Comparative Analysis Of Optimized Leach And Modified Leach

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Abstract –Wireless Sensor Networks consists of number of tiny sensor nodes to monitor and track physical or environmental conditions like temperature, pressure. Wireless sensor networks generally characterized by properties like limited power they can harvest, dynamic network topology, large scale of deployment. The main focus was on the analysis of LEACH based on parameter like network lifetime. Some modifications are made in LEACH so as to decrease energy consumption by the nodes and so as to increase network lifetime. Network lifetime is needed to increase so as to get continuous information of a particular area. Proposed algorithm is implemented and it improves the energy consumption by nodes and network lifetime increased. Optimization of LEACH is done using Bacterial Foraging Algorithm to find optimal position of minimum distance node. Comparative analysis of proposed algorithm and optimized LEACH has been done to compare the network lifetime. In proposed algorithm network lifetime has been improved as compared to optimized LEACH.

Keywords–Wireless sensor network, sensor nodes, lifetime, BFO, Optimization, Modified LEACH.

1. Introduction

Wireless sensor networks consist of number of sensor nodes. These sensor nodes are small in size. Sensor nodes do three major functions, that are-sensing, processing and sending data to destination. Sensor node can sense the different environmental conditions like temperature and pressure. They can give particular data continuously until there battery die. Wireless sensor networks are having several applications in the field of tracking and monitoring. There is one main constraint to be concerned about that is network lifetime, which depends on the battery life of sensor nodes. Sensor nodes are having fixed battery life. So they can sense and process the data until they are having battery life. There are number of modifications has been done till now so as to enhance network performance and battery life of nodes. There are number of algorithms and protocols related to wireless sensor networks like LEACH (Low Energy Adaptive Clustering Hierarchy). LEACH protocol has been used more popularly as compared to others. For enhancing the efficiency of wireless sensor network there are several proposed algorithms and comparative analysis in the literature. M.J Handy et al.[2] focused on reducing the power consumption of wireless sensor networks. Communication protocol LEACH has been modified and extend LEACH's stochastic cluster head selection algorithm by a deterministic component. Network lifetime can be increased by 30 % by using this deterministic configuration. J. N. Al- Karaki et al.[5] focuses on optimal data aggregation in WSN's. Data aggregation has been affected by several factors, such as placement aggregation points, the aggregation function and the density of sensors in network. So, selection of aggregation points is very important. They mainly focuse on selection of minimum number of aggregation points so as to enhance the network lifetime. Liang Ying et al.[6]focuses on a method to choose a cluster head so that network lifetime can be improved. An energy efficient cluster head selection has been done so as to maximize the network lifetime. N. NarasimhaDatta et al.[8]has done a survey of routing algorithms for wireless sensor networks and studies that using which algorithm network lifetime can be increased. Fan Xiangning et al.[9] has improved LEACH protocol of wireless sensor network so as to enhance network performance. RaghavendraV.Kulkarni et al .[13] focused on real time autonomous deployment of sensor nodes from an unmanned aerial vehicle. This deployment is having importance mainly in ad-hoc WSNs, for emergency applications such as disaster monitoring and battlefield surveillance. Bio-inspired algorithms like PSO (Particle Swarm Optimization) and BFO (Bacterial Foraging Optimization) are presented in this paper to show that both the algorithms perform multilevel image segmentation faster than energy exhausting search for optimal threshold. Besides, PSO based localization is faster and BFO based localization is more accurate. In this paper a simple scheme is proposed to improve the network lifetime and a comparative analysis has been done to compare the results of optimized LEACH with Modified LEACH and

results shows the increased lifetime using Modified1. LEACH.

2. Improving the lifetime of a WSN

In Wireless Sensor Networks, energy is a critical resource. Thus there is both a need and opportunity to optimize the network architecture for the application in order to minimize resource consumed. LEACH protocol has some limitations like nodes die earlier, because of more consumption of 2. energy and due to which network lifetime get reduced. By optimization of LEACH protocol using BFO network optimum results can form in terms of energy efficiency and optimum selection of position of cluster member nodes. Modified LEACH introduced in order to improve energy efficiency of WSN by transferring load of cluster head node to other cluster member nodes to aggregate the data. So there wer mainly three objectives to be completed in order to increase the lifetime of network that are implementation of optimized LEACH using BFO algorithm then to implement Modified LEACH and finally the comparative analysis of Optimized LEACH with Modified LEACH.

