IJASC 16-1-2

The Comparison of Performance Hierarchical Routing Protocols in Wide Area Sensor Field

SeaYoung Park*, KyeDong Jung** and Jong-Yong Lee**,+

Department of Information System Kwangwoon University Graduate School of Information Contents, Seoul, Korea
**Department of Culture, Kwangwoon University, Seoul, Korea*
e-mail : {seayoung, gdchung, jyonglee}@kw.ac.kr

Abstract

Studies have been made for the wireless sensor network protocols by a number of researchers to date. In particular, the studies as to the hierarchical protocol LEACH algorithm was concentrated. Various studies have been derived for the performance of the protocol is based on the LEACH protocol have been made. Improved algorithms have been proposed continuously. On the other hand, The performance comparison and evaluation of the improved algorithm is insufficient. Therefore, we compared the performance for the ML-LEACH (Multi Hop-Layered) and DL-LEACH (Dual Hop-Layered) been derived mainly LEACH. scalability, energy consumption, CH elected, network lifetime were selected as a Performance evaluation items.

Keywords: WSN(Wireless Sensor Network), BSN(Body Sensor Network), Routing Protocol, Performance, comparison, LEACH, ML-LEACH, DL-LEACH.

1. Introduction

Routing protocols of the Wireless Sensor Network defines a transmission route setting method of the sensor node to the BS in the network field. Used as case, It is used for the data measured for the body in the BSN(Body Sensor Network). Sensor type in the body sensor network is as follows. EEG sensor, Visual sensor, Blood pressure sensor, ECG sensor, Temperature sensor, EMG sensor, etc. the Body Sensor Network must be created in Heterogeneous type network. The collected information transmits to the medical team for monitoring and helping to predict the target health status. The wireless body area networks promise to revolutionize health monitoring.[1] many researchers have come to a number of studies relating to LEACH of hierarchical routing protocol. In particular, the energy remaining in the life and improve the network of sensor nodes, and proposed various LEACH As the field of networks. However, performance has been evaluated according to the type of network protocol is limited to the life and FND, LND.[2] In this paper, examine the routing protocols have a direct impact on the life of the wireless sensor network. Typical

hierarchical routing protocol based on the improved LEACH ML-LEACH, and to present a comparison of the performance of DL-LEACH routing protocol. In relation to the existing performance evaluation, the performance criteria defined for the ratio of the remaining energy and the like, and the cluster head selection ratio to evaluate. The rest of this paper is related in Chapter 2 Research, Chapter 3, we describe the performance evaluation of the performance criteria and the simulation results. And Section 4 presents the conclusions.

2. Related Researches

2.1 LEACH Routing 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. [3]

2.2 Multi Hop-Layered Leach Routing Protocol

ML-LEACH routing protocol is Young-Il Song proposed 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 Layer that they belong to the data.

2.3 Dual Hop-Layered Leach Routing Protocol

DL-LEACH routing protocol is a protocol proposed by Young-Il Song, 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 described in Section 2.2. 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.[4]

The DL-LEACH consists of the work process as a Set-Up phase and the Steady State. Level Layer defines, based on the sensor field is formed at the base station and placing the sensor node.

3. Performance criteria and evaluation

3.1. Item Definition Performance

Evaluation items for comparison of performance between the protocols DL-LEACH and LEACH and ML-LEACH was defined by considering the following.

- Network Lifetime
  In general, the wireless sensor network life time is meant the time elapsed since the sensor network do the operability of the operation of the sensor network is started. The first node is dead time (FND), the last node that has the most considering the dead time (LND). In addition, by taking account of the case 80% of the node is dead, and defines the meaning of the absence of the network performance.

- Energy Consumption
  Energy consumption of the wireless sensor network refers to a network operating in the energy consumption for the sensor network nodes configured. This has a direct relationship to the lifetime of wireless sensor networks. That is, the evaluation to define the consumption energy and the remaining energy therefor.

- Scalability
  It refers to the receptivity in accordance with the change in extensibility of the number of nodes in the network size and the sensor field of the wireless sensor network. A wireless sensor network in a wide area field is required endpoints.

