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Some WSN Characteristics Effects on the Performance of LEACH and MODLEACH Protocols

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Abstract: This paper studies a number of network characteristics of Low Energy Adaptive Clustering Hierarchy (LEACH), and Modified Low Energy Adaptive Clustering Hierarchy (MODLEACH) protocols. It intends to enumerate dead nodes, alive nodes, and packet-to-BS and packet-to-CH consumed by the entire network, and affected by its characteristics e.g. network area, probability, number of rounds, number of nodes, and energy of data aggregation. Different values of these characteristics produce different results of dead nodes numbers, which effect network performance. Finally, a brief performance analysis of Low Energy Adaptive Clustering Hierarchy (LEACH) and Modified Low Energy Adaptive Clustering Hierarchy (MODLEACH) is carried out considering metrics of the previous characteristics of wireless sensor network.

Keywords: WSN, LEACH, MODLEACH, network area, probability, number of rounds, number of nodes and data aggregation energy.

1 Introduction

Wireless sensor networks have become an attractive research field because it is considered the largest growing technology today. It has several unique characteristics including, a dense level of node deployment, high unreliability of sensor nodes, inexact computation, and energy and storage constraints [1]. These characteristics pose serious challenges to its applications and development. WSN consists of a large number of sensors, which have low cost, low power, and small size that allows it to be used in an array of fields including military and medical applications [2]. Routing in WSN has many constrains such as transmission power, energy, processing capacity, and the storage of sensor node that requires careful resource management. It is largely different from traditional wireless ad hoc networks. Various previously studied protocols depend fundamentally on how to communicate alive and dead nodes' numbers to the network [3]. Dead nodes of a network can denote the network's lifetime, accordingly it is important to study. we used, a number of network characteristics such as network area, probability, number of rounds, number of nodes and energy of data aggregation are discussed. Additionally, dead nodes, alive nodes, packet-to-BS and packet-to-CH were also studied in relation to their direct effect on the network's lifetime. The network characteristics were applied to the main hierarchical protocols LEACH and MODLEACH protocol. LEACH protocol is typically classified as a hierarchical routing protocol. It is a self-organized and adaptive protocol that uses 'round' as a measuring unit and each round is made up of a cluster set-up stage, and steady state storage devised to eliminate unnecessary energy costs [4,5]. Modified Low Energy Adaptive Clustering Hierarchy (MODLEACH) [6,7] has efficient head replacement scheme, and a dual transmission power level that also helps in energy conservation. It also performs better on various levels, especially network lifetime and optimized clustered head formation [8]-[10]. We simulate LEACH and MODLEACH hierarchical protocols of WSNs using MATLAB. For the simulation, we use the parameters indicated in table 1, that include various numbers of nodes 200,5000,1000, different network area 100*100, 300*300, 500*500 and deferent cluster head probability 0.1, 0.3, 0.6. We considered the BS placed the center of the network field as shown in Table 1. Section 2 of the paper shows the motivation for work. Section 3 describes the experimental process and results. In section 4, the main conclusions are discussed, and in the last section, references are presented.

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2 Motivation

LEACH comprises several protocols. These protocols' procedure is compact, and copes well with homogeneous protocols of sensor networks. In each round of this protocol, new cluster head is selected, accordingly, new cluster formation is crucial to the process. Consequently, we could conclude that any unnecessary routing overhead results in excessive use of limited energy [11]-[13]. If cluster head does not use the majority of its energy during a given round, there is a probability that some nodes that have low energy will replace it as a cluster head in the proceeding cluster-head selection process. Accordingly, assuming residual energy of existing cluster head, preventing change of cluster heads is required at every round. Based on the above, an efficient cluster head manipulated with an algorithm is expected to conserve energy. Therefore, employing the LEACH protocol, nodes use same ampilified energy to transmit data while ignoring the distance between transmitter and receiver. To save energy, the selected transmission process requires ampilification energy to communicate with base station. Locating and calculating distances within full network topology requires substantial routing; accordingly, this paper tests a number of network characteristic devised to save energy, and tests the protocols' performance properties using dead nodes, packet-to-base station, number of cluster heads, and alive nodes elements [14]-[16].

3 Experimental and Results

We simulated LEACH protocol and the Modified LEACH (MODLEACH) protocol with different parameters as showed as in table 1.

