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The Comparison of the 3D graph for the energy-equal of LEACH-Mobile

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Abstract

In this paper, propose an algorithm to improve network lifetime by equally consuming energy of LEACH - Mobile sensor nodes. LEACH is one of energy efficient protocols. However, we did not consider the mobility of nodes. Therefore, the transmission reception success rate of the moving data is reduced. LEACH-Mobile is a protocol that has improved the drawbacks of these LEACH. However, since LEACH-Mobile has a larger number of data packets and consumes more energy than LEACH, it has a disadvantage that the lifetime of the network is short. In order to improvement these disadvantage, Based on the average of the remaining energy of the node, cluster heads are elected with a number of nodes whose energies are larger than the average of the remaining energy from the member nodes. After that, by trying to increase the lifetime of the network by equalizing the remaining energy. In to confirm whether improve the lifetime of the network, In this paper, the number of nodes and the position of all nodes are varied for each specific round, the rest energy is equalized, and the algorithm which uniformly selected the cluster head is compared with LEACH.

Keywords: *Wireless sensor network (WSN), Mobile node, LEACH, LEACH-Mobile, energy equal*

1. Introduction

Wireless sensor networks are the core technology of the ubiquitous network which has been developed rapidly recently. A wireless sensor network is a network of ones that continuously monitor environmental and resources using sensors. The wireless sensor network consists of sensors and processors, radios, and base stations. Sensor senses, processor processes, takes over wireless communication, collects data from base stations, and controls the network. Generally, wireless sensor nodes have their own energy restrictively.

Wireless sensors are placed in places out of reach of people, since the number of sensors is large and it is not possible to exchange energy regularly, it is necessary to use it efficiently. A solution that increases energy efficiency with limited energy is the main point of the wireless sensor network protocol, and many

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researches on this are under way. A representative clustering-based protocol for these studies is LEACH (Low Energy Adaptive Clustering Hierarchy) [1]. LEACH is a clustering routing protocol, each cluster consists of a cluster head and a member node. Nodes that function as cluster heads are different for every round, and at least all nodes are configured to be cluster heads at least once. Therefore, energy consumed by the nodes in the network will be even. So LEACH is more energy efficient than other routing protocols.

However, when transmitting and receiving data while the node moves, the success rate markedly decreases. Therefore, it is not suitable for a network where nodes have mobility. In order to remedy these drawbacks, an algorithm of LEACH - Mobile [2] was proposed in which the node improved the problem of data transmission reception success rate when moving. LEACH-Mobile has larger than node energy consumption the LEACH, but the success rate when sending and receiving data while the node is moving is better than LEACH. However, when transmitting and receiving data, since the total number of data transfer packets is large, the remaining energy consumption of the node is unequal and large. Due to these shortcomings, network life is unstable due to energy imbalance.

In this paper, we to improve the lifetime of the network by equalizing the remaining energy consumption of the LEACH-Mobile node. Also, the existing LEACH-Mobile does not consider the case where a sensor node is added, in the proposed algorithm, the total number of nodes and the position of the node are varies for each specific round. Also, cluster heads were chosen equally.

2. Related Researches

2.1 LEACH protocol

LEACH (Low Energy Adaptive Clustering Hierarchy) is a hierarchical routing protocol. This protocol that uses a method of managing a network divided into a plurality of clusters to improve the overall energy efficiency of the network and optimize the lifetime of the network. A cluster consists of a member node and a cluster head, and the cluster head changes for every round. Member nodes are responsible for collecting data and forwarding it to the cluster head. The cluster head has a role of transferring data received from a member node to a base station. The LEACH transmits data to the cluster head according to the time slot allocated according to the TDMA of FIG. 1, and the cluster head merges the received data and transmits to the base station. In order to elect cluster heads, cluster heads are selected out of the member node using stochastic critical equations such as equation (1). Nodes elected to the cluster head once are not selected again until all nodes not elected to the cluster head are selected as cluster heads.

$$T(n) = \begin{cases} \frac{p}{1-p(r \bmod \frac{1}{p})} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

In addition, the cluster head does not have to send unnecessary additional data by merging data and transmitting to the base station. Since the role of the cluster head is alternated by all nodes, energy consumption is dispersed and the lifetime of the network is increased.

