will run much faster than the sensor nodes. The role of the cluster head is to circulate all the nodes in network and matches the load balance of network [3].

For the energy efficiency, the change time from each sensor node to head should be appropriate. The time of node being to the head role is the ratio of the time to operate in the active mode of the entire frame time. The clustering uses the most cluster head and TDMA scheduling of communication sensor node. All the nodes operate actively only when the nodes arrive on the allocated time slot. In a result, the clustering reduces the time changes from nodes to cluster head [4].

New clustering proceeds after the specific time limit called round time. The round time is an entire duration time for cluster setup continuing data handling step. An energy efficiency of clustering algorithm depends on this round timing. This study is focused on variable round time which is adoptable on behalf of dynamic changes on network for energy efficiency. To increase energy efficiency, variable round time is applied than constant time round of LEACH or the most protocols based on LEACH. According to management attribute of WSN, it has a dynamic network with high potential of node addition and deletion. Therefore adjusting the number of nodes due to the round time developed the effectiveness in energy. Moreover, it considered the characteristic of detected data by applying comparison technique.

In this thesis, the related researches are addressed in section 2 and suggested clustering technique is studied in following section 3. The section 4 is the analysis of suggested technique and evaluation and finally section 5 is the conclusion.

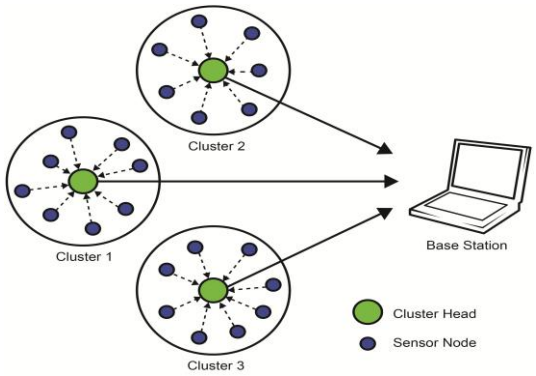

Figure 1. Structure of a LEACH Network

2. Related Reserchs

2.1. LEACH protocol

The figure1 structure like LEACH is the routing protocol of principle cluster based hierarchical for wireless sensor network [5]. The sprinkled sensors on the field are divided into numerous cluster groups. Each cluster controls all the relevant nodes and fuses the transmitted data, then collect data and head nodes that sends to the base station. So that it consists of sensor nodes that transmits data to the head in a cluster to which they belong. The cluster head struggles when sending merged transmission data to distance base station, for that reason, all the nodes circulates to take a role as a head in the beginning of each round with fixed probability.

A. Structure and operation of LEACH protocol

As shown in figure2, LEACH is consisted in round unit. Every round has setup and steady states. The setup state includes the division of sensor nodes to numerous clusters which is the selection process of the clustering and the steady state is the process of transmitting detected data from sensor nodes to the head as well as sending merged data to the base station [6].

The detailed setup process is composed into sections. Firstly, the head itself spreads out the selected notification to other sensor nodes through ADV (advertisement) message and based on a signal intensity of received ADV message from sections, the sensor node choose a cluster to be a part. Then let other clusters to identify the incorporation of relevant cluster via join-REQ (request). Lastly, based on the join-REQ message, fill out SCH in order to send to every member nodes including cluster that has been chosen. The steady state section is divided to frames and each frame has time slot for sending sensor node data in SCH order [1,5].

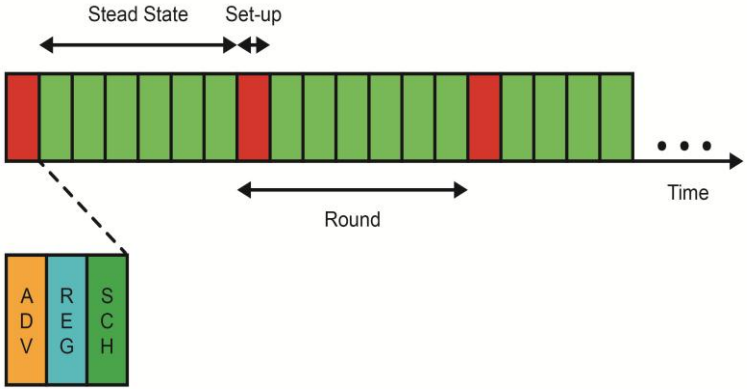

Figure 2. Time line showing operation of LEACH

B. Cluster head selecting technique of LEACH

The cluster head in LEACH needs to transmit the data to distant base station than the sensor node, it requires higher energy consumption. In support of consume equivalent amount of energy on every node, the cluster head selection needs to be done as shown in the equation (1) [5].