Figures (1, 2, 3): depict the different values of network area effects on the performance of LEACH and MODLEACH protocols 1- 100X100, 2- 300X300, 3- 500X500 respectively.

The first simulation runs on different area-network =100*100, 300*300, 500*500, and constants of the other parameters such as Number of node =200, Number of round =1000 Probablity =0.1, Data aggregation energy =100*0.00000000. Figures 1,2,3 show the simulation by using different network area 100X100 on the LEACH and MODLEACH protocols. From figure (1) it can be seen that the dead nodes and alive nodes of MODLEACH are fewer in number than those of LEACH. The packet-to-base station and number of cluster heads seem to be similarly affected. Figure (2) shows that the dead and alive nodes of MODLEACH decreased more than those of LEACH protocol as the network area increased. The packet-to-base station of MODLEACH increased unlike that of LEACH. Number of cluster heads of MODLEACH increased unlike that of LEACH protocol. Figure (3) shows that by increasing network area; unlike the previous test, the dead nodes, alive nodes,

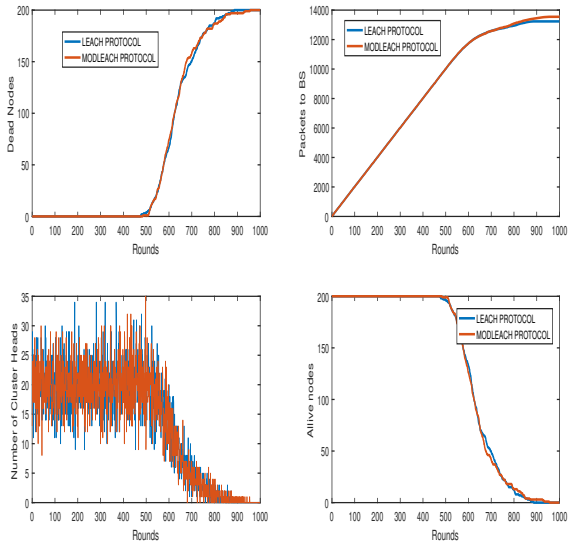

Fig. 1: comparison of LEACH and MODLEACH with network area is 100*100.

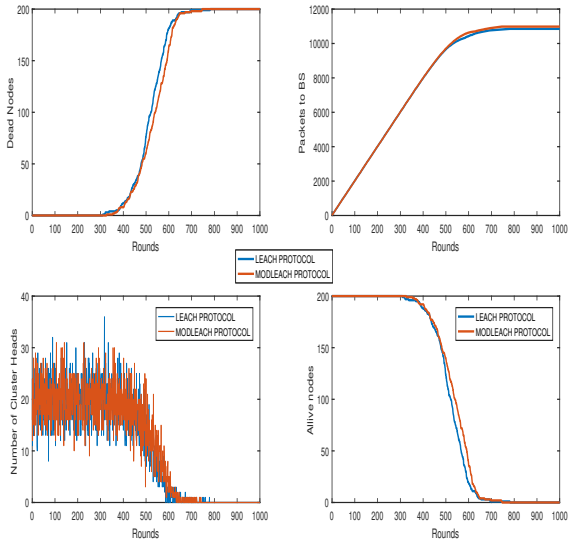

Fig. 2: comparison of LEACH and MODLEACH with network area is 300*300.

packet-to-base station and the number of cluster heads of MODLEACH increased at a higher rate compared to those of LEACH protocol.

Figures (4, 5, 6) show the different values of nodes numbers' effects on the performance of LEACH and

Table 1: Table 1: list of simulation parameters

S. No.	Parameters	Values
1	Network Area	100*100,300*300,500*500
2	Number of Nodes	200,500,100
3	Cluster head Probability	0.1,0.3,0.6
4	Initial Energy	0.1
5	Transmiter Energy	10*0.000000001, 50*0.000000001, 100*0.000000001
6	Reciever Energy	10*0.000000001, 50*0.000000001, 100*0.000000001
7	Aggregation Energy	20*0.000000001,50*0.000000001,100*0.000000001
8	Amplification Energy	0.0013* 0.000000000001
9	Number of Rounds	1000,2000,3000