3. Optimized LEACH

There is a population based optimization algorithm that is Bacterial Foraging Algorithm. Its main motive is to optimize the network. This algorithm has been used to 4. optimize LEACH protocol so that there will be optimal selection of cluster head due to which network performance enhanced. BFO worked on a principal of selecting the strong bacteria for foraging process and eliminating those who become weak. Those who become weak can be improved and then again be used for the foraging process. Same concept can be used to enhance the network performance by optimum selection of cluster heads and eliminating those nodes which become weak and by time those nodes can be improved or can be eliminated permanently. So, BFO has been used to implement LEACH protocol so as to select cluster heads with optimum results of network. The implementation of LEACH with BFO has been done in four steps that are chemotaxis, swarming, reproduction and elimination and dispersal. In the following steps each bacteria is treated as a sensor.

Let position of the bacterium is θ.The combined effect of repellants and attractants from environment is taken as J(θ). J(θ)<0 represents that bacterium at position θ is nutrient rich, J(θ)=0 represent neutral and J(θ)>0 represents noxious environment.

The first step is chemotaxis. In this step movement of bacterium has been defined. Bacterium can move in two different ways-either it can run or tumble or alternate between these two. $\emptyset(j)$ direction is generated to represent a tumble which is used to define direction after tumble.

$\theta^i(j+1,k,l) = \theta^i(j,k,l) + c(i)\emptyset(j)$

i^{th} bacterium represented by $\theta^i(j+1,k,l)$ at j^{th} chemotactic, k^{th} reproductive and l^{th} elimination and dispersal step.

When a group of bacterium are placed in a semisolid agar with sensor, then they move out from center by consumption of nutrient by the group. The bacterium releases attractant aspartate if level of succinate as nutrient is high. The bacterium provides attraction signal to each other and move in concentric circles and swarm together. Swarming can be represented mathematically by following relation

$j_{cc}\big(\theta, P(j,k,l)\big) = \sum_{i=1}^{S} j_{cc}^{i}(\theta, \theta^i(j,k,l))$

The cost function which is to be added to actual cost function to be minimized to present time varying cost function that is $j_{cc}\big(\theta, P(j,k,l)\big)$. The number of parameters which are to be optimized are represented by P.

With the continuous movement a bacteria which is least healthy dies and the bacterium which is healthy it break up into two bacterium. By this process number of bacterium remains constant. This step is reproduction step.

The bacterium which don't come close to nutrient rich area become weak and after sometime it eliminate from the group and dispersal is usually tends the bacterium close to nutrient rich area.

LEACH is implemented by following the above steps. By this LEACH is optimized so as to carry on optimal cluster head selection and to find minimum distance nodes. Results are improved by the implementation of LEACH using Bacterial Foraging Optimization Algorithm.

4. Modified LEACH

In LEACH protocol in a cluster there are number of nodes out of which one node is chosen as cluster head so as to aggregate data after getting from the other nodes and then send this data to base station. The cluster head has to do two main functions that are aggregation of data and then sending data to base station. So cluster head's energy more frequently used as compared to all other nodes. In proposed algorithm one modification has been done in order to divide the load of work of cluster head. This has been explained in following steps. In the implementation of Modified LEACH same steps has been followedexcept in steady state phase a

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aggregation node has been chosen. The phases of operation are as follows:

3.1 Setup Phase

In setup phase network of nodes is divided into clusters. Each cluster is having one cluster head node and other nodes are cluster member nodes. The cluster head node is chosen according to the threshold value T (n). Setup phase operation is same as in LEACH.

$$T(n) = \frac{p}{1 - p * \left(rmod\left(\frac{1}{p}\right)\right)}$$

$$if n \in G and otherwise\ 0$$

3.2 Steady State Phase

In this phaseafter selecting cluster head node having highest energy value is not doing aggregation, because if cluster head node do aggregation and then transmit the information to base station. In all this work more energy is used. Energy of cluster head node decreased more rapidly. So to maintain balance in energy distribution of network workload of cluster head node can be divided. From other cluster member nodes one node is chosen having second highest energy value which is used for doing aggregation process. That node is called as aggregator node. After aggregation aggregator node sends aggregate data to cluster head node. Then cluster head node sends data to base station. By doing this energy is balanced between network because workload of cluster head node decreased. Due to which energy of cluster head node is not decreased rapidly. Implementation of Modified LEACH is same as LEACH except the aggregation part. In this implementation number of parameter have been taken as shown in below table:

Table 4.2 Parameter description of Modified LEACH

Parameter	**Parameter Values**
Field size	100m * 100m
Number of nodes	10
Energy per node	0.5 joules
Election probability for a node to become the cluster-head	0.05
Packet Length	L bits
Control Packet Length	200bits

In order to measure energy consumption of sensor nodes, same energy parameters and radio model as discussed in LEACH protocol is used. Mainly energy consumption is divided into two parts: Receiving and Transmitting messages. The transmission energy consumption needs additional energy to amplify the signal depending on the distance to the destination. Thus, to transmit a k-bit message a distance d, the radio power consumption will be,

$$E_{tx}(l,d) = k.E_{elec} + k.\in_{fs}.d^2 if d \le d_o$$

$$E_{tx}(l,d) = k.E_{elec} + k.\in_{mp}.d^4 if d > d_o$$

and to receive this message, the radio expends will be,

$$E_{rx} = k * E_{elec}$$

Simulated model parameters are set as: Eelec=50nJ/bit, $\in_{fs}$ =10pJ/bit/m2, $\in_{mp}$ =13/10000pJ/bit/m4, do =$\sqrt{\in_{fs}/\in_{mp}}$.

In Modified LEACH after formation of clusters and cluster heads are chosen. The highest energy node is chosen as cluster head. The second highest energy node is chosen as aggregator node. Aggregator node performs aggregation process. This node collects all the data from the nodes and then collectively sends this data to cluster head node. Then cluster head node send this data to base station from where user from anywhere at anywhere can get the required information. Aggregator node is chosen for dividing the workload of cluster head node. By doing this energy balanced between all the nodes. So a balanced energy network is created. The implementation process of Modified LEACH is divided into rounds. Modified LEACH improves energy distribution between sensor nodes in each round and prolongs the network lifetime.

5. Results

Results of optimized LEACH and Modified LEACH has been evaluated and their comparative analysis has been done and from results it is found that in modified LEACH network lifetime has been increased. Optimization of LEACH is done in order to optimize the network. Optimization is done in terms of selection of cluster head optimization, optimal node position. When simulation is starts it asks for number of nodes and number of positions. If number of nodes are more and if number of locations is one then at one location all the nodes are deployed. So number of locations are selected accordingly. Results of optimized LEACH are shown below-

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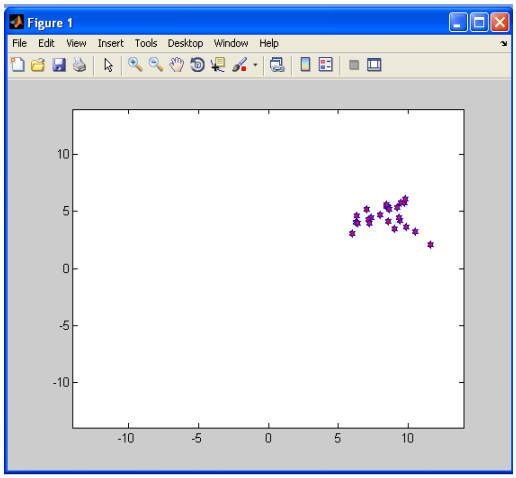