- CH elected ratio
  CH elected ratio in wireless sensor networks is the ratio of the number to be elected as a full member in the cluster head node clustering can work through the Setup-Phase. Considering the selection of a cluster head in each round is defined by the selection rate and the stability distribution of cluster head.

3.2. Comparison of the performance evaluation items

3.2.1. Network Lifetime

The performance compared to the lifetime of the network and the ML-LEACH and LEACH DL-LEACH is summarized in the following Table 1 and Figure 1. Distinguished by the size of your network is based on the left bar graph LEACH, ML-LEACH, the DL-LEACH. Based on the total node in a wireless sensor network FND, ND of 50%, and the ND of 80% in the performance evaluation.
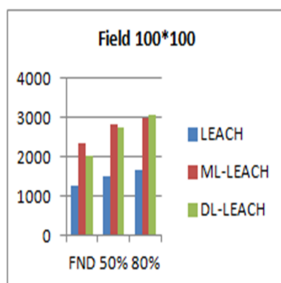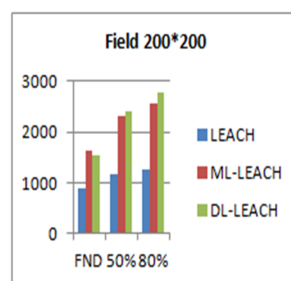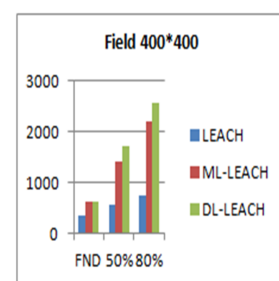

Figure 1-a   Figure 1-b   Figure 1-c

Figure 1. Each of Fields of Protocols FND, ND of 50%, ND of 80%

In the Field 200m * 200m is based on the LEACH. ML-LEACH, DL-LEACH showed an increase each of 183.45%, 17
2.90% in FND. ML-LEACH, DL-LEACH showed an increase each of 198.37%, 206.45% in ND of 50%. ML-LEACH, DL-LEACH showed an increase each of 203.58%, 221.86% in ND of 80%. Also in the Field 400m * 400m is based on the LEACH. ML-LEACH, DL-LEACH showed an increase each of 169.32%, 173.70% in FND. ML-LEACH, DL-LEA
CH showed an increase each of 249.39%, 301.23% in ND of 50%. ML-LEACH, DL-LEACH showed an increase each of 291.50%, 341.57% in ND of 80%. As the size of the field increment improved ML-LEACH, the energy efficiency of the DL-LEACH it is seen that even with the increased.

Table 1. Each of Protocols of Fields of Increase Rate of FND, ND of 50%, ND of 80%

Field 200*200	LEACH	ML-LEACH	DL-LEACH
FND	882	1618	1525
Rate of increase	100%	183.45%	172.90%
ND of 50%	1163	2307	2401
Rate of increase	100%	198.37%	206.45%
ND of 80%	1258	2561	2791
Rate of increase	100%	203.58%	221.86%
LND	1717	-	-

Field 400*400	LEACH	ML-LEACH	DL-LEACH
FND	365	618	634
Rate of increase	100%	169.32%	173.70%
ND of 50%	571	1424	1720
Rate of increase	100%	249.39%	301.23%
ND of 80%	753	2195	2572
Rate of increase	100%	291.50%	341.57%
LND	1386	-	-

3.2.2. Energy Consumption

Comparison of the energy consumption of the DL-LEACH and LEACH and ML-LEACH is shown in the following
2. The energy consumption of the entire each of the size of the protocol was measured. Depending on the size of the sensor field, Figure 2- (d), (e), (f) on the field size of 200 * 200. ND of 80% of LEACH is shown as 927. ND of 80% of ML-LEACH is shown as 1819, ND of 80% of DL-LEACH is shown as 1923. In addition, Figure 2- (g), (h), (i) the field size of 400 * 400. ND of 80% of LEACH is shown as 491. ND of 80% of ML-LEACH is 1092, ND of 80% of DL-LEACH is shown as 1352.

