Performance of I-LEACH Routing protocol for Wireless Sensor Networks

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ABSTRACT-In wireless sensor networks, sensor node always have a limited power resource. The energy consumed by sensor nodes to transfer the data to its destination becomes critical issue in designing WSN routing protocols. In this paper we propose a cluster routing protocol named I-LEACH to enhance the routing protocol LEACH. In the I-LEACH algorithm, selection of cluster heads is modified by using power of the sensor nodes in order to balance the network loads. The simulation results shows that I-LEACH performs 55% better than LEACH algorithm in terms of network lifetime

Keywords: Wireless Sensor Network; LEACH; cluster.

I. INTRODUCTION

Wireless Sensor Networks (WSNs) consist of many sensor nodes. The typical configuration of such a sensor node in a WSN includes single or multiple sensing elements, a data processor, communicating components and a power source. Normally, the sensing elements perform measurements related to the conditions existing at its surrounding environment [1]. The wireless sensor networks (WSNs) can be installed in an extensive geographical space to observe physical phenomenon with adequate precision and dependability. The sensors can observe numerous objects such as: humidity, temperature, salinity, pressure, metallic objects, and motion. Sensor nodes form network, assemble the network themselves and manage movement of sensor nodes Each sensor comprises both processing and communication elements and is able to observe the surroundings by the operator of the network [2],[3]. Therefore we can say Sensor networks have an extensive variety of Uses and features. The sensor networks can be used in Military situation, Disaster management, Habitat observing, Medical and health care, Industrial fields, Home networks, Spotting chemical, Biological, radiological, Nuclear, and Explosive material etc.

In this paper , we propose an energy efficient routing protocol based on clustering method . It follows two considerations : a) Maximizes the lifetime of the whole network , b) Maximizes the amount of data transmitted to base station .This paper proposed a enhanced routing protocol which uses the new technique to select the nodes as cluster heads. So that, the nodes die rate can be reduced and enhance the network lifetime simultaneously.

II. LEACH PROTOCOL

A. LEACH Algorithm

LEACH (Low Energy Adaptive Clustering Hierarchy) is first proposed by Wendi B. Heinzelman of MIT [5].This protocol provides a round concept. Each round contains two phases: cluster setup phase and steady phase. In the setup phase, selection of cluster head node occurs. The selection depends on decision made by the node by choosing a random number between 0 and 1. If the number is less than the threshold $T(n)$ [4], the node becomes a cluster head for the current round. The threshold is set as:

$$T(n) = \begin{cases} \dfrac{P}{1 - P \times \left(r \bmod \dfrac{1}{P} \right)} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

Where *p* is the probability of the node being selected as a cluster-head node, *r* is the number of rounds , and *G* is the set of nodes that have not been cluster-heads in the last *1/p* rounds, *mod* denotes modulo operator. Nodes that are cluster heads in round *r* shall not be selected in the next *1/p* rounds At the end of every round, every sensor node which is not a cluster head select the nearest cluster head and joins that cluster to transmit data. The cluster heads combine and abbreviate the data and forward it to the base station, therefore it maximizes the life time of major nodes. In this algorithm, the energy consumption will allocate approximately uniformly among all nodes Time Division Multiple Access (TDMA) is used for better management and scheduling in steady state phase.

B. Merits and Demerits of the LEACH Protocol

The merits of LEACH are:

¨ Localized coordination and control for cluster setup and operation.

¨ Randomized rotation of the cluster and the corresponding clusters.

¨ Local compressions.[5].

Demerits of LEACH are:

-- The nodes with low energy have the equal priority to be a cluster head as the node with high energy. Therefore, those nodes with less remaining energy may be chosen as the cluster heads which will result that these nodes may die first.

--LEACH cannot be used in large-scale wireless sensor networks for the limit effective communication range of the sensor nodes [6].

III. THE PROPOSED ALGORITHM

In this paper we propose a routing algorithm called I-LEACH based on LEACH algorithm to balance the energy utilisation of sensor nodes in order to maximizes the lifetime of the network and reduce the energy consumption .I-LEACH based on the round concept of LEACH. In routing protocols, the number of cluster head nodes is the main factor that affects the performance of the protocol. If the number of cluster head nodes is less then each cluster head will have to cover larger area, which will create problem that energy consumption will increase and reduces the lifetime of network Therefore, it is necessary to choose sufficient number of cluster heads to reduce energy consumption .In the I-LEACH , we use the technique that will choose the cluster head which has largest residual energy as the root node

A. Cluster head Selection:

The LEACH's selection algorithm easily leads to the imbalance of the stored energy of sensor nodes; therefore, the consumption of energy is increased. To remove this problem, the energy load should be uniformly distributed throughout the network, the additional parameters that are the residual energy and the consumed energy for transmitting data are required for the optimization of the process of cluster head selection. The main aim behind the improved cluster head selection algorithm is to neglect the lower residual energy nodes and select higher consumed energy nodes as the cluster head. A new $T(n)$ is defined as follow:

$$T(n) = \begin{cases} \dfrac{p}{1 - p\,(r * \bmod(1/p))} * \dfrac{E_{current}}{E_{initial}} + Rs \; ; \\ if \rightarrow n \in G \end{cases}$$

else T(n)=0, where Rs is as follows :

$$Rs = \frac{r * \bmod(1/p)}{p} * \frac{1 - E_{current}}{E_{initial}}$$

Where the $E_{residual}$ is the residual energy of nodes at the *r* round, *Einitial* is the initial energy of nodes. By using new $T(n)$, the probability for low residual energy nodes being cluster head is greatly reduced and the probability for high residual energy nodes being cluster head is increased.