Fig.4.1 Representation of movement of bacteria

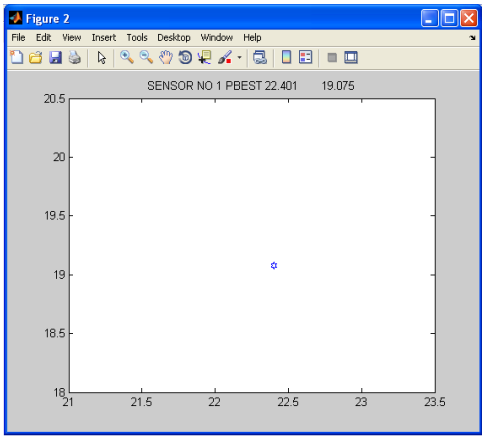

Fig.4.2 Representation of minimum distance node and its optimal position

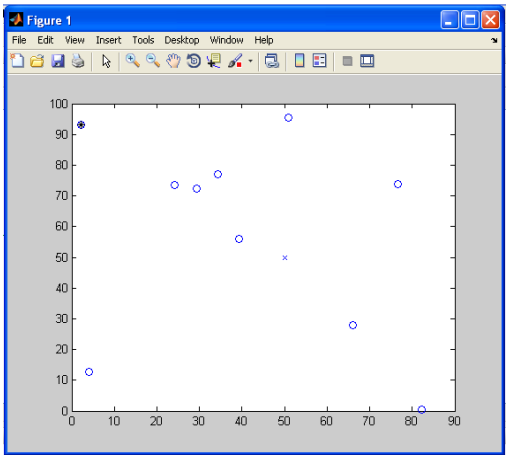

Fig. 4.3 Representation of nodes during transmission after optimization of LEACH

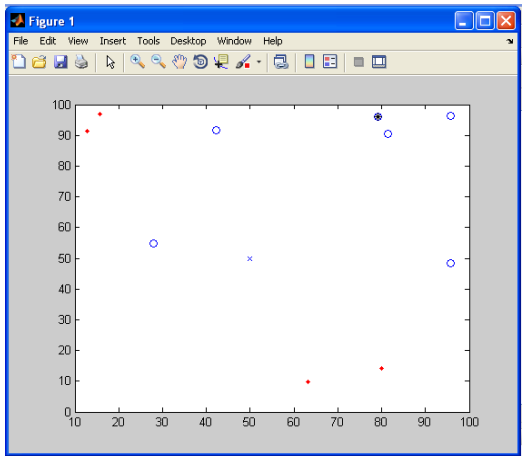

Fig. 4.4 Representation of Dead nodes after some time in Optimized LEACH

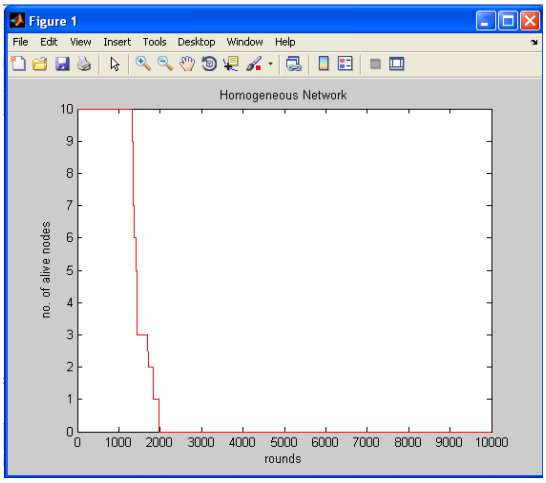

Fig4.5 Representation of alive nodes over simulation time in Optimized LEACH

From above results after performing the number of simulations it is clear that nodes start dieing after 1000 rounds and nodes keep on dieing. Transmission keeps on going until all the nodes has been died.

To evaluate the performance of Modified LEACH consider a 100×100 network configuration. Number of nodes taken are 10. Initial energy of all the nodes is same. That is network is homogeneous network. In a homogeneous network all the nodes in the network are having same energy. Transmission between nodes is as shown in figure below. After sometime nodes start die due to full use of their energy. Nodes shown as red dots in the below figure are dead nodes. In LEACH nodes starts die earlier than in Modified LEACH. In Modified LEACH protocol nodes start die after 2500 rounds. In LEACH protocol nodes started die after 1500 rounds. So, Network lifetime in case of Modified LEACH increased in comparison to LEACH protocol.

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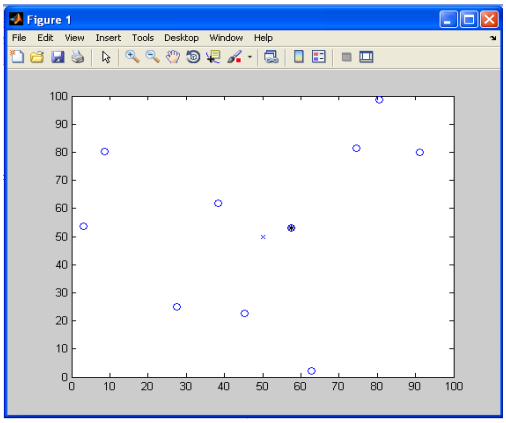