However, as the data transmission / reception distance increases, the energy consumed abruptly increases, and the life expectancy of the overall network decreases. For this reason, in order to display the maximum efficiency, the field is small and the base station must be centrally located. Also, since LEACH is a protocol that does not consider data transfer at the time of movement, the data transmission success rate at the time of movement is lower.these disadvantages are improved by LEACH-Mobile.

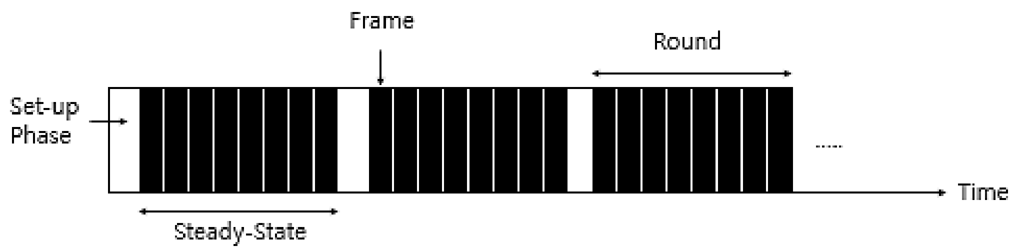


Figure 1. TDMA of LEACH

2.2 LEACH-Mobile

LEACH-Mobile is a protocol complementing the success rate of data transmission in a mobility-centric environment by adding a mobility mobile node to the disadvantage that the success rate of LEACH data transfer decreases in a mobility-centric environment. The mobile node periodically transmits a message on whether to join the cluster head, thereby improving the data transmission rate with the movement of the node.

TDMA of LEACH-Mobile is different from TDMA of LEACH. In the LEACH TDMA schedule, the cluster head receives data of the member node according to the TDMA schedule in order to receive the data. On the other hand, the TDMA of the LEACH-Mobile [4] in FIG2 transmits a request message that the cluster head allocates slots to the member nodes to receive data and transmits data to the nodes at corresponding time intervals. The node receiving the send-request message sends the data to the cluster head and the node that has not received the send-request message of the cluster head waits until it receives the send-request message. If it does not receive the send-request message, the node transmits a join message to the cluster head, allocates a time slot, receives the send-request message, and transmits the data. If data from the node that sent the send-request message is not received and the join message is not sent, the corresponding node deems it to be out of the cluster and excludes it from the schedule. The node leaving the cluster sends a join message to the cluster head of the current cluster, joins the cluster, and is assigned a slot. TDMA of LEACH-Mobile increase the transmission success rate of data from the movement of the node. However, it has the disadvantage that the energy consumption of the sensor node is unequal. In the wireless sensor field, problems associated with addition of sensor nodes were not considered. Therefore, in this paper, we would like to propose an algorithm for equal energy consumption of sensor nodes as a result of movement of nodes in the sensor field and addition of sensor nodes.