Field 200*200		
LEACH	ML-LEACH	DL-LEACH
(d)	(e)	(f)

Field 400*400		
LEACH	ML-LEACH	DL-LEACH
(g)	(h)	(i)
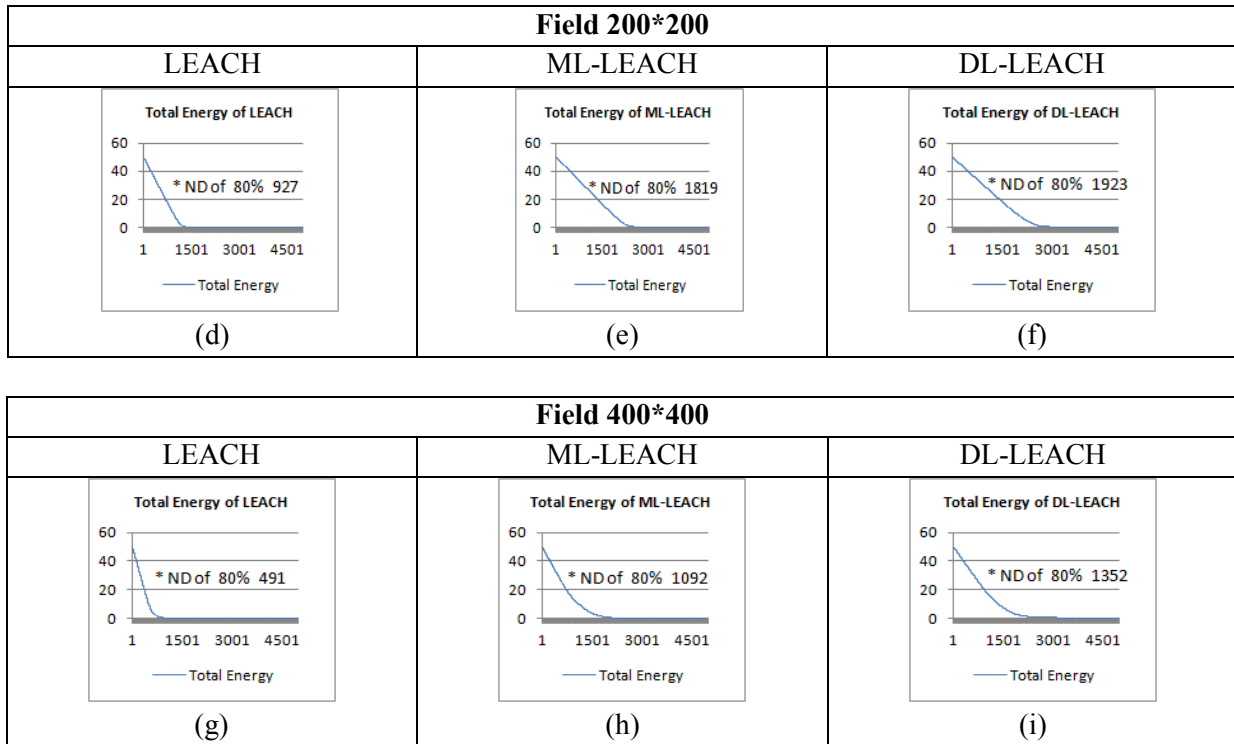
Figure 2. Each of Protocols of Fields Total Energy Consumption

The energy consumption represented in Figure 2. To compare the energy consumed through each round about. To this it was defined as follows.

