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Improve Energy Consumption of Enhanced Dl-Leach

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Abstract: In wide-area wireless sensor networks, network lifetime is short due to energy consumption and transmission distance. To improve this problem, we divide the sensor field into layers and reduce transmission distance through multi-hop method. However, there is a problem in that the transmission rate drops because there is no cluster head in the layer or the transmission distance increases due to the layer and energy is wasted. There are DL-LEACH (Dual-hop Layered-LEACH) and EDL-LEACH (Enhanced Dual-hop Layered LEACH) as protocols to improve this. DL-LEACH uses either single-hop transmission or multi-hop transmission depending on the situation. As a result, the transmission distance is optimized, thereby reducing energy consumption. In case of EDL-LEACH, it is proposed to improve the data rate in DL-LEACH. It is the same as DL-LEACH but the cluster head is mandatory for all layers to improve the transmission rate. Although, there is no cluster head for each layer, the transmission rate is improved, but the network life is shortened. In this study, we try to improve the network lifetime while maintaining the EDL-LEACH transmission rate. The shortened network lifetime is due to cluster head overload near the base station. To improve this the cluster head distribution method is improved and the network lifetime is improved.

Key words: WSN, Layer, LEACH, ML-LEACH, DL-LEACH, EDL-LEACH

INTRODUCTION

It is important to minimize the energy consumption in order to maximize the network lifetime, since sensor nodes in a Wireless Sensor Network have the limited energy such as a battery (Lee *et al*., 2014; Gauta *et al*., 2015; Kwon and Roh, 2009).

There is a LEACH protocol (Heinzelman *et al*., 2000) among representatives of the routing protocol for maximizing network lifetime. LEACH protocol shall select a cluster head randomly through the threshold equation as a routing protocol based on clustering. When a cluster is formed, member node of cluster transmits the data to the cluster head, the cluster head transmits the data to the Base Station by aggregation. But LEACH protocol is not suitable for wide area sensor network. Because cluster head may be far from the base station, LECAH protocol has a problem that energy consumption is large. To solve this battery shortage problem, ML-LEACH (Multi-hop Layered-LEACH) routing protocol that add layer conception in LEACH protocol has been proposed. After network field of ML-LEACH is divided into several uniform layers each layer forms a cluster or more. It can reduce the energy consumption by reducing distance between the cluster head and the base station. In this protocol, all node must multi-hopping to transmitting data. But this makes some node to use more useless energy. In order to improve this, DL-LEACH (Dual-hop Layered-LEACH) (Lee and Lee, 2015) that add the dual-hop (Single hop method+multi hop method) (Song *et al*., 2015, 2016; Park *et al*., 2016) method has been proposed. A single-hop transmission is more effective to some nodes than multi-hop transmission. In case the distance between individual node and the base station is shorter than the distance between individual node and the cluster head or the transmission distance between cluster head and the base station is shorter than the transmission distance between the cluster head and the next cluster head, single-hopping transmission is executed. Applying dual-hop method that combined single-hop and multi-hop, DL-LEACH can optimize energy consumption and increase the network lifetime.

Random cluster head elect algorithm based on the threshold equation cause non-uniformity of the number of cluster head. This means that the number of cluster head very changeable to many cluster head or to small cluster

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head in some round. To improve this problem, uniform cluster head elect algorithm was applied. And DL-LEACH still has distribution problem of cluster head in layers. Without evenly distribution of cluster head, there could be no cluster head or too many cluster head in some layer each round. EDL-LEACH (Enhanced Dual-hop Layered-LEACH) distributes the number of cluster heads to be selected for each layer, the problem of the absence of cluster head nodes is solved. However, there is a problem that nodes near the base station dead quickly due to high energy consumption.

In this study, we improve the cluster ratio in the layer close to the base station to solve this problem. And we will see how much improvement we have made through simulations.

Body

LEACH (Low Energy Adaptive Clustering Hierarchy) protocol: The LEACH (Low Energy Adaptive Clustering Hierarchy) routing protocol hierarchical clustering based routing protocol proposed by Wendi B. Heinzelman. LEACH is divided largely into set-up phase and steady state. Set-up phase constitute the cluster through the configuration of a cluster head node election work with the members. This multiple clusters formed in the field through networks and creates a hierarchical structure composed of a cluster head and member nodes.

ML-LEACH (Multi-hop Layered LEACH): Young-Il Song propose ML-LEACH protocol. ML-LEACH routing protocol is proposed to improve the LEACH protocol to improve the phenomenon of the sharp drop in the energy efficiency in the far transmission LEACH protocol.