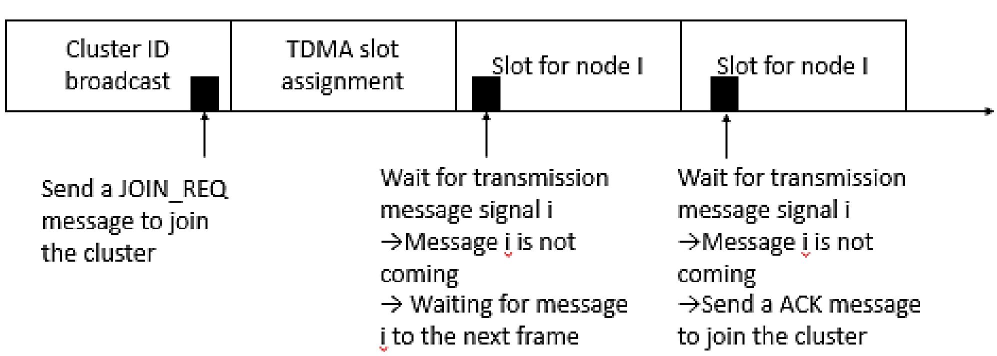


Figure 2. TDMA of LEACH-Mobile

2.3 Proposed algorithm

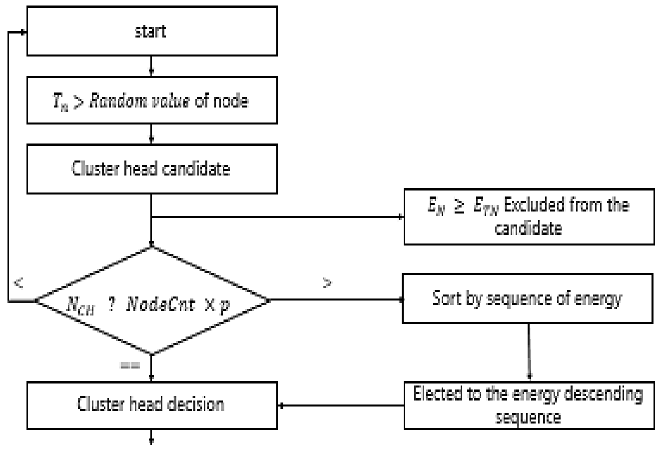


Figure 3. Cluster head considering remaining energy equal of elect algorithms

In this paper, we would like to propose an algorithm for equal energy conservation of sensor nodes along with movement of nodes in the sensor field and addition of sensor nodes. In the environment of the algorithm to be proposed, variables occur in the number of sensor nodes. However, even if a variable occurs in the number of sensor nodes, if a cluster head is selected as in the conventional method, as time passes, most of the energy consumed will be borne by the existing node.

Therefore, we propose a method of selecting the cluster head by equalizing the remaining energy of the node. The algorithm in FIG 3 is an algorithm for equalizing the remaining energy and selecting the number of cluster heads equally.

If the probability equation T (n) is greater than the random value of the node, that node is elected as the cluster head candidate. The cluster head candidate is excluded from candidates when the remaining energy of the candidate is smaller than the average value of the residual energy of the entire node. If the elect cluster head candidate is smaller than the cluster head equal count, the candidate is selected again. If there are many cluster heads, arrange them in order of energy and elect even number of cluster heads in descending order of residual energy. In the same case, it is selected as it is as a cluster head. Thereafter, the cluster head elected via the algorithm, receives and merges the data of the member node according to the TDMA of LEACH in Fig 1 LEACH, and transmits it to the base station.

3. Simulation Result

The values of simulation environment and radio mode are the same as those in Tables 1 and 2 below. For simulation, the size of the field and the position of the base station are fixed, and the condition is defined as Table 1.

The number of nodes is 50 nodes from 1 round to 100 rounds, 70 nodes from 101 rounds to 300 rounds, 100 nodes from 301 rounds to 500 rounds, 70 nodes from 501 rounds to 700 rounds, 50 nodes from 701 rounds to 900 rounds.

Moreover, the conventional LEACH-Mobile does not consider the case where a sensor node is added. According to the proposed algorithm, the positions of all the nodes and the number of nodes are varied every specific round.

