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Energy- Efficient Communication Protocol for Wireless Sensor Networks

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***Abstract*— A wireless sensor network contains a set of sensor devices that are usually operating on battery power with a limited energy resources and due to the dimensionality of these networks, replacing the batteries is a complicated task. Thus energy efficiency is one of the most important issues and designing energy efficient protocols is critical for prolonging the lifetime. This paper introduces a two routing protocols namely, LEACH and EAMMH in Homogenous & Heterogeneous system supported by simulation scripts, and analysis of the results against known metrics with energy and network lifetime being major among them. Simulation results using MATLAB shows that the proposed EAMMH in Homogenous & Heterogeneous system significantly reduces energy consumption and increases the total lifetime of the wireless sensor network.**

***Keywords*— Wireless Sensor Networks; Increasing Network Lifetime; Energy Efficient; LEACH; EAMMH; Multi Path; Multi Hop;Dead Node;Clustering; Comparison**

I. INTRODUCTION

A wireless sensor network (WSN) is the network system formed by a large number of sensor nodes working together to gather information from the environment and then transmitting this data to a base station for further processing [1]. The WSN nodes operates on battery power which is often deployed in a rough physical environment; changing the batteries is therefore a complicated task, as some networks may consists of hundreds to thousands of nodes. Such large physically distributed networks increase the difficulty of changing batteries and makes recharging almost impossible during operations, furthermore the applications which WSN are used in, such as forest fire detection, temperature, humidity and military [2]. Hence the power efficiency is one of the challenging topics for wireless communication techniques that are being used for WSN applications. The life time of a wireless sensor node depends on available energy sources and its overall energy consumption. Therefore, many routing algorithms have been proposed due to the challenges in designing an energy efficient network. Among all, hierarchical routing protocols, also known as cluster-based routing, greatly satisfy the limitations and constraints in WSNs [3]. low-energy adaptive clustering hierarchy (LEACH) is an efficient example of an hierarchical routing protocol. The LEACH approach involves formation of clusters of sensor nodes centered on the received signal quality and the use of a local cluster heed (CH) as a router to the base station (BS). A reduction in energy consumption in data transmission is achieved since the CH is involved in transmission to the BS rather than individual sensor nodes [4]. Communication in wireless sensor network can be either of the single-hop or multi-hop. Single-hop simply refers to direct communication from sensor node to cluster head while multi-hop does not require direct communication from all sensors to the base station. But, it can send data to the next cluster head which is closer to the base station. Therefore, multi-hop communication has higher energy efficiency than the single hop within the clusters. When the sensor node is at a far distance from the CH, much energy is expended thereby reducing the lifetime of sensor network [5]. Other many routing protocols have been suggested in [6] [7]. Clustering algorithms have been of much interest as they will balance several key factors of Wireless Sensor Networks operation simultaneously [8].

In the rest of this paper, a working and analysis of LEACH and EAMMH protocols in homogenous and heterogeneous system are presented. The details about simulations using MATLAB tool and the analysis of results are also presented. In conclusion, the effectiveness of both LEACH and EAMMH for respective scenarios and recommendations are proposed.

II. LOW-ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

The low energy adaptive clustering hierarchy [4] (LEACH) is a cluster based protocol; LEACH randomly selects a set of sensor nodes as cluster heads. In LEACH, the cluster heads (CH) have many responsibilities: firstly they are responsible for collecting data from the member nodes; secondly, they transmit the aggregated data to the base station; and thirdly, they are responsible for creating a TDMA schedule which specifies the time slots allocated for each member of the cluster. The communication process is divided into rounds with each round including set-up and steady-state phases. In the setup phase, the cluster heads are selected and the clusters are formed; while the steady state phase focuses on data collection and the transferring of data to the base station. During the setup phase, a set of sensor nodes select themselves as cluster heads as follows: a sensor node chooses a random number between zero and one; the sensor node then becomes a cluster head if its generated random number is less than a threshold value, T(n).

$$T(n) = \begin{cases} \dfrac{p}{1 - p * [r \bmod (1/p)]}, & n \in G, \\ 0, & n \notin G, \end{cases} \quad (1)$$

Where p is the predetermined percentage of the cluster heads, r is the current round, and G is the set of nodes that were not cluster heads in the last 1/p round. The cluster heads broadcast an advertisement message to the remaining sensor

nodes. Each sensor node selects a cluster head, based on the received signal strength, In this phase a node may receive more than one broadcast message from different cluster heads, but the node can judge its distance to a cluster from the strength of received broadcast signal; the stronger the signal, the closer to a cluster. The cluster head creates a TDMA schedule and assigns each sensor node a time slot when it can transmit; this schedule is broadcasted to all member nodes.

During the steady state phase, sensor nodes sense the environment, collect data and send the sensed data to the cluster heads. After receiving all data, the cluster heads aggregate the data and send it to the base station. After a certain time, which is determined a priori, the network goes back into the setup phase again and enters another round of selecting new CH. Each cluster communicates using different CDMA codes to reduce interference from nodes belonging to other clusters. The length of the steady state phase period is critical to achieving the energy reduction: a short steady state period increases the communication overhead; whereas, a long steady state period can lead to cluster head energy exhaustion. The complete operations of LEACH Protocol can be depicted in the flowchart as shown in" Fig.1,"