ML-LEACH is configured based on the LEACH, it is a modified form of the transmission system. LEACH by changing an existing transmission system in the transmission method of multi-hop and improving the energy consumption is proportional to the square of the maximum transmission distance and the transmission distance between the respective sensor nodes. Multi-hop transmission method of the ML-LEACH is made of the transmission unit that is set in the field to layer, layer is set to be constant relative to the base station. Layer the more near the base station and is defined at a lower level, the clustering takes place in the interior of each layer. The cluster head in the ML-LEACH receives all the data of the node corresponding to the cluster members. And sent to the cluster head belongs to one level lower than layer that they belong to the data.

DL-LEACH (Dual-hop Layered LEACH): Young-Il Song propose DL-LEACH protocol. DL-LEACH is the energy consumption efficiency of the routing protocols at the remote transport. DL-LEACH is also based on the form of LEACH and improve transmission. However unlike ML-LEACH changed the conventional transmission scheme of the transmission system of a dual-hop (Single-hop and Multi-hop) LEACH. The hierarchical clustering of DL-LEACH is a member nodes and cluster heads in LEACH applied is maintained. Relative to the transmission of a base station to a cluster head in a long distance in the Multi-hop routing scheme used. Multi-hop transmission method of the DL-LEACH is the same as that of the ML-LEACH. The nodes that are not included in the cluster in the lowest layer are only way to transfer directly to the base station. That is the single-hop transmission is performed.

EDL-LEACH (Enhanced Dual-hop Layered LEACH): Since, DL-LEACH selects the cluster head by probability, the cluster head may be selected too much or too few. This may result in the absence of the cluster head of the layer. If a cluster head member occurs, the data transmission success rate is lowered.

Therefore, we proposed EDL-LEACH to select the cluster head according to the node ratio of each layer to prevent the cluster head from being present. This distributes the number of cluster heads to be selected in the sensor field according to the node ratio of each layer. Therefore by preventing the cluster head from being blocked, the data transmission success rate is increased.

MATERIALS AND METHODS

Proposed method: However, EDL-LEACH have a problem that nodes near the base station dead quickly due to high energy consumption. This is a problem that nodes in the layer close to the base station are overloaded.

In order to solve this problem, the cluster head selection near the base station is improved so as to be more selected. This increases the number of cluster head nodes so that the data to be provided by the nodes can be dispersed to improve the network lifetime. Here's how to improve:

- Step 1: determine the number of cluster heads to be selected for the sensor field
- Step 2: the number of cluster heads to be selected is distributed according to the node distribution of each layer

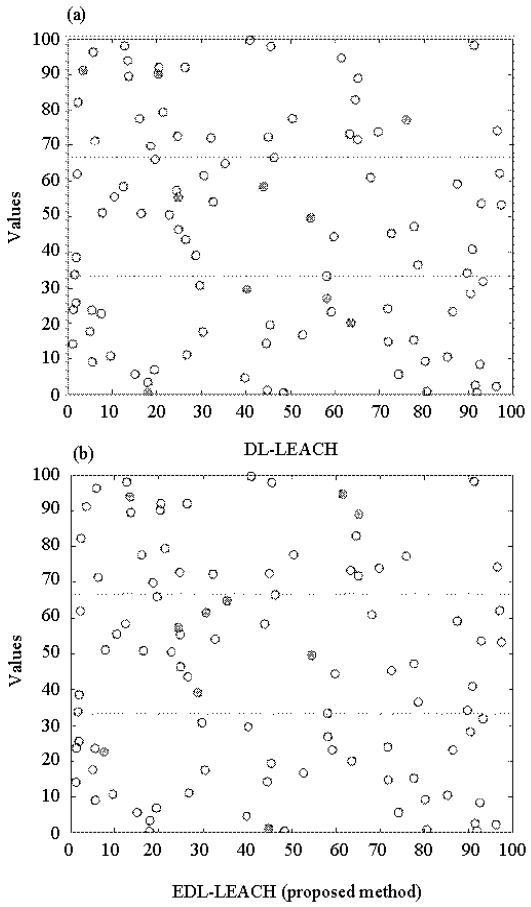

Fig. 1: Comparison of cluster head distribution

- Step 3: the number of cluster heads in a layer close to the base station is increased and the number of cluster heads in other layers is decreased

The comparison of the cluster head distribution of the proposed method with the existing DL-LEACH is shown in Fig. 1.

RESULTS AND DISCUSSION

Simulation and results

Radio model: Figure 2 when transmitting data, transmission energy according to data size and amplification energy depends on the distance are required.