3.2.3. Scalability
The scalability of ML-LEACH and LEACH and DL-LEACH shown in Table 2.

Table 2. The Number of Round of Each Protocol of FND, ND of 50%, ND of 80% for the Field Size

FND	100*100	200*200	400*400
LEACH	1258	882	365
Rate of decrease	100%	70.11%	29.01%
ML-LEACH	2341	1618	618
Rate of decrease	100%	69.12%	26.40%
DL-LEACH	2011	1525	634
Rate of decrease	100%	75.83%	31.53%
ND of 50%	100*100	200*200	400*400
LEACH	1514	1163	571
Rate of decrease	100%	76.82%	37.71%
ML-LEACH	2819	2307	1424
Rate of decrease	100%	81.84%	50.51%
DL-LEACH	2767	2401	1720
Rate of decrease	100%	86.77%	62.16%

ND of 80%	100*100	200*200	400*400
LEACH	1670	1258	753
Rate of decrease	100%	75.33%	45.09%
ML-LEACH	3008	2561	2195
Rate of decrease	100%	85.14%	72.97%
DL-LEACH	3073	2791	2572
Rate of decrease	100%	90.82%	83.70%

First in the case of FND, Compared to the ML-LEACH and DL-LEACH and LEACH 200 * 200 and 400 * 400, so the change in the range of 3% and 5% in the sensor field, is also seen to change with the change in the sensor field is incomplete. And in the event of ND of 50%, ML-LEACH and DL-LEACH by comparison with LEACH. it showed each of 5% and 10%, 13% and 24% of the increase in the sensor field. Finally, when the ND of 80%, ML-LEACH and DL-LEACH by comparison with LEACH. each of 10% and 15%, 28% and 38% increase in the sensor field. In other words, ML-LEACH is excellent scalability than LEACH. And DL-LEACH is excellent scalability than ML-LEACH.

3.2.4. CH elected ratio

Performance comparisons for each round CH elected ratio of ML-LEACH and LEACH and DL-LEACH is as follows: Figure 3
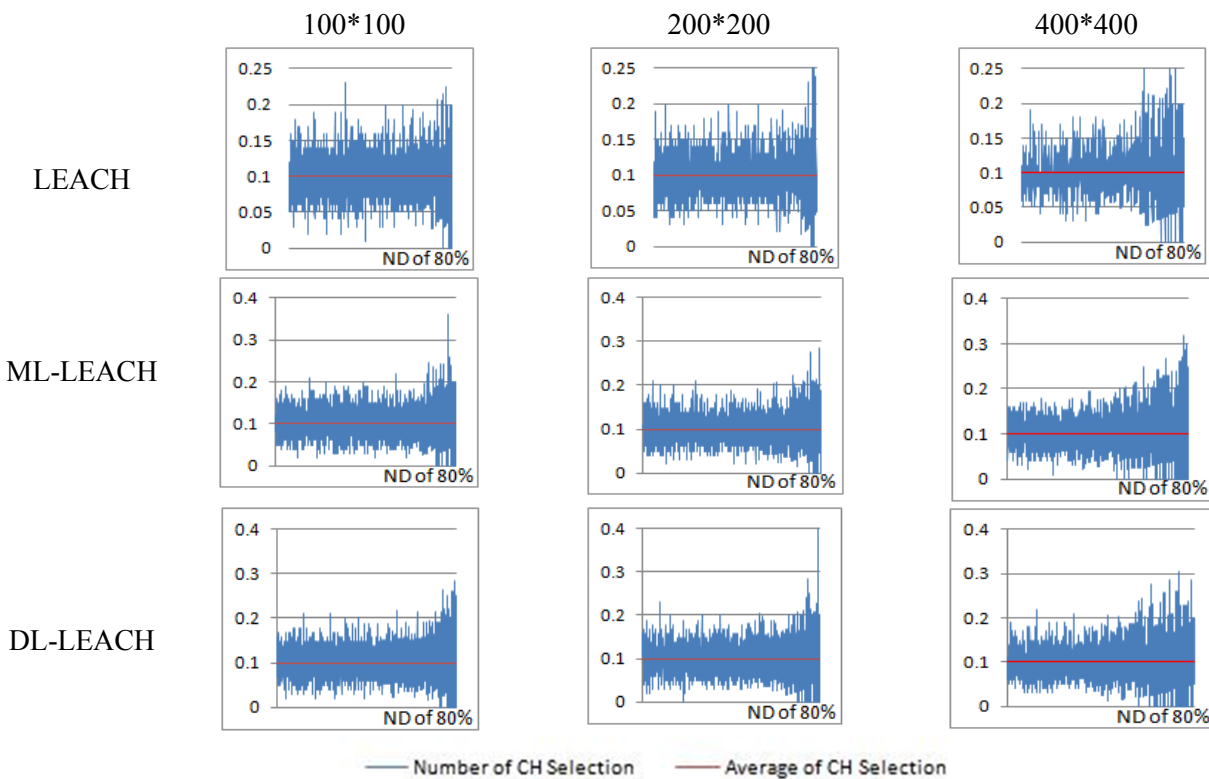