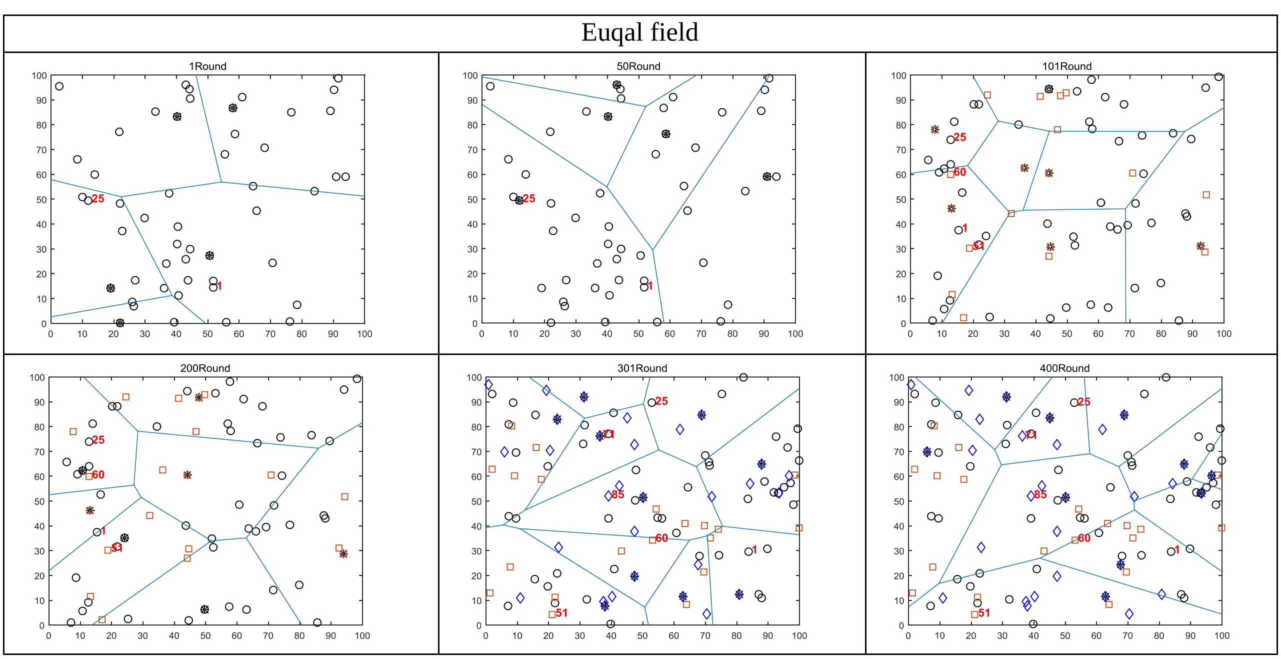
Table 1. Simulation Condition

Parameter		Value
Sensor Field		100m*100m
Position of Base Station		50m*150m
Probability of Cluster Selection(p)		0.1%
Number Of Sensor Nodes	1~100 round	50
	101~300 round	70
	301~500 round	100
	501~700 round	70
	701~900 round	50

Table 2. Radio Model

Parameter	Value
Initial Energy(J)	0.5
Size of Packet	2000
ε_{elec}	$50*10^{-9}$
ε_{fs}	$0.1*10^{-10}$
ε_{mp}	$13*10^{-16}$

FIG 4 shows that the number of nodes and positions of the nodes are varies for each specific round. In FIG 4, shown in Circle from No. 1 to No. 50 of the node, Square from No. 51 to No. 70 of the node, Diamond from No. 71 to No. 100 of the node, and cluster head is shown in star. In order to confirm the node position change, the positions of 1, 25, 51, 60, 71, and 85 nodes are shown for each round in Table 4.