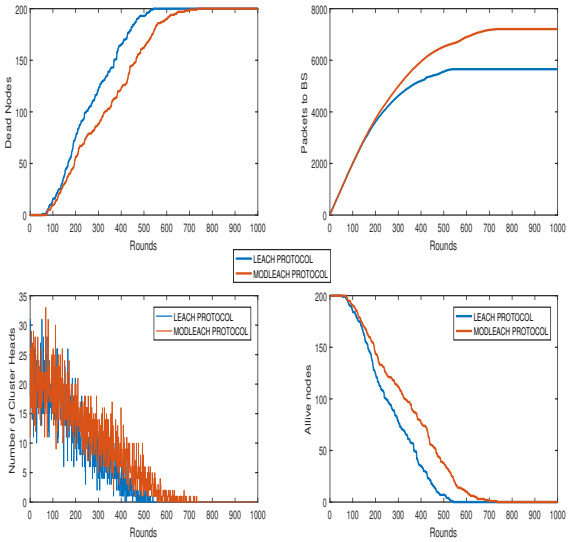

Fig. 3: Comparison of LEACH and MODLEACH with network area is 500*500.

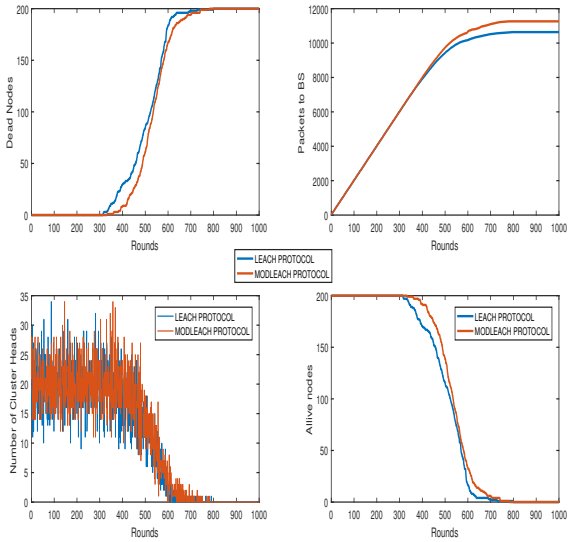

Fig. 4: comparison of LEACH and MODLEACH with Number of nodes is 200.

MODLEACH protocols 4- 200, 5- 500, and 6- 1000 respectively.

As similar as the second simulation experiment the runs on different Number of node =200, 500,1000 and a constant of the other parameters like network area =300*300, Number of round =1000, Probability =0.1, Data aggregation energy =100*0.000000001. To illustrate, figure (4) shows a simulation using 200 nodes numbers on the LEACH and MODLEACH protocols to compare the performance of each protocol. The dead nodes and packet-to-base station, number of cluster heads and alive nodes of MODELEACH increased compare to those of the other LEACH protocol. Figure (5) shows another simulation by increasing the number of nodes to 500, where all of dead nodes, packet-to-base station, number of cluster heads and alive nodes of LEACH showed insignificant decreased compared to those of MODLEACH protocol. Figure (6) indicates that the dead nodes, packet-to-base station, number of cluster heads and alive nodes of all protocols increased with increasing number of nodes to 1000, yet the level of increase was higher in the case of MODLEACH compared to LEACH protocol.

Figures (7, 8, 9) show the different values of rounds numbers' effects on the performance of LEACH and MODLEACH protocols, where 7- 1000, 8- 2000, and 9- 3000 respectively.

Similar to first and second simulations, the third one tests different number of rounds (1000, 2000, 3000), and constants of other parameters like network area (300*300), Number of node (200), Probablity(0.1), Data aggregation energy =100*0.000000001. Correspondingly,

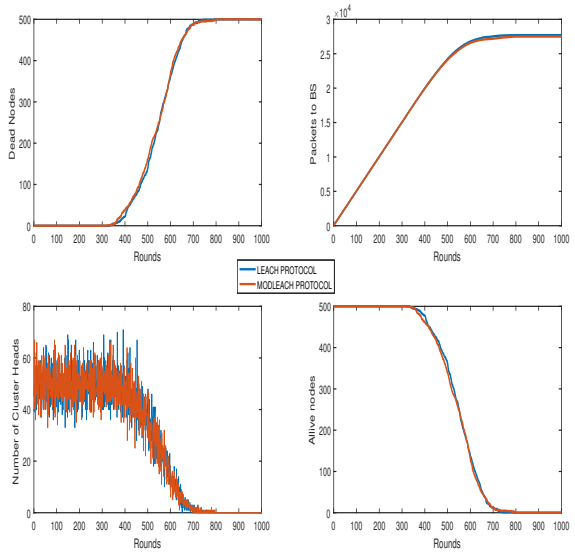

Fig. 5: Comparison of LEACH and MODLEACH with Number of nodes is 500.