Energy consumption is proportional to the square of the distance if the transmission distance is within the free space distance and is proportional to the fourth power of the transmission distance when the transmission distance is outside the free space. Therefore, in a wireless network, energy consumption increases as the transmission distance increases (Eq. 1).

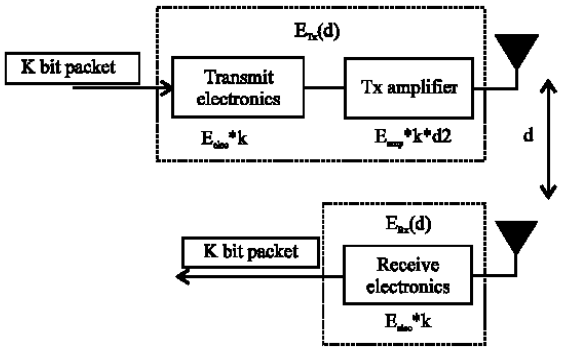

Fig. 2: Radio model

Table 1: Radio model parameters

Parameters	Values
Data aggregation	5 nJ/bit/signal
Energy dissipation to run the radio device	50 nJ/bit
Free space model of transmitter amplifier	10 pJ/bit/m^2
Multi path model of transmitter amplifier	0.0013 pJ/bit/m^4

Table 2. Simulation parameters

Parameters	Values
Number of sensor nodes	100
Sensor field	200×200
Position of base station	100×100
Initial energy	0.5 J
Number of Layers	3

$$E_{TX}(l, d) = E_{TX-elec}(l) + E_{TX-amp}(l, d)$$

$$E_{TX}(l, d) = \begin{cases} l\varepsilon_{elec} + l\varepsilon_{fs}d^2, & d \le d_0 \\ l\varepsilon_{elec} + l\varepsilon_{mp}d^4, & d > d_0 \end{cases} \quad (1)$$

When receiving data, it requires receiving energy according to the size of the data message. The energy equation required at this time is shown in Eq. 2:

$$E_{RX}(l) = E_{RX-elec}(l) = lE_{elec} \quad (2)$$

Simulation: In order to see how much better the proposed method than the existing protocol, a simulator is constructed with MATLAB. The transmission model uses the radio model and the radio model parameters are shown in Table 1 and 2 show the parameters for the simulation.

Results: The graph of Fig. 3 is the result of applying the simulation parameters in Table 2. This Fig. 3 is alive node per round graph which shows that the proposed method is improved compared to the existing method. Up to 15% increase in network life time compared to the existing method. Table 3 and 4 show the number of nodes and cluster heads per layer. Compared with the

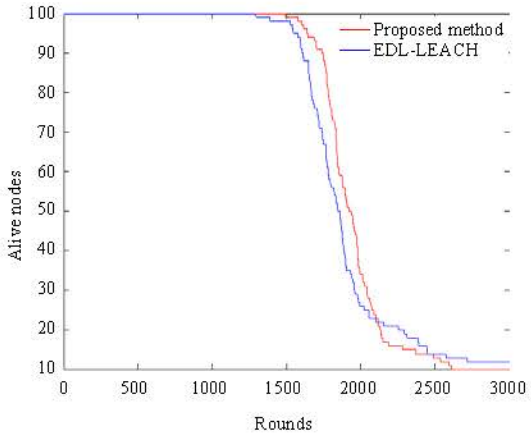

Fig. 3: Simulation result; 200×200, B/S 100×100 nodes

Table 3: Number of nodes per layer

Layer	EDL-LEACH	Proposed method
1	31 [C/H: 3]	31 [C/H: 2]
2 [B/S layer]	33 [C/H: 3]	33 [C/H: 5]
3	36 [C/H: 4]	36 [C/H: 3]

Table 4: Simulation result

FND	EDL-LEACH	Proposed method
FND	1293	1492 (15%▲)
80% node alive	1668	1782 (6%▲)
50% node alive	1845	1925 (4%▲)
30% node alive	1956	2042 (4%▲)

existing method, we can see that the proposed method selects more cluster heads near the base station.

CONCLUSION

EDL-LEACH has been proposed to improve the transmission rate of existing DL-LEACH. EDL-LEACH improves the cluster head selection which improves the data rate but the network lifetime is short. Because cluster head overload near the base station. To improve this problem, the number of cluster heads selected near the base station is increased. As the cluster head increases, the load is distributed. Therefore, energy consumption is reduced. As a result, the data rate is improved as compared with the DL-LEACH and the network life can be improved.

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