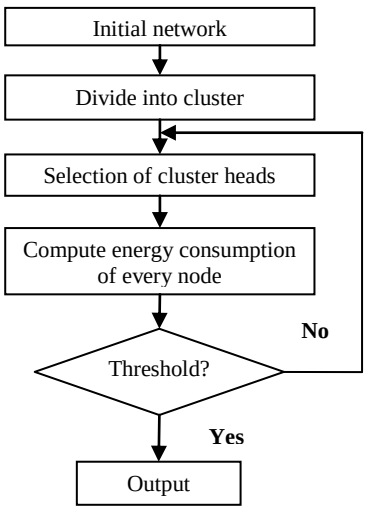

Fig. 1. Flowchart depicting the steps in LEACH

Most of the simulation results for LEACH-type [4] schemes are obtained assuming that the nodes of the sensor network are equipped with the same amount of energy; this is the type of homogeneous sensor networks. A homogeneous sensor networks can be defined as a network consisting of identical nodes in terms of energy, processing capabilities, and sensing range [9]. On the other hand, heterogeneous sensor network consists of sensor nodes with different capabilities, such as different energy level, sensing Range and Computation power. Being a cluster-head node consumes more energy than a non-cluster head node which leads the cluster head nodes to die earlier than other nodes [10]. We study the impact of heterogeneity in terms of node energy is considered. In this it is assumed that a percentage of the node population is equipped with more energy than the rest of the nodes in the same network [11].

III. RADIO MODEL FOR ENERGY CALCULATION

A simple model for the radio hardware energy dissipation was assumed, where the transmitter dissipates energy to run the radio electronics and the power amplifier, and the receiver dissipates energy to run the radio electronics [12], as shown in "Fig. 2,"The first order radio model offers an evaluation of energy consumed when transmission or reception is made by a sensor node at each cycle.

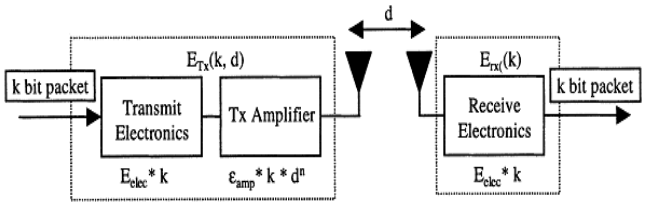

Fig. 2. First Order Radio Energy Model [13]

The energy spend by any transmitter to send a k-bit message over a distance d is,

$$E_{Tx}(k,d) = \begin{cases} k * E_{elec} + k * E_{fs} * d^2 & d < d0 \\ k * E_{elec} + k * E_{amp} * d^4 & d \geq d0 \end{cases} \quad (2)$$

$$d0 = \sqrt{\frac{E_{fs}}{E_{amp}}} \quad (3)$$

The first term represents the energy consumption of radio dissipation, while the second represents the energy consumption for amplifying radio. The electronics energy (E_{elec}) depends on factors such as the digital coding, modulation, filtering, and spreading of the signal, the use of free space (E_{fs}) and the multi-path (E_{amp}) fading channel models depends upon the transmission distance d. If the distance is less than a threshold, the free space model is used; otherwise, the multi path model is used. When receiving this data, the radio expends:

$$E_{Rx}(k) = k * E_{elec} \quad (4)$$

Additionally, data aggregation operation will consume the energy EDA.

IV. SIMULATION AND ANALYSIS OF RESULTS FOR LEACH PROTOCOL IN HOMOGENEOUS & HETEROGENEOUS SYSTEM

This paper analyzed the basic distributed clustering routing protocol LEACH , which is a homogeneous system, the impact of heterogeneity in energy of nodes was studied to prolong the life time of WSN. Then a comparison between EAMMH and LEACH will introduced in Homogenous & Heterogeneous system. The parameters taken into consideration while evaluating EAMMH and LEACH are as follows.

1. Round Number vs. Number of Dead Nodes.
2. Round Number vs. Average Energy of Each node.

With the nodes being deployed, some assumptions were made concerning the node features and these are as follows:

1. Nodes always have to send data.
2. All nodes start with the same initial energy.
3. Clusters and nodes are static.

4. Nodes are assumed to have a limited transmission range after which a another equation for energy dissipation is used.
5. Homogeneous distribution of nodes.

The simulation parameters used in the experiment are shown in Table1.

TABLE 1. SIMULATION DETAILS

Simulation Area	100*100
Base Station Location	(150,50)
Channel Type	Wireless Channel
Energy Model	Battery
CH proportion	P=0.2
Number of nodes	200
E0 (Initial Energy)	0.1J
Transmission Amplifier E_{fs} E_{mp}	 10*0.000000000001 J 0.0013*0.000000000001 J
Packet Size k	4000 bits
Data Aggregation Energy E_{AD}	5*0.000000001 J
Transmission Energy, E_{Tx} Receiving Energy, E_{Rx}	50*0.000000001 J 50*0.000000001 J

A. LEACH IN HOMOGENEOUS SYSTEM

"Fig.3," demonstrates the wireless sensor network initialization for homogeneous system. The simulations were configured with a network size of 100 x 100 meters and with 200 nodes randomly distributed; the base stations were located at positions 150 and 50. All of the sensor nodes periodically sensed the environment and transmitted the data to the cluster heads. Every result shown is an average of 50 experiments. O indicates Normal nodes and dark O indicates CHs. X indicates BS. The simulation parameters used in the experiment is shown in Table 1.