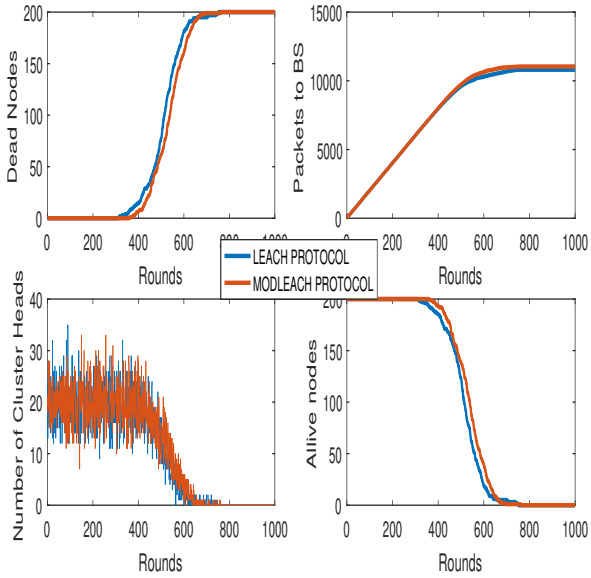

Fig. 7: Comparison of LEACH and MODLEACH with number of round is 1000.

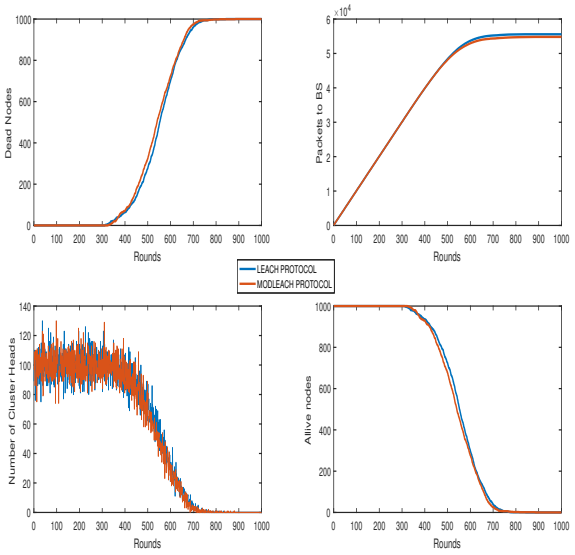

Fig. 6: Comparison of LEACH and MODLEACH with number of nodes is 1000.

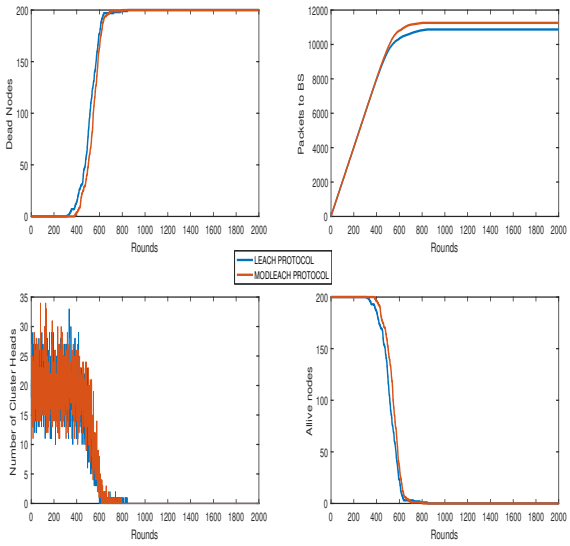

Fig. 8: Comparison of LEACH and MODLEACH with number of round is 2000.