$$P_i(t) = \begin{cases} \frac{k}{N - k \times (r \bmod \frac{N}{k})} & ; C_i(t) = 1 \\ 0 & ; C_i(t) = 0 \end{cases} \quad (1)$$

To ensure all the nodes have selected as equal times, every node need to be the head for once in average of N/k at each round. N in the equation (1) is the number of nodes, i is the node identifier, t is the time, r is the

round and k is the number of clusters. Where Ci(t) is the function whether the node i was the head in the recent round (r mod N/k). For example, when the node i was not the head, Ci(t)=1 and if the node i was the head, then Ci(t)=0. As it takes turn by N/k period, all the nodes have same probability to be selected as the head [6~7].

C. Problems of LEACH protocol

LEACH and network protocols that are based on this, set the round time according to the number of sensor nodes that were applied on field initially and until the end of network life cycle, the network operates based on fixed round time. However wireless sensor network operates in tough conditions like surveillance of enemy military territory, natural disaster such as forest fires or flooded region, wild nature to observe the ecology of plants and animals or even in extremely difficult places for human to approach.

Consequently nodes are interspersed on a field and the network did not operated due to the various reasons on initial drive. In the process of incorporating to a new sensor node, the sensor node could not be existed or can cause sudden death by network failure. Thus operating fixed round time at the beginning of network until the end of the cycle, the waste of cluster head energy consumption will be increased via long round time. On the other hand, a short round time will create frequent cluster reconstruction for the node numbers which will affect the energy depletion on nodes.

3. Routing technique for the energy efficiency

A clustering technique is a partition into number of groups of nodes and this is an energy efficiency method in wireless sensor network. Besides, the round time for re-clustering network is an important part to improve the effectiveness. In a position of the cluster head, a long round time will extents the role as the head with huge energy usage. Whereas a short round time will increases the energy usage in sensor nodes. The adjustment in context round time is essential to control energy efficient protocol.

LEACH and algorithm based on LEACH usually have fixed round time and selects the round time based on the number of initial sensor nodes. When reflecting the characteristic of WSN, this operates on the rough condition which means that the sensor nodes can be added or may run out of energy. In the circumstances of protocol having fixed round time, the sensor operates perfectly when added but will run out of time and creates frequent reconstitution clustering to form network overload. While the sensor nodes expires, the existing fixed round time will increase relatively and ends up with energy consumption growth on head. If the variable round time is available according to the number of sensor nodes, the network will take a new lease of life. In the matter of fact, all the nodes in WSN can act as the cluster head and allows being the head for appropriate time to maximize the life of the network.

The cluster head role performing time of node, in other words, ensure the number of sensor nodes in network and refer the value to control the round time like in figure 3. Where the numbers of survived sensor nodes are high, the round time reduces in inverse proportion. A fixed round time is composed with wireless sensor network on behalf of condition that all the nodes survive. So if the sensor nodes are starting to die out, the initially fixed round time is proved that is was not appropriate.

The round time is adjusted by the number of sensors in the network. When the numbers of sensor nodes are decreasing in the later half in network, the round time will also be reduced. A short round time needs a frequent cluster reconfiguration however it uses more energy. To avoid this issue, in case of the left energy

of sensor nodes reach lower than certain level, the network will redesigned to have a fixed round time. Furthermore, it allowed considering the detected data characteristic and through a comparison process, the user can be conscious of interested information. This technique was unavailable in the existing LEACH but in this proposed study, it runs continuously until the end of network process.