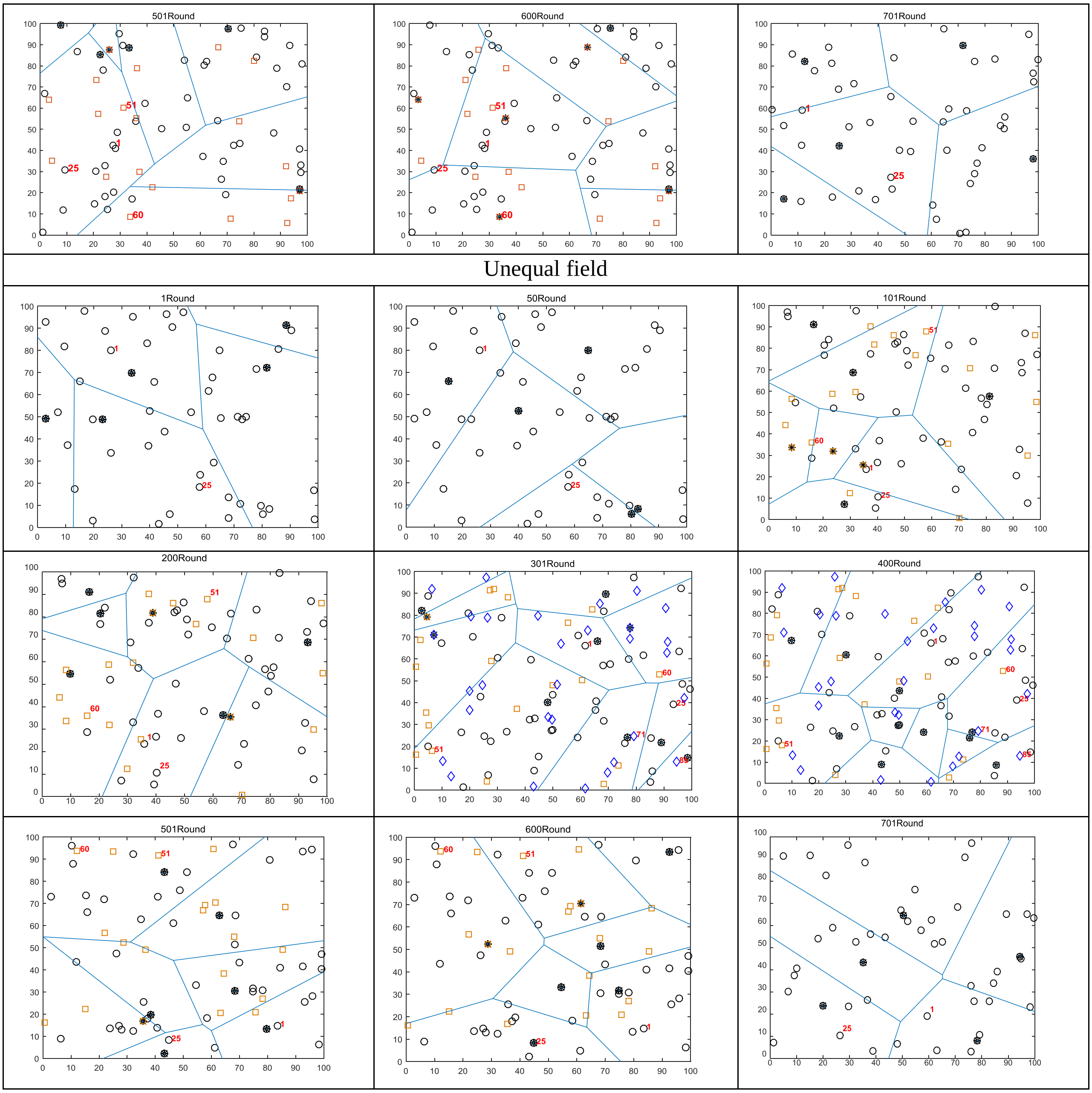


Figure 4. Move nodes and clusters

Table3. Number of clusters in a specific round

Round	1	50	101	200	301	400	501	600	701
Node_Count	50	50	70	70	100	100	70	70	50
Cluster_Count	5	5	7	7	10	10	7	7	5

Table4. Node location for a specific round

Node_number	1	25	51	60	71	85
1round	51.69, 14.31	11.92, 49.5	x	x	x	x
50 round	51.69, 14.31	11.92, 49.5	x	x	x	x
101 round	15.34, 37.33	12.67, 73.94	18.74, 30.3	12.7, 59.9	x	x
200 round	15.34, 37.33	12.67, 73.94	18.74, 30.3	12.7, 59.9	x	x
301 round	83.68, 29.69	52.92, 89.55	21.16, 4.2	53.02, 34.33	36.18, 76.1	39.02, 51.9
400 round	83.68, 29.69	52.92, 89.55	21.16, 4.2	53.02, 34.33	36.18, 76.1	39.02, 51.9
501 round	27.34, 42.45	9.42, 30.84	31.19, 60.31	33.64, 8.73	x	x
600 round	27.34, 42.45	9.42, 30.84	31.19, 60.31	33.64, 8.73	x	x
701 round	11.74, 59.11	44.7, 27.3	x	x	x	x