Figure 3. Cluster head selection ratios of the protocol

CH elected stochastic according to the Round in Figure 3. Selected with respect to the stochastic value selection p = 0.1, CH elected stochastic is about the LEACH 100 * 100 and 200 * 200 and 400 * 400. Each

0.105, 0.106, 0.105 As is showing a relative error of 5% and 6% and 5%. And CH elected stochastic is about 100 * 100 and 200 * 200 and 400 * 400 in ML-LEACH. Each 0.1009, 0.1012, and 0.9963 seen as the relative error of 0.9% and 1.2% and -0.37%. also CH elected stochastic is about 100 * 100 and 200 * 200 and 400 * 400 in DL-LEACH. Each 0.1001, 0.10018, and 0.1001 as showing a relative error of 1% and 1% and 1%. DL-LEACH is evenly depending on the field size than the ML-LEACH. The elected cluster head 10 shows that the distribution is centered. However, The size of the field can be seen that the distribution becomes unbalanced, so the larger.

Next, the listed above four kinds of network lifetime, energy consumption, scalability, CH elected ratio Compare between protocols have indicated the CH elected ratio item. ML-LEACH and DL-LEACH is excellent network scalability field compared to LEACH. And it was confirmed that extending the lifetime. It is summarized in Table 3.

Table 3. The Comparison Itmes Table of Protocols

Routing Protocols	Classification	Data Transmission Cuminication	Scalability	Energy Usage	CH Selection	Network Time
LEACH	Hierarchical Rounting Protocol	Two – Hop Transmission	Normal	Normal	Approximate p	Normal
ML-LEACH	Hierarchical Rounting Protocol with layerd	Multi – Hop Transmission	High Space Scalability	Low	Approximate p	Long
DL-LEACH	Hierarchical Rounting Protocol with layerd	Dual –Hop Transmission	High Space Scalability	Low	Approximate p	Long

4. Conclusion

  Study on the routing protocol of the wireless sensor networks to date has been proposed to improve the performance of the sensor network. In particular, a method for extending the life of the wireless sensor network is finished the main. Accordingly, verification of performance of the proposed routing protocols have been limited to the life time. ML-LEACH, DL-LEACH than LEACH through Performance Comparison is extending the life of the network, and it was confirmed the energy consumption efficiency is excellent. In addition, excellent scalability could confirm the excellent uniformity of the CH elected to chance. Also it places a great significance for what came up derive the criterion for performance comparison Compare beyond the limited performance compared to the existing network life cycle.

References

[1] C. Otto, A. Milenkovic, C. Sanders and E. Jovanov, "System Architecture of a Wireless Body Area Sensor Network for Ubiquitous Health Monitoring", Journal of Mobile Multimedia, Vol. 1, pp. 307-326, 2006.

[2] Mohammed Abo-Zahhad, Sabah M. Ahmed, Nabil Sabor and Shigenobu Sasaki, A NEW Energy-Efficient Adaptive Clustering Protocol Based on Genetic Algorithm for Improving the Lifetime and the Stable Period of Wireless Sensor Networks, International Journal of Energy, Information and Communications, Vol.5, No. 3, (2014), pp.47-72. B. Sklar, Digital Communications, Prentice Hall, pp. 187, 1998.

[3] Heinzelman, W. R., Energy-efficient communication protocol for wireless microsensor networks. In System sciences, pp.10. 2000.

[4] Youngil Song., The Hierarchical Multi-hop Routing Protocol For The Wireless Sensor Network. ISAAC 2014 & ICACT 2014, AACL 03, p.148, 2014.