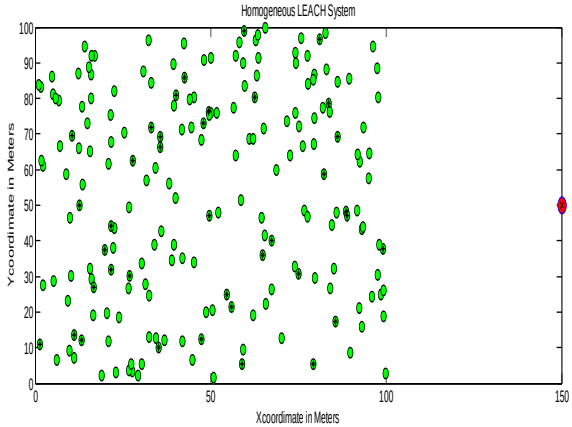

Fig.3. Initialization of the wireless sensor network

B. LEACH PROTOCOL IN HETEROGENEOUS SYSTEM

A heterogeneous network is a network where part of the sensor nodes namely advanced nodes, are equipped with more initial energy than the rest of the normal nodes and these advanced nodes with extra energy can improve the lifetime of the network [10]. Let us assume that the total number of nodes is n & m fraction of the nodes has α time more energy than the other nodes. They are called as advanced nodes. Therefore,

Number of normal nodes = (1-m) x n
Energy per normal node = e0
Number of advanced nodes = m x n
Energy per advanced node = e0 x (1 + α)
Hence the total energy of the network = ((1-m) x n) x e0 + (m x n) x (e0 x (1 + α))

The same procedure as in the normal LEACH protocol is followed i.e., the formation of the clusters is same in this heterogeneous system and also the cluster head selection by comparing the residual energy of the individual in every round. The structure of the LEACH Heterogeneous system for wireless sensor networks is shown in "Fig.4," Here 200 nodes are distributed in 100x100 meters area. BS is located at the (150, 50). 'O' indicates Normal nodes and 'red o' indicates Normal nodes CHs. '+' symbol indicates Advance Node and 'red +' indicates Advance Node CHs. X indicates BS.

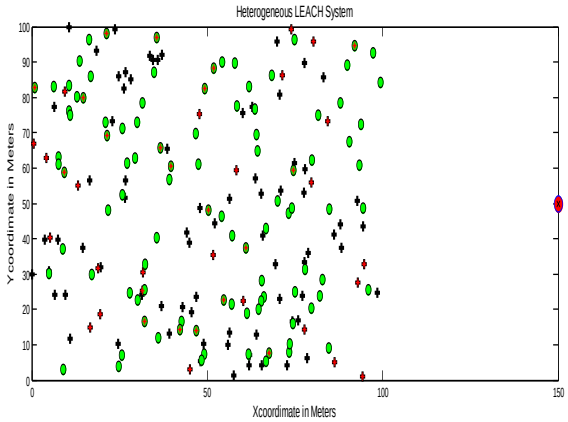

Fig.4 . Heterogeneous LEACH system. '+'symbol indicates Advance Node.

In this LEACH -Heterogeneous system (0.5) of nodes are having more initial energy than the other nodes in the wireless sensor networks. For this case of LEACH - Heterogeneous system 100 nodes are having 0.2 Joule of initial energy out of 200 nodes in the network. The remaining 100 nodes are having 0.1 joules of initial energy. It considered that m=0.5 as when comparing Heterogeneous LEACH system against m=0.1, 0.2, 0.3, 0.4, 0.5 it was found that the performance of the system increases since the dead nodes decrease and average energy of each node increases. "Fig.5, 6", indicates this comparison. Depending upon the application, the number of advanced nodes can be increased and the total system lifetime can be increased significantly.

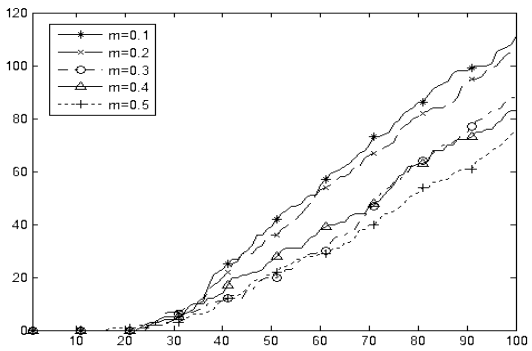

Fig.5. Number of Dead Nodes vs. Number of Rounds in LEAC Heterogeneous System at vs. m

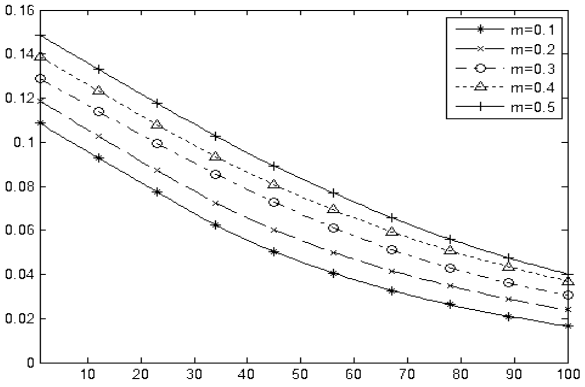

Fig.6. Average Energy of Each Node vs. Number of Rounds in LEACH Heterogeneous System at Vs. m.

C. Comparison between the LEACH-Homogeneous and LEACH-Heterogeneous routing protocols.

LEACH -Heterogeneous system at m=0.5 was compared with Leach-Homogeneous system. The simulation parameters used in the experiment is shown in Table 1. It can be seen that nodes remain alive for a longer time (rounds) in Leach-Heterogeneous system than LEACH - Homogeneous system. "Fig.7, 8", describe the comparison between the Leach Homogeneous and Leach-Heterogeneous System in terms of number of dead nodes and average energy of each Node. Simulation results using MATLAB shows that the LEACH heterogeneous system significantly reduces energy consumption and increases the total lifetime of the wireless sensor network.