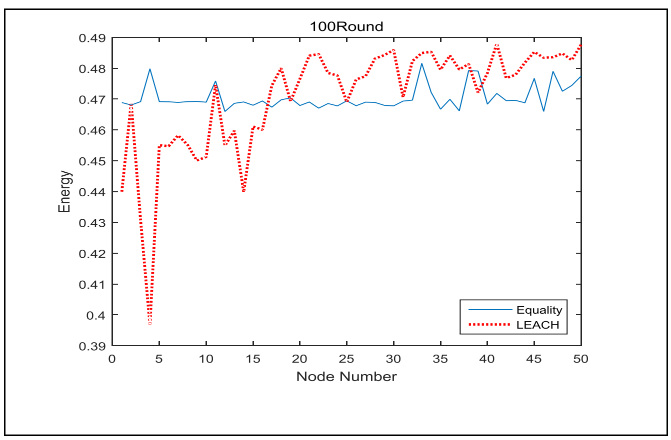


Figure 5. The remaining energy up to 100 rounds

Table5. Comparison up to 100 rounds

	size	Node Number	Residual energy	X_location	Y_location
Equal	Maximum	33	0.48	90.1	93.93
	Minimum	12	0.46	65.59	45.19
Unequal	Maximum	41	0.48	35.09	83.13
	Minimum	4	0.39	57.85	23.72

FIG 5 is the remaining energy of the node from the 1 round to 100 rounds. The number of nodes is 50. Blue is a case where the proposed equalization algorithm is applied, and red is a case where the general LEACH algorithm is applied. As shown in FIG 3, it shows that the energy of the entire node is evenly consumed (Table 5 shows the remaining energy and the node number and location of many nodes and small nodes.).

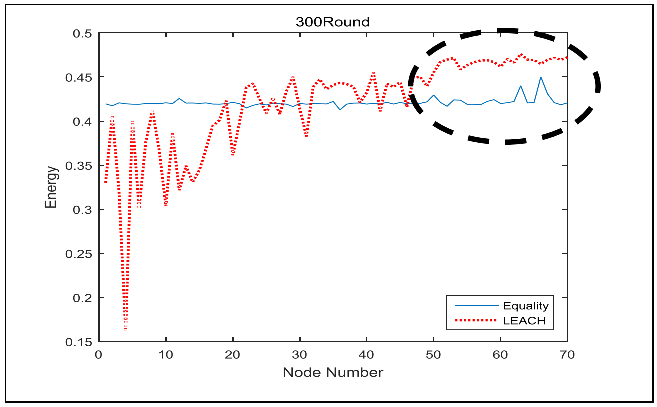


Figure 6. The remaining energy up to 300 rounds

Table6. Comparison up to 300 rounds

	size	Node Number	Residual energy	X_location	Y_location
Equal	Maximum	33	0.48	90.1	93.93
	Minimum	12	0.46	65.59	45.19
Unequal	Maximum	41	0.48	35.09	83.13
	Minimum	4	0.39	57.85	23.72

FIG 6 is a graph of the remaining energy of the node from 101 rounds to 300 rounds. 20 nodes from the 101 round to the 51 to the 70 nodes are added, totaling 70. In the case of equality, the cluster head election count of the existing node is 820 times, and the node number 51 to 70 is 580 times. In the case where energy is not taken into account, the cluster head selection count of the existing node is 1311 times, and the added node is 89 times.

The portion indicated by an ellipse in FIG 6 is an added node. When the equalization algorithm is applied, the number of times of selection between the existing node and the added node is similar and the remaining energy difference is not large, but in the case of LEACH, the number of times of selection of the existing nodes is different greatly can be confirmed.