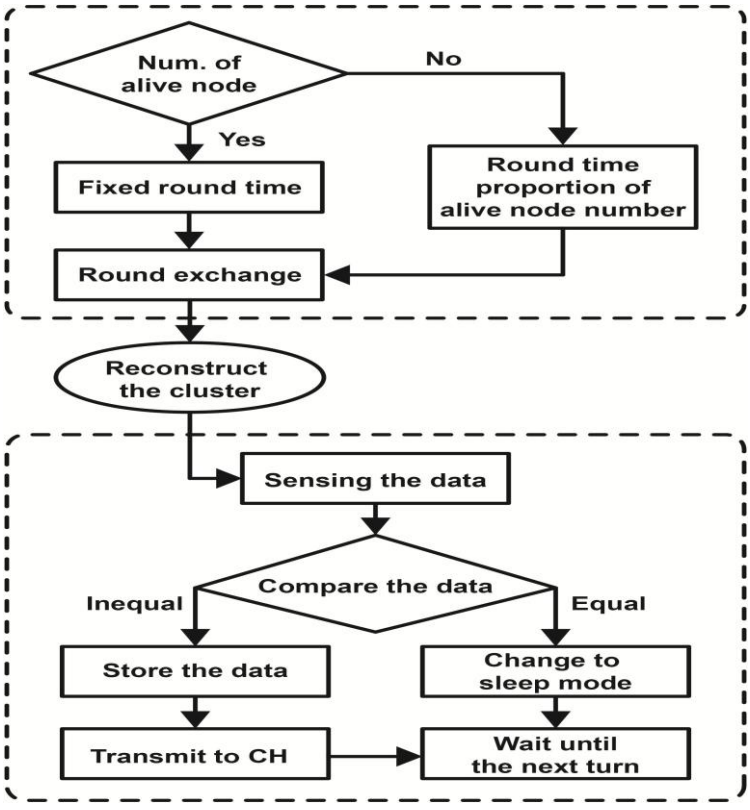

Figure 3. The Scheme of the Proposed System

4. Performance Analysis

In this section, the performance analysis of on typical routing protocol LEACH using clustering technique and the suggested method have been carried out. The survived node numbers due to the time and the average energy consumption presenting the energy usage of the node due to the time are selected as the standard performance result and analyzed by comparing the network efficiency of suggested technique.

4.1. Simulation environment

The simulation is proceeded based on NS-2 and LEACH extension [8~9]. A randomly arranged 100 sensor nodes on area with length of 100×100 and fixed local base station was set for the simulation. The cluster formation process and other details were used just like preference with LEACH radio wave model and TEEN (Threshold sensitive Energy Efficient sensor Network protocol). This is shown in table1 [5.10].

Additionally, when applying the suggested technique, it has been ignored as assuming the comparison analysis process regarding to energy consumption would be extremely low. Since the condition which occurs at random temperature change was simply to reduce the deviation of data which appears randomly in several

simulation for balancing environment condition.

Table 1. The Simulation Parameter of the Proposed Method

Parameter	Value
Base Station	(50,175)
Eelec	50nJ/bit
Initial Energr/node	2J
EDA	5n/bit
ε amp	100pJ/bit/m2
ε fs	10pJ/bit/m2
ε mp	0.0013pJ/bit/m4

4.2. Simulation results and Evaluation

The existing LEACH protocol technique is applied to this suggested method to proceed the performance analysis which is depending on the number of nodes that survived from each round time process. As shown in the figure4, when fixed time round is applied comparing to the existing protocol, applied the time control technique proved with improved result. This is the main reason on this paper why pressure of the cluster head through round time is controlled in a proportion of existing node numbers.

The figure5 illustrating the received data from the base station, and also confirmed that a lot more data have been received. When a head takes the role during the fixed round time in later half of network where low energy left, the head can be ends up with death as well as failing the duty. In this case the sensor nodes detect the failure and disappear among the head without transmitting the data to the base station. However, the proposed technique using the round time over existing node numbers has reduced than the early stage, a probability of death on cluster head decreases and so, the loss of data decreases as well.