V. EAMMH (ENERGY AWARE MULTI-HOP MULTI-PATH HIERARCHICAL) ROUTING PROTOCOL.

A. INTRODUCTION

LEACH is one of the algorithms for packet routing in the wireless sensor network by reducing the energy consumption by nodes, but the routing strategy adopted in LEACH, still results in considerable energy consumption of node for transmitting and reception of the data. In order to reduce the consumption of the energy, we have proposed a routing scheme called Energy Aware Multi-hop Multi-path -

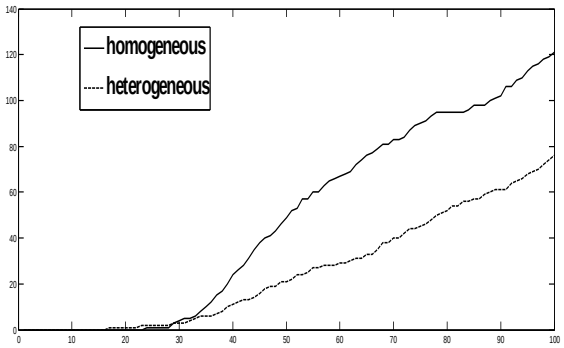

Fig.7. Number of Dead Nodes vs. Number of Rounds in LEACH Homogeneous & Heterogeneous System.

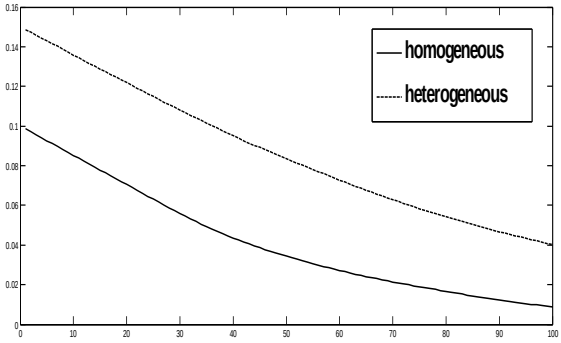

Fig.8. Average Energy of Each Node vs. Number of Rounds in LEACH Homogeneous & Heterogeneous System

Hierarchical (EAMMH) Routing Protocol for energy efficient routing in wireless sensor networks. Energy-aware multipath routing protocols are mostly heuristic protocols that pick up the next hop primarily based on the remaining energy of neighboring nodes. Because sensor nodes have very limited amounts of energy, and in order to prolong the network lifetime, energy-aware approaches avoid choosing sensors with low energy in data forwarding. Therefore, it is a good heuristic in balanced efficient routing protocols. Moreover, these protocols aim to balance the communication load based on the remaining energy of sensor nodes to balance energy consumption and provide data reliability using multiple paths. The protocols in this category construct the routes by broadcasting messages to whole network. The main purpose of message broadcasting is to collect information of the neighboring nodes and to build the neighboring table. Each node contains a neighboring table which stores the significant information about the neighboring nodes including residual energy, hop distance, and signal strength. The neighboring table helps the node to decide the best next hop by using the attributes stored in the table. This scheme leads to a multiple path infrastructure, which is created from the nodes that satisfy the specific requirements. Energy-aware protocols use reactive routing, meaning that the path is created only when it is required. This reduces much of the communication overhead. In the following we present Energy Aware Multi-hop Multi-path Hierarchical (EAMMH) Routing Protocol.

B. EAMMH PROTOCOL

EAMMH routing protocol was expanded by inducing the countenance of energy aware routing and multi-hop intra cluster routing [14]. The below flow chart "Fig.9", describes the overview of the protocol initially the user has to give the input which is in the form of number of nodes.

The communication process in EAMMH protocol is divided into rounds with each round including set-up and Data Transmission phases. In the setup phase after the node deployment the neighbor discovery takes place. This can be done using many methods like: k-of-n approach, ping, beacon messaging. After the neighbor discovery [15], when cluster are being created, each node decides whether or not to become a cluster-head for the current round. This decision method is similar to the one used in LEACH. Cluster Formation and CH (Cluster Head) Selection are the two main tasks operate in setup phase.

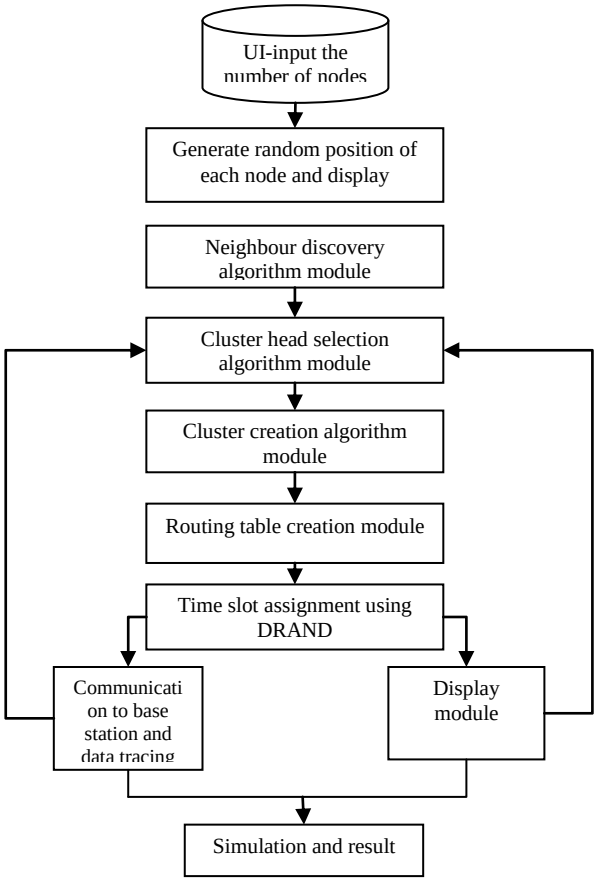

Fig.9. Flowchart of EAMMH

During Data Transmission phase, sensor nodes are allotted timeslots to send the data. Assuming nodes always have data to send, they transmit it at their allotted time interval. When a node receives data from one of its neighbors, it aggregates it with its own data. While forwarding the aggregated data, it has to choose an optimal path from its routing table entries. It uses a heuristic function to make this decision and the heuristic function is given by,