figure (7) shows the simulation using 1000-round numbers on LEACH and MODLEACH to cross-reference the protocols' performance. The dead nodes and packet-to-base station, number of cluster heads and alive nodes of MODELEACH increased compared to those of LEACH protocol. Figure (8) shows another simulation where the number of rounds was increased to 2000. In that case, all of dead nodes, packet-to-base station, number of cluster heads, and alive nodes of LEACH showed insignificant decrease compared to those of

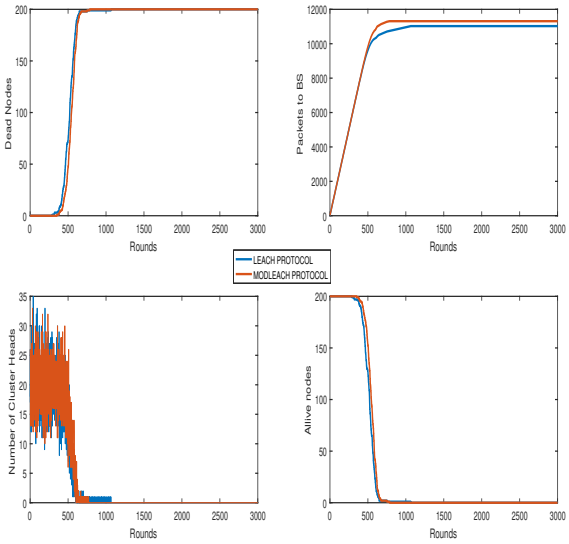

Fig. 9: Comparison of LEACH and MODLEACH with number of round is 3000.

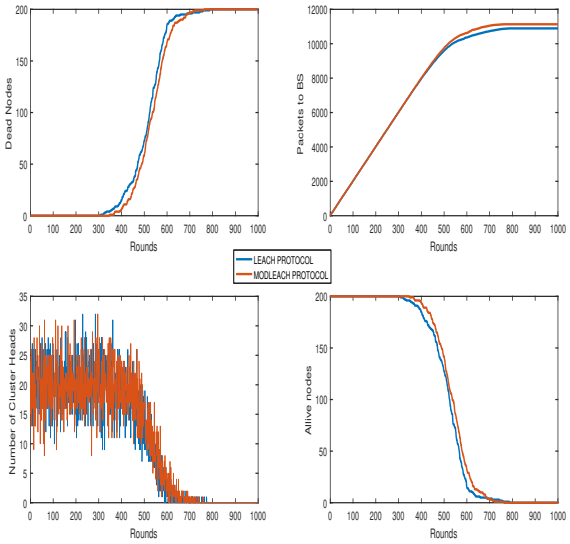

Fig. 10: Comparison of LEACH and MODLEACH with cluster head probability is 0.1.

MODLEACH protocol. Figure (9) illustrates that the dead nodes, packet-to-base station, number of cluster heads, and alive nodes of all protocols increased with increasing number of rounds to 3000, yet increased more significantly in the case of MODLEACH protocol compared to LEACH. As can be inferred from figures, the parameters that are used to test performance reach a stable steady-state stage after approximately 700 rounds.

Figures 10, 11, and 12 show the different values of Cluster head probability effects on the performance of LEACH and MODLEACH protocols. Where 10- 0.1, 11- 0.3, 12- 0.6 respectively.

In the fourth simulation we tested different values of cluster head probablity (0.1, 0.3, 0.6), and left constant of another parameters like network area =300*300, number of node =200, number of round =1000, data aggregation energy =100*0.000000001. Figure (10) shows the simulation using 0.1 cluster head probability on LEACH and MODLEACH protocols to compare the performance for each protocol. The dead nodes and packet-to-base station, number of cluster heads and alive nodes of MODELEACH increased in similar manner compared to other LEACH protocol. Figure (11) shows another simulation in which cluster head probability was increased to 0.3. All of dead nodes, packet-to-base station, number of cluster heads and alive nodes of LEACH decreased compared to MODLEACH protocol, but dead nodes numbers and alive nodes number remained the same by increasing number of round to 500 approximately. Figure (12) shows that the dead nodes, packet-to-base station, number of cluster heads and alive