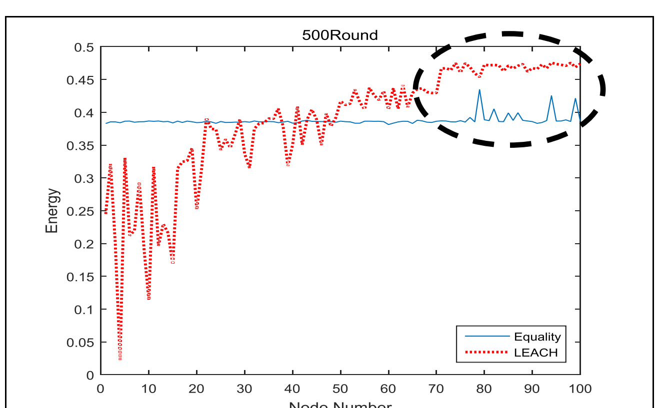


Figure 7. The remaining energy up to 500 rounds

Table7. Comparison up to 500 rounds

	size	Node Number	Residual energy	X_location	Y_location
Equal	Maximum	79	0.43	31.31	92.05
	Minimum	91	0.38	84.26	57.13
unequal	Maximum	88	0.47	51.5	48.17
	Minimum	4	0.02	68.07	57.11

FIG 7 is a graph of the remaining energy of the node from 301 rounds to 500 rounds. 30 nodes from the 301 round to the 71 to the 100 nodes are added, totaling 100. In the case of equality, the cluster head election count of the existing node is 560 times, and the node number 71 to 100 is 1494 times. In the case where energy is not taken into account, the cluster head selection count of the existing node is 1860 times, and the added node is 140 times.

The portion indicated by an ellipse in FIG 7 is an added node. Likewise, when the equal algorithm is applied, it can be confirmed that the difference between the existing node and the remaining energy is not large, but in the case of LEACH, the difference is large.

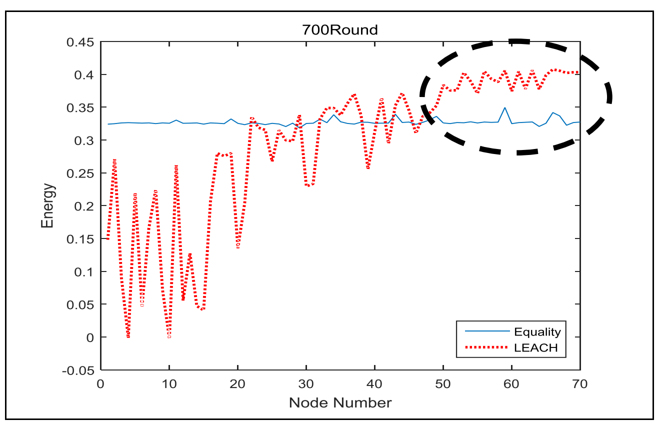


Figure 8. The remaining energy up to 700 rounds

Table8. Comparison up to 700 rounds

	size	Node Number	Residual energy	X_location	Y_location
Equal	Maximum	59	0.34	3.4	63.88
	Minimum	64	0.32	35.94	55.28
unequal	Maximum	66	0.40	14.99	22.32
	Minimum	4	0	40.63	13.91

FIG 8 is a graph of the remaining energy of the node from 501 rounds to 700 rounds. The nodes numbered 71 to 100 are reduced, which is a total of 70 nodes. In the case of equality, the cluster head election count of the existing node is 1059 times, and the node number 51 to 70 is 341times. In the case where energy is not taken into account, the cluster head selection count of the existing node is 1324 times, and the added node is 76 times.

The portion indicated by an ellipse in FIG 8 is an added node. Equal algorithm is applied, the energy difference between the existing node and the rest is not large. In the case of LEACH, a dead node occurs in an existing node, whereas the added node has a lot of remaining energy.