$$h = K\,(E_{avg} / h_{min} * t) \quad (5)$$

Where K is a constant, E_{avg} is average energy of the current path, h_{min} is minimum hop count in current path, t = traffic in the current path. The path with highest heuristic value is chosen. If this path's E_{min} > threshold, it is chosen. Else the path with the next highest heuristic value is chosen, where

$$E_{min} = E_{avg} / \text{const} \quad (6)$$

Where cont is the constant may be any integer value like 10. If no node in the routing table has E_{min} greater than threshold energy, it picks the node with highest minimum energy.

The last operation in EAMMH protocol is a Periodic Updates the information about paths and routing table entries at each node becomes stale after a little while. The heuristic values calculated based on the stale information often leads to wrong decisions. Hence the nodes are to be supplied with fresh information periodically. This will increase the accuracy and timeliness of the heuristic function. During the operation of each round, the necessary information is exchanged at regular intervals. The interval of periodic updates is chosen wisely such that the node does not base its decisions on the stale information and at the same time, the periodic update does not overload the network operation.

VI. Simulation and Analysis of Results for EAMMH protocol in homogeneous & heterogeneous system.

The Energy Aware Multi-hop Multi-path Hierarchical (EAMMH) Routing Protocol in homogeneous system was analyzed, then the impact of heterogeneity in energy of nodes was studied to prolong the life time of WSN. The EAMMH routing protocols have been simulated using MATLAB. The simulation parameters used in the experiment is shown in Table 1.

A. EAMMH In Homogeneous System.

"Fig.10," represents the Simulation result of EAMMH - Homogeneous System uses a randomized rotation, after 100 rounds 'o' indicates Normal nodes, 'dark o' indicates CHs and 'yellow ^' indicates dead nodes . Result shown is an average of 50 experiments. "Fig.11," represents the number of dead nodes against the round number elapsed for 200 nodes for a cluster head probability of 0.2. In "Fig.11", it is observed that with a simulation of a total 200 node, the number of dead nodes after 100 rounds is 99 nodes and the first node died after 26 rounds. "Fig.12," represents the average energy of each node as the round progresses for EAMMH protocol for the cluster head selection probability of 20% or 0.2.

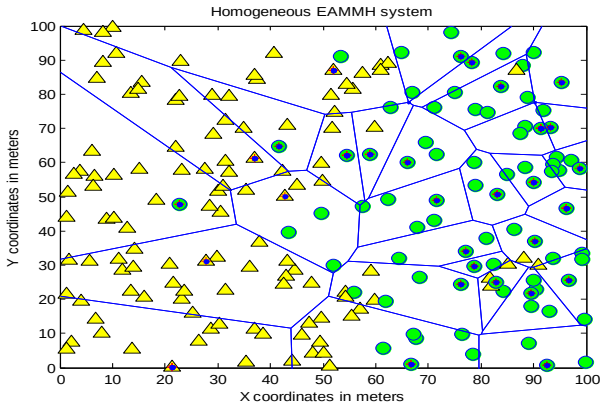

Fig.10. Simulation result after 100 rounds in EAMMH -Homogeneous System.