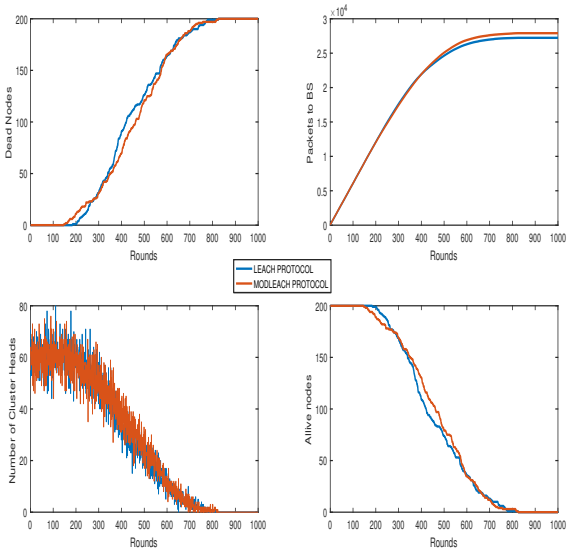

Fig. 11: Comparison of LEACH and MODLEACH with cluster head probability is 0.3.

nodes of all protocols increased with increasing cluster head probability to 0.6. It is observed that the dead and alive nodes remained the same starting from 400 rounds, yet only insignificant difference was detected.

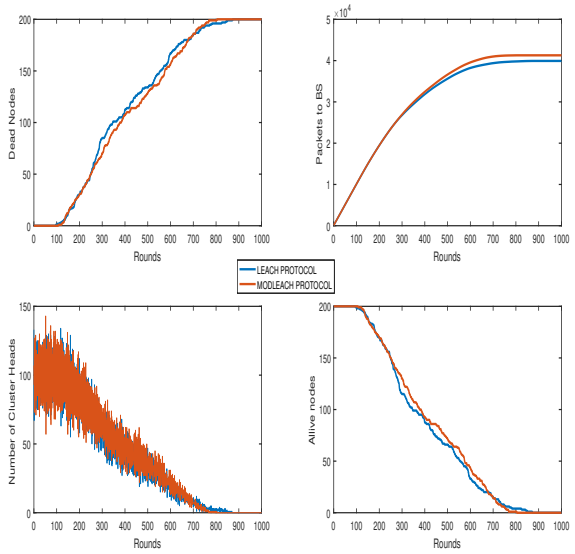

Fig. 12: Comparison of LEACH and MODLEACH with cluster head probability is 0.6.

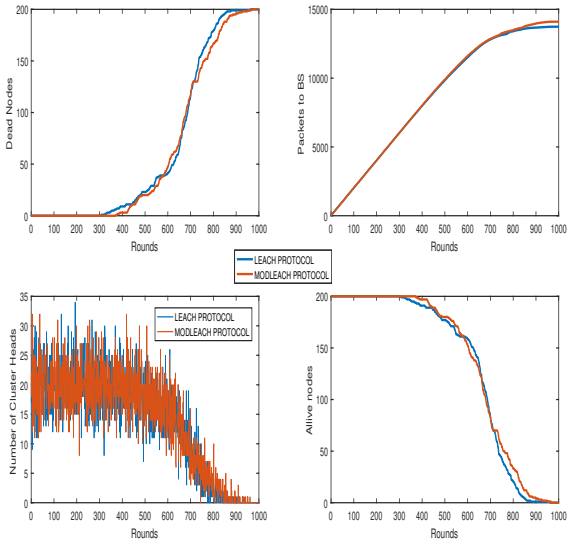

Fig. 14: Comparison of LEACH and MODLEACH with data aggregation energy is 50*0.000000001.

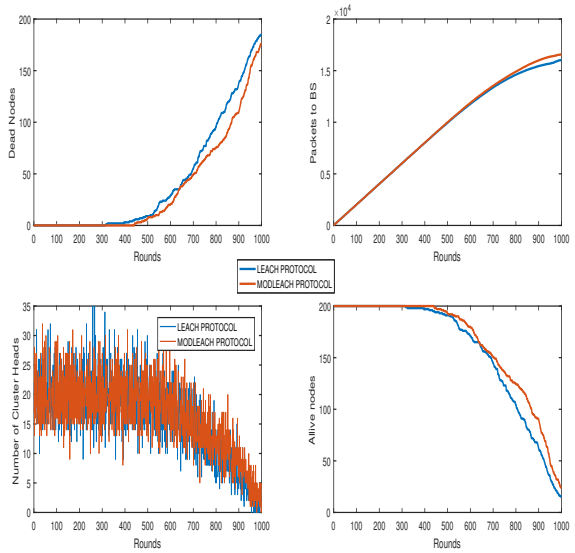

Fig. 13: Comparison of LEACH and MODLEACH with data aggregation energy is 20*0.000000001.