Fig.4.6 Representation of nodes during transmission in Modified LEACH

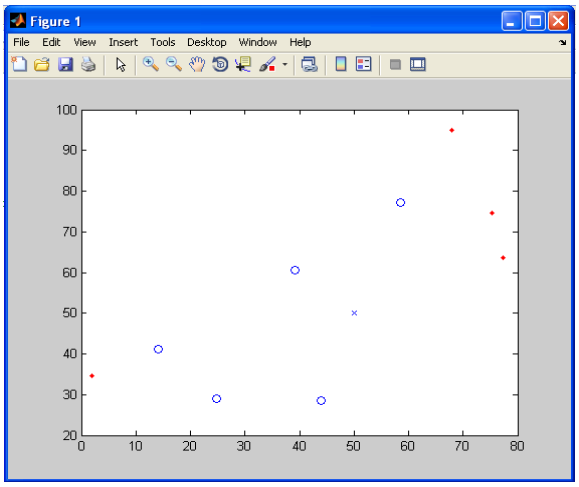

Fig.4.7 Representation of dead nodes in network after sometime in Modified LEACH

After number of rounds in simulation number of alive nodes calculated in respect with number of rounds. Simulation result is as shown in below figure.

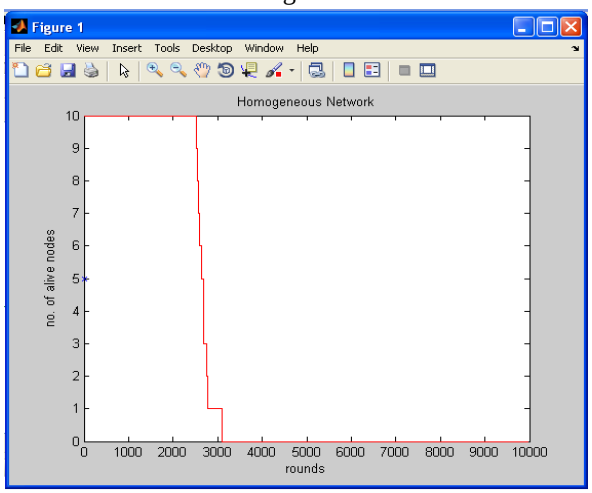

Fig Simulation result of Modified LEACH**Fig.4.8** Representation of alive nodes during simulation time in modified LEACH

4.1Comparison of Optimized LEACH and Modified LEACH

From comparison it is clear that Modified LEACH increase network lifetime more than LEACH protocol. As shown above in figure nodes started die after 1500 rounds and near 2000 all the nodes get die and there is no alive node at the end.

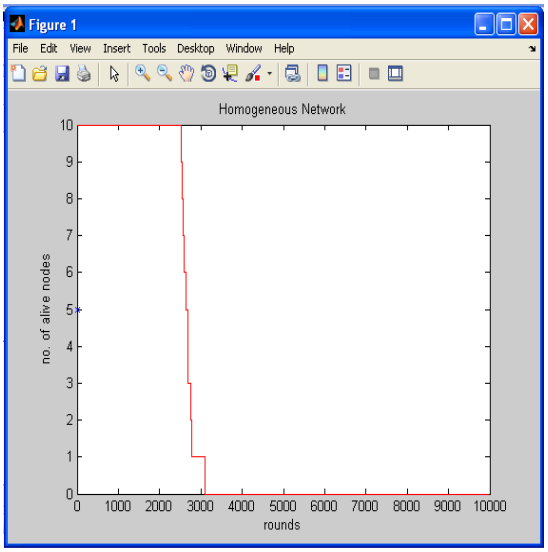

Fig Simulation result of LEACH protocol

But in Modified LEACH nodes started die after 2500 nodes and upto 3000 rounds all the nodes get die. But network lifetime in Modified LEACH is more than optimized LEACH.

6. Conclusion

Main limitation of Wireless Sensor Network is its energy consumption is more. To get information like in surveillance applications for more time network lifetime of wireless sensor network must be more so as to monitor or track a particular place for more time. There are number of protocols as discussed in introduction part to enhance the energy efficiency of a network. From above discussion it is concluded that Modified LEACH is more energy efficient than LEACH protocol. In Modified LEACH there is balanced energy distribution in network. Network lifetime is more in Modified LEACH than in LEACH protocol. Because network lifetime of Modified LEACH is more than LEACH protocol. This can be usefull for many applications of wireless sensor network.

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