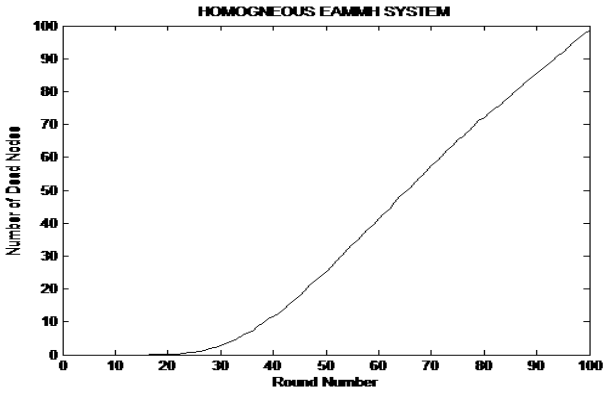

Fig.11. Number of Dead Nodes vs. Number of Rounds in EAMMH Homogeneous System

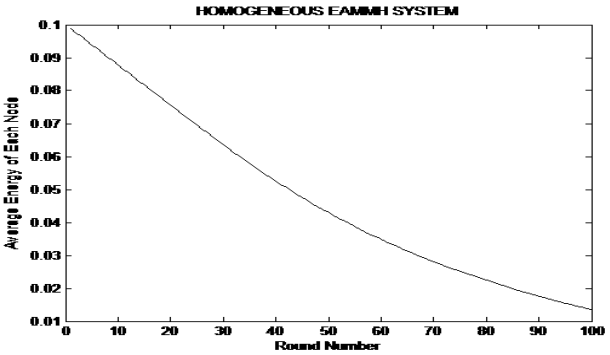

Fig.12. Average Energy of Each Node vs. Number of Rounds in EAMMH Homogeneous

B. EAMMH -Heterogeneous System.

In this approach the same procedure as in the Homogeneous EAMMH protocol is followed, the formation of the clusters and cluster head selection is same in this heterogeneous system but the all nodes do not have equal energy as we introduced in LEACH heterogeneous system. The structure of the EAMMH Heterogeneous system for wireless sensor networks is shown in "Fig.13," The simulation parameters used in the experiment is shown in Table 1. 'o' indicates Normal nodes and 'red o' indicates Normal nodes CHs. '+' symbol indicates Advance Node and 'red +' indicates Advance Node CHs. X indicates BS. In this EAMMH-Heterogeneous system (0.5) of nodes are having more initial energy than the other nodes in the wireless sensor networks. For this case of EAMMH -Heterogeneous system 100 nodes are having 0.2 Joule of initial energy out of 200 nodes in the network. The remaining 100 nodes are having 0.1 joules of initial energy. "Fig.14," represents the number of dead nodes against the round number elapsed for 200 nodes for a cluster head probability of 0.2. It is observed that the number of dead nodes after 100 rounds is 62 nodes and the first node died after 28 rounds. "Fig.15," represents the average energy of each node as the round progresses for EAMMH protocol.

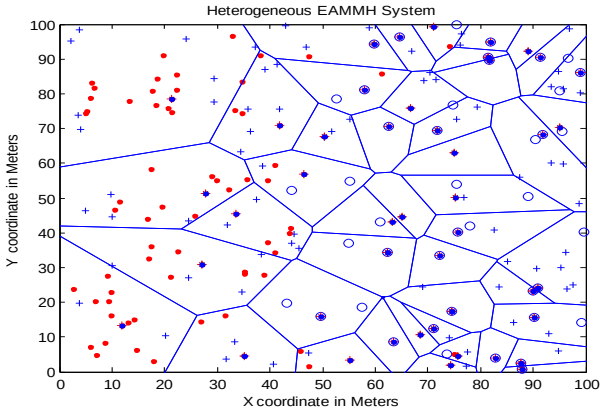

Fig.13. Heterogeneous EAMMH system

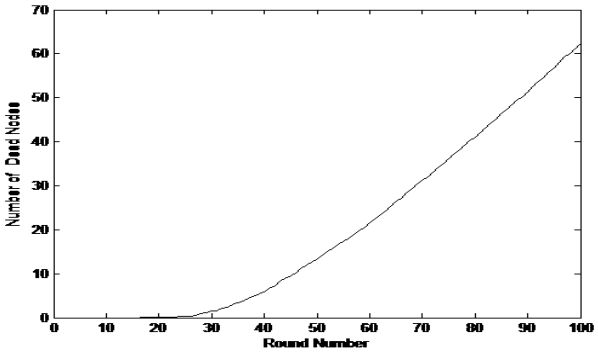

Fig.14. Number of Dead Nodes vs. Number of Rounds in EAMMH Heterogeneous System at m=0.5.

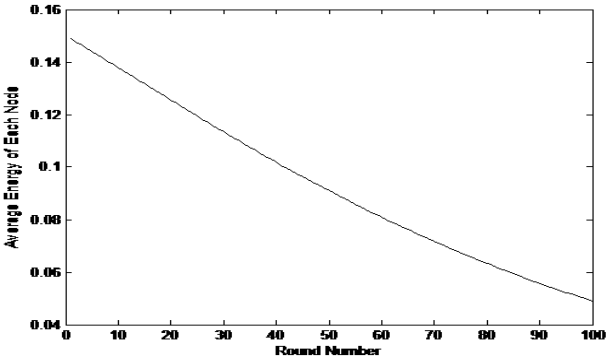

Fig.15. Average Energy of Each Node vs. Number of Rounds in EAMMH Heterogeneous System at m=0.5.

C. Comparison between the EAMMH - Homogeneous & Heterogeneous routing protocols.

The EAMMH-Heterogeneous system at m=0.5 and EAMMH-Homogeneous system was compared. The simulation parameters used in the experiment is shown in Table 1. In "Fig.16," it can be seen that the total Number of dead nodes in EAMMH- Heterogeneous system Less than the total Number of dead nodes in EAMMH- Homogeneous system after 100 Rounds. "Fig.17," describes the comparison between the EAMMH in Homogeneous &Heterogeneous System in terms of Average Energy of Each Node. Here the total energy efficiency is increased by using EAMMH-Heterogeneous system. The improvement in energy efficiency as seen in "Fig.18," is increasing with increasing the number of rounds.

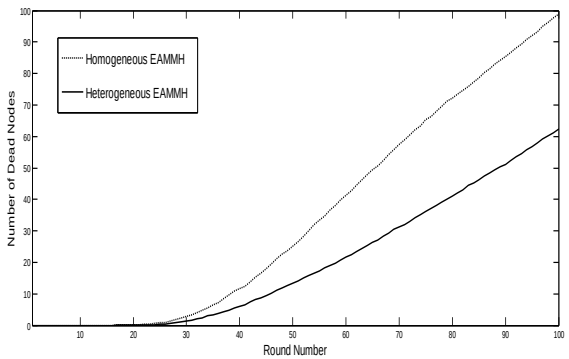

Fig.16. Number of Dead Nodes vs. Number of Rounds in EAMMH Homogeneous & Heterogeneous System

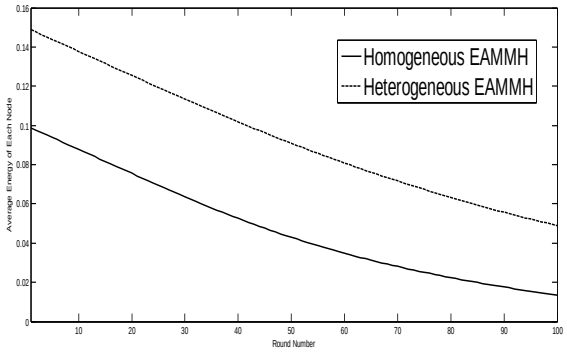

Fig.17. Average Energy of Each Node vs. Number of Rounds in EAMMH Homogeneous & Heterogeneous System