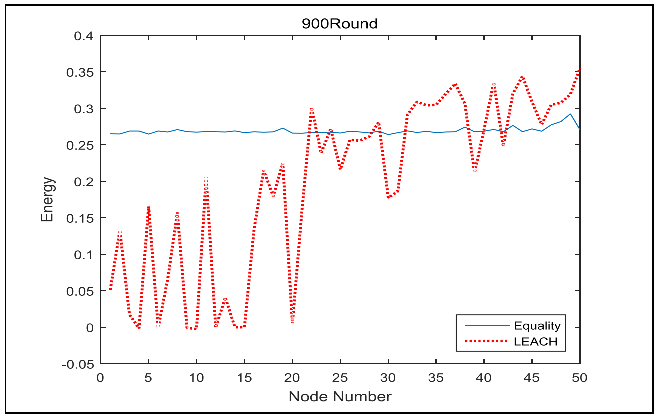


Figure 9. The remaining energy up to 900 rounds

Table9. Comparison up to 900 rounds

	size	Node Number	Residual energy	X_location	Y_location
Equal	Maximum	49	0.29	61.96	7.54
	Minimum	25	0.26	44.7	27.3
unequal	Maximum	50	0.35	20.99	82.7
	Minimum	4	0	44.9	21.37

FIG 9 is a graph of the remaining energy of the node from 701 rounds to 900 rounds. Nodes 51 to 70 are reduced, which is a total of 50 nodes.

All the added nodes disappear and are elected as existing nodes. In the case of equality, the number of cluster head elections of the existing node is 1000, and in the case where energy is not taken into account, the number of cluster head election times of the existing node is 1000 times.

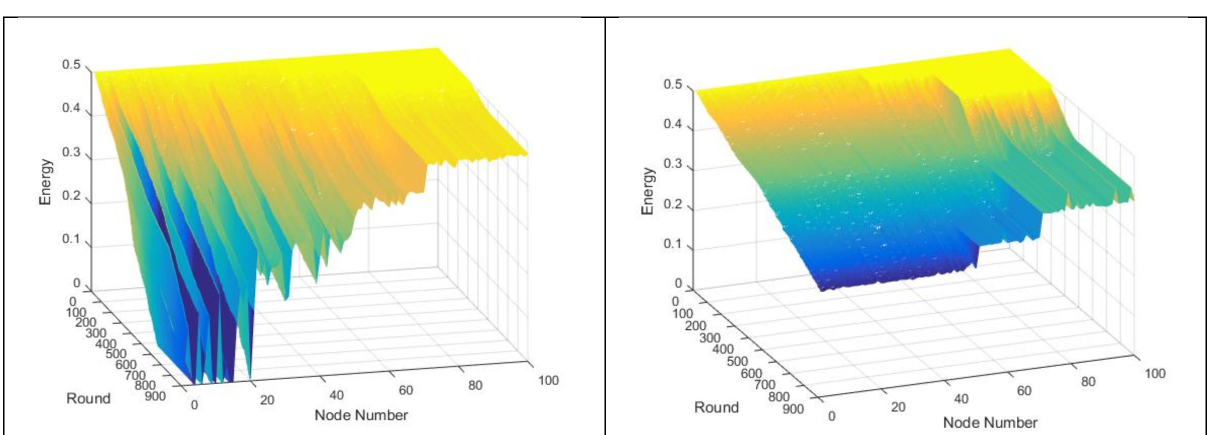


Figure 10. 3D graph of existing algorithm (left) and proposed algorithm (right side)

That is, when the residual energy to the node by round is represented by a 3D graph, it is as shown in FIG 10. When the remaining energy is equalized, it consumes mainly nodes having a large amount of energy when the number of nodes changes. Therefore, the shows a gentle graph. On the other hand, when the remaining energy is not considered, Even if variables occur, existing nodes are continuously used and the residual energy difference between the nodes increases.

So, can see the rapid graph is displayed. Therefore, the proposed method can know that even if the number and position of the nodes are varied, the energy consumption of each node is equalized.

4. Conclusion

LEACH-Mobile is a protocol that improves the disadvantage that the success rate of data transfer is low when LEACH moves. However, the lifetime of networks with high energy consumption is short. In order to increase the lifetime of the network, for every specific round, the remaining energy equalization algorithm was compared with LEACH in a situation where all nodes moved and the number of nodes was variable. As shown in 3 d graph, in the algorithm not applied evenly, the remaining energy difference of the node is severe. On the other hand, as shown in the 3d graph using the proposed protocol, energy is not intensively consumed by one node. In Therefore, the proposed protocol the energy is exhausted equally, the lifetime of the network has improved. Addition, when a new node flows in, cluster heads are selected, centering on new nodes.

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