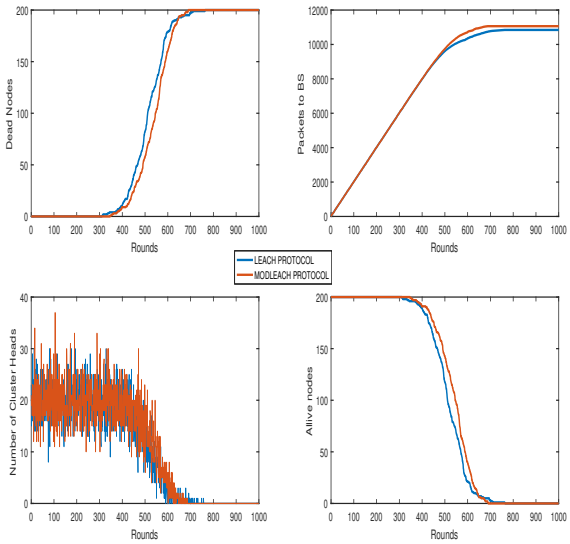

Fig. 15: Comparison of LEACH and MODLEACH with data aggregation energy is100*0.000000001.

Figures 13, 14, and 15 depict the different values of Data aggregation energy effects on the performance of LEACH and MODLEACH protocols. 13- 20*0.000000001, 14- 50*0.000000001, 15- 100*0.000000001 respectively.

The fifth simulation runs on different values of data aggregation energy: (20*0.000000001, 50*0.000000001, 100*0.000000001), and a constant parameter including network area (300*300), number of node (200) , number of round (1000), probablity (0.1). Figure (13) shows the

simulation using 20*0.000000001 data aggregation energy on LEACH and MODLEACH protocols to compare the performance for each protocol. The dead nodes and packet-to-base station, number of cluster heads and alive nodes of MODELEACH increased compared to those of LEACH protocol, and the increasing stile to more than 1000 rounds. Figure (14) shows another simulation in which data aggregation energy increased to 50*0.000000001. Under these conditions, all dead nodes, packet-to-base station, number of cluster heads and alive nodes of LEACH decreased compared to those of MODLEACH protocol, and reached a stable stage at approximately 900 rounds. Figure (15) shows that the dead nodes, packet-to-base station, number of cluster heads and alive nodes of all protocols increased, as the data aggregation energy increased to 100*0.000000001, yet the increase in MODLEACH was more than LEACH protocol. The increase, however, remained constant at approximately 600 rounds.

4 Conclusion

The LEACH protocol is more time consuming than MODLEACH protocol. This was evident in all simulation with different parameters. We observed that the first node dies faster in the non-hierarchical formation since all nodes tend to send captured data via one randomly selected cluster head per round to the base station. The constrained load on the elected cluster heads during the round of simulation significantly reduced the CHs' energy over a short period. We used several network characteristics on LEACH and MODLEACH protocols, which directly affected the dead node's numbers, packet-to-base station, number of cluster heads, and alive node's consumption of the entire network characteristics including network area, probability, number of rounds, number of nodes and energy of data aggregation. Different results have been obtained by different values of these characteristics. Number of parameters that have been used to compare the performance decreased with the increase of network area, while insignificant decrease was witnessed with increasing number of nodes. Additionally, these parameters increased in MODLEACH more than LEACH by increasing number of round and reached a constant stage of increasing after 700 rounds. Again, with increasing cluster head, probability parameter increased in MODLEACH more than in LEACH. Finally, the parameter of simulation increased with increasing data aggregation energy, yet the increase was more in the case of MODLEACH compared to LEACH. Accordingly, the changes of these characteristics must be taken into account while developing wireless sensor networks.

4.1 Future Work

Future improvements should focus on network performance so that the deferent parameters are taken in consideration in order to improve the performance of the wireless senor networks. The different parameters that were used proved that the performance of hierarchical routing protocols have been affected, along with cluster head probability changes, node density and network area. The effects of the protocol's performance can be checked, and they can be made more flexible to all kinds of life applications.

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