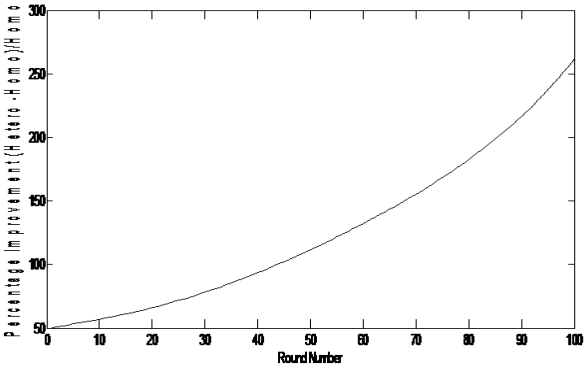

Fig.18. Percentage Improvement in energy efficiency vs. Number of Rounds in EAMMH Homogeneous & Heterogeneous System

VII. Comparison between LEACH and EAMMH in homogenous and heterogeneous system.

First: we compare between LEACH and EAMMH in homogenous system. The simulation parameters used in the experiment are shown in Table 1. "Fig.19, 20," describes the comparison between the LEACH and EAMMH Homogeneous System in terms of number of dead nodes and average energy of each node. Here the number of dead nodes in EAMMH decreased, the total energy efficiency is increased nearly 53% than the Leach-Homogeneous system after 100 round.

Second: LEACH is compared against EAMMH in Heterogeneous system."Fig.21, 22," describes the comparison between the LEACH and EAMMH heterogeneous System in terms of number of dead nodes and average energy of each node. Here the total energy efficiency is increased nearly 21%after 100 round than the Leach- heterogeneous.

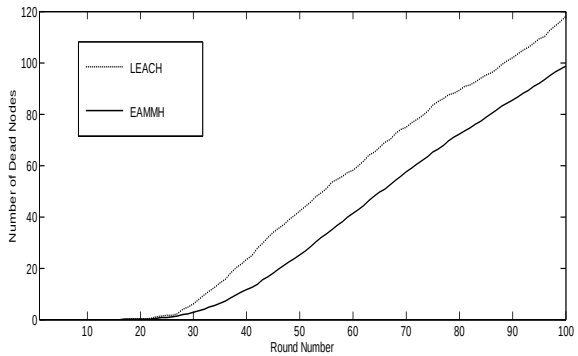

Fig.19. Number of Dead Nodes vs. Number of Rounds in LEACH & EAMMH Homogeneous System

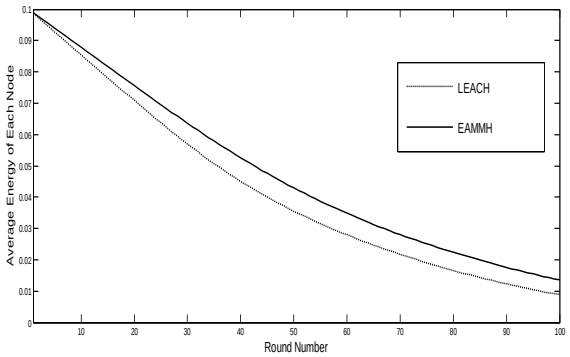

Fig.20. Average Energy of Each Node vs. Number of Rounds in LEACH & EAMMH Homogeneous System

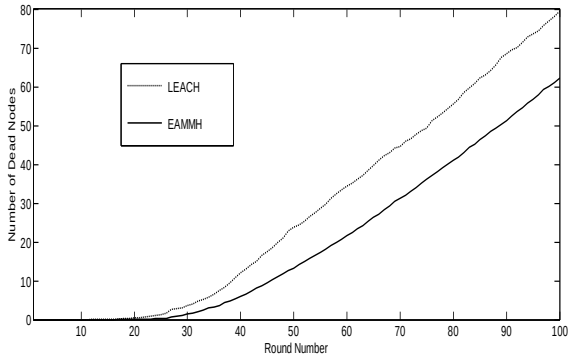

Fig.21. Number of Dead Nodes vs. Number of Rounds vs. in LEACH & EAMMH Heterogeneous System

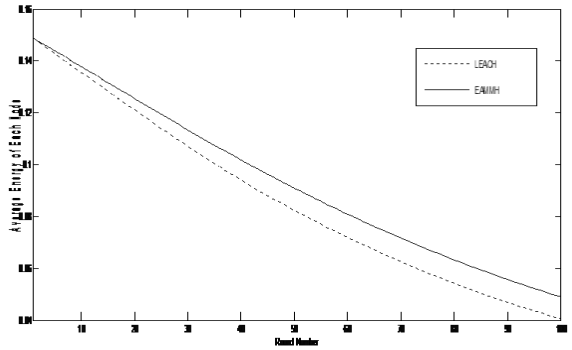

Fig.22. Average Energy of Each Node vs. Number of Rounds in LEACH & EAMMH Heterogeneous System

VIII. Observations & Results

- It is observed from "fig. 8, 12, 15, 17, 20, 22," both LEACH and EAMMH protocols in homogenous & heterogeneous system lose energy as the number of round increases. It is also observed that once a node reaches the value of zero it is no longer functional and is deemed as a dead node.
- "Fig.5, 6," indicates that the performance of the Leach Heterogeneous system increased when increasing the fraction of the advanced nodes (m). Since the dead nodes decrease and average energy of each node increases by increasing (m). Depending upon the application, the number of advanced nodes can be increased and the total system lifetime can be increased significantly.
- At 0.2 CH probability selection, we take Leach Heterogeneous system at m=0.5 and compare it with

Leach homogenous system. It is observed from "fig.7," that nodes remain alive for a longer time (rounds) in proposed Leach-Heterogeneous system than Leach- Homogeneous system and from "fig.8," Leach Heterogeneous System provides better performance in energy efficiency, the Percentage Improvement in energy efficiency varies with Number of Rounds.