In addition, the average energy consumption of each node is illustrated in figure6 and verified the developed performance than in comparison with LEACH. Regarding to the round time control, the node performance time as a cluster head is reduced. The head has higher energy usage than sensor nodes and due to reduction in energy consumption as the head node, the use of energy consumption in nodes are fall.

After the networking is starting practically, a sensor node can be added and when considering the early stage survival of sensor nodes in the field with presumed network condition in random data generation, regarding to the number of matching times to previous data occurred, the applied protocol performance can be reviewed that is slightly flexible. The wireless sensor network applied in rough environment and if considering over than 100 sensors located, a round time control technique can be the outstanding routing algorithm over the existing method.

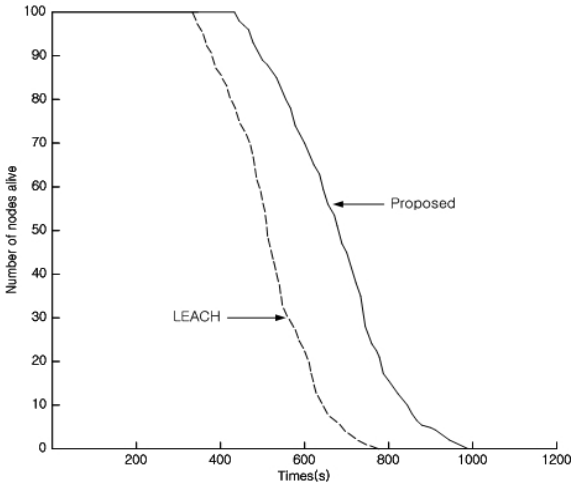

Figure 4. Number of active nodes.

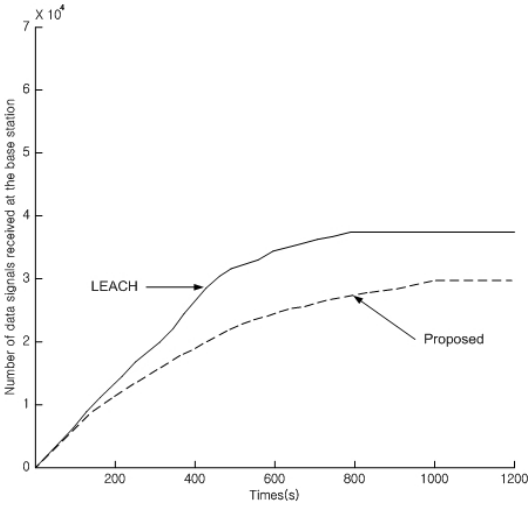

Figure 5. Total data received at the BS over time.

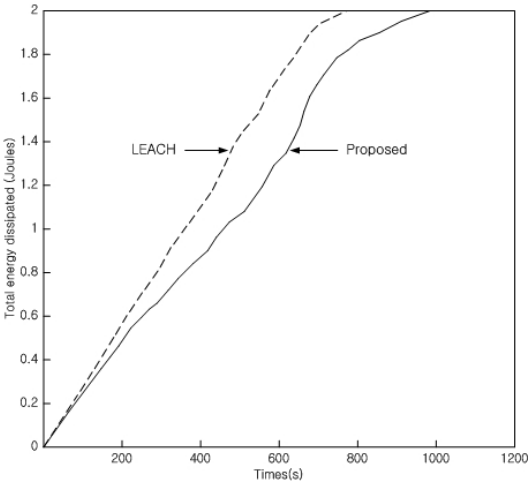

Figure 6. Average energy dissipated.

5. Conclusion

In this study, most of the attention has been drawn in setup and steady state stages under the fixed round time in order to use the energy more effectively on hierarchical separation routing algorithm LEACH which depends on the role of sensor nodes composing WSN and similarity protocols based on this LEACH. Nevertheless as the WSN node can be added or removed, this thesis proposed the variable round concept to control the round time over the number of living nodes. Also suggested methods were to minimize the pressure on the node (a node with the head role) and when there is low residual energy left in the later network, minimize the death of head. Throughout several performance analyses, it proved that there was average 10% of improvement on network life expectancy and average 8% of development on performance.

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