- EAMMH Heterogeneous system at m=0.5 was compared with EAMMH homogenous system; It is observed from "fig.16," that nodes remain alive for a longer time (rounds) in EAMMH -Heterogeneous system than EAMMH - Homogeneous system and from "fig.17," EAMMH Heterogeneous System provides better performance in energy efficiency, the Percentage Improvement in energy efficiency varies with Number of Rounds as shown in "fig.18,".
- At 0.2 CH probability selections, EAMMH energy factor out-performs when compared to LEACH by 53% for 200 nodes after 100 round in homogenous system (Fig.20) and by 21% in heterogeneous system. (Fig.22)
- For most cases though EAMMH performs better - The first dead node in most of the operations is by EAMMH; whereas LEACH has a delayed time in getting the first dead node but a larger number of nodes run out of energy in a short period of time subsequently in LEACH.
- From the simulations it is observed that the nodes which are far away from the base station are the ones which run out of energy more quickly than the rest which are nearer to the Base Station. This is due to the fact that the nodes or the Cluster Head which are farther from the Base Station have to dissipate large amounts of energy to send the information as they will have to travel longer distances when compared to the ones which are nearer. The reason why EAMMH performs better than LEACH in majority of the scenarios is for the reason that EAMMH consists of a inter cluster routing mechanism which will help make the network survive for a longer time. LEACH on the other hand has a direct hop communication with the Cluster Head and then to the Base Station.

IX. CONCLUSION

The main challenge in the design of protocols for Wireless Sensor Network is energy efficiency due to the limited amount of energy in the sensor nodes. The major reason behind any routing protocol is to be as energy efficient as possible to keep the network running for a longer period of time. In this paper we have presented a detailed description of LEACH and EAMMH protocols in homogenous and heterogeneous system, which an energy efficient clustering protocol for wireless sensor networks that aims to maximise the network's lifetime and minimise the energy consumption.We have also presented the details about the simulation and the results of it. From the brief analysis of the simulation we have come to a conclusion that LEACH and EAMMH Heterogeneous System provides better performance in energy efficiency and increasing level in lifetime of the wireless sensor networks than LEACH and EAMMH Homogeneous System but when comparing between LEACH and EAMMH in Homogeneous or in Heterogeneous System EAMMH is preferred in larger WSN where it performs better compared to LEACH.

X. REFERENCES

[1] I. Akhyildiz and M. C. Vuran, Wirless Sensor Networks, 4 ed., Tsinghua, China: John Wiley & Sons, 2010.

[2] L. Jianzhong and G. Hong, "Survey on sensor network research," Journal of Computer Research and Development, vol. 45, no. 1, pp. 1-15, 2008.

[3] J. N. Al-Karaki and A. E. Kamal, "Routing techniques in wireless sensor networks: a survey," Wireless communications, IEEE, vol. 11, no. 6, pp. 6-28, 2004.

[4] W. R. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy-efficient communication protocol for wireless microsensor networks," in System sciences, 2000. Proceedings of the 33rd annual Hawaii international conference on, 2000.

[5] S. Ghiasi, A. Srivastava, X. Yang and M. Sarrafzadeh, "Optimal energy aware clustering in sensor networks," Sensors, vol. 2, no. 7, pp. 258-269, 2002.

[6] J. Yick, B. Mukherjee and D. Ghosal, "Wireless sensor network survey," Computer networks, vol. 52, no. 12, pp. 2292-2330, 2008.

[7] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam and E. Cayirci, "Wireless sensor networks: a survey," Computer networks, vol. 38, no. 4, pp. 393-422, 2002.

[8] V. Rajaravivarma, Y. Yang and T. Yang, "An overview of wireless sensor network and applications," in System Theory, 2003. Proceedings of the 35th Southeastern Symposium on, 2003.

[9] L. Han, "LEACH-HPR: An energy efficient routing algorithm for Heterogeneous WSN," in Intelligent Computing and Intelligent Systems (ICIS), 2010 IEEE International Conference on, 2010.

[10] V. Mhatre and C. Rosenberg, "Homogeneous vs heterogeneous clustered sensor networks: a comparative study," in Communications, 2004 IEEE International Conference on, 2004.

[11] G. Smaragdakis, I. Matta and A. Bestavros, "SEP: A stable election protocol for clustered heterogeneous wireless sensor networks," Boston University Computer Science Department, 2004.

[12] F. Xiangning and S. Yulin, "Improvement on LEACH protocol of wireless sensor network," in Sensor Technologies and Applications, 2007. SensorComm 2007. International Conference on, 2007.

[13] N. Mittal, D. P. Singh, A. Panghal and R. Chauhan, "Improved leach communication protocol for WSN," in National Conference on Computational Instrumentation, 2010.

[14] M. R. Mundada, V. Cyrilraj and T. Bhuvaneswari, "Energy aware multi-hop multi-path hierarchical (EAMMH) routing protocol for wireless sensor networks," European Journal of Scientific Research, vol. 88, no. 4, pp. 520-530, 2012.

[15] V. Galluzzi and T. Herman, "Survey: discovery in wireless sensor networks," International Journal of Distributed Sensor Networks, 2012.