In the I-LEACH, the sensor node is randomly assigned a number between 0 and 1, if value of the number is less than $T(n)$, the sensor node is selected as the cluster-head at the given round.

B. Steady-state Phase

In this phase, each node sends the gathered information during its own TDMA time slot. After getting information of all the cluster-heads, the base station analysis the data and transfer the data further for communication to communication interface. After the broadcasting of the information to the network, cluster heads prepare for the next round.

V. SIMULATION ENVIRONMENT

A. Simulation Platform

MATLAB is used for simulating different routing protocols. MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. Developed by MathWorks,

B. Simulation Setup

The basic simulation parameters for our model are mentioned in Table I. The experiment is carried out by using the same energy source whose initial energy is 0.5J. Every node transmits a *k* bits data packet per round to its cluster head. The size of a control packet *L*ctrl is 200 bits.

A hundred sensor nodes are arranged randomly in the field of 100m×100m square meters .The Base Station is (BS) or sink node located at (50,140) m, As shown in Figure 1

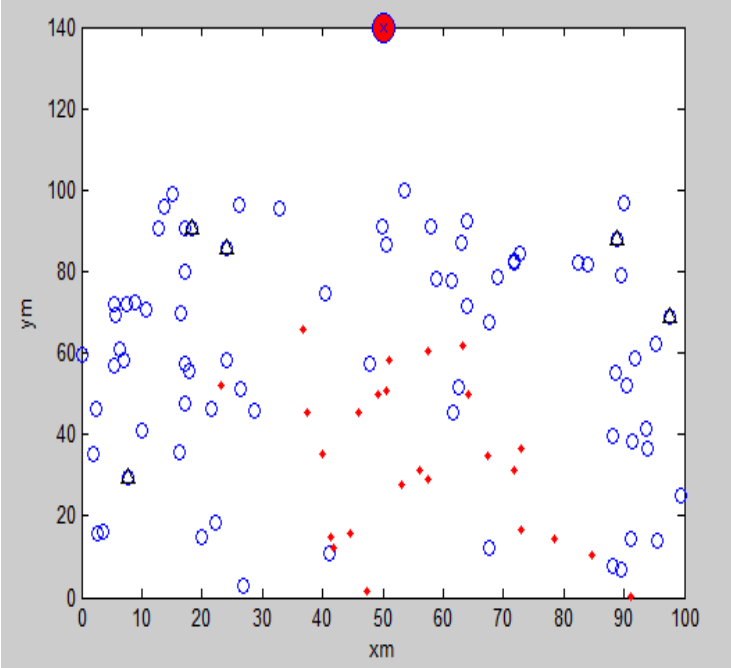

Figure1: Shows 100 nodes random topology for a 100m * 100m, Base Station (red circle) and Red dots represent dead nodes

TABLE I. TRANSMISSION PARAMETERS VALUE

Description	***Symbol***	***Value***
Number of Nodes	N	100
The initial Energy	Eo	0.5J
Energy consumed by the amplifier to transmit at a short distance	Efs	10pJ/bit/m^2
Energy consumed by the amplifier to transmit at a longer distance	Emp	0.0013pJ/bit/m^4
Energy consumed in the electronics circuit to transmit or receive the signal	ETX/ERX	50pJ/bit
Data Packet	K	4000 bits
Data Aggregation Energy	Eda	5pJ/bit/report
Cluster probability	P	0.05
The Sensing area	Xm * Ym	100 m * 100 m
Control packet	L_{ctrl}	200 bits
The initial energy	$E_{initial}$	0.5J

VI. SIMULATIONS RESULTS

In WSNs, there are a lot of parameters to evaluate a clustering algorithm. In this paper, the number of dead nodes and the number of alive nodes are chosen to compare the performance of the improved algorithm I-LEACH with LEACH. If a node's energy is less than zero, we define it as a dead node. When all nodes in the network are dead, we define it as network failure.

This paper selects the parameters that first node dies (FND), half of nodes dies respectively to evaluate the network.The number of dead nodes can reflect the balance of energy consumption in the network. Lesser the die rate of nodes , higher energy efficiency of network . In Fig.2, x-coordinate represents the number of rounds and y-coordinate stands for the number of dead nodes per round.

Figure 2 is the simulation result of network lifetime for I- LEACH algorithm and original LEACH algorithm. It is clear from the figure that the original LEACH algorithm began to death of nodes at 823th round, while the I-LEACH algorithm began to death of nodes at 1282th round. The time of HND is at 1178th round for the original LEACH algorithm, while the HND is at 1692th round for the I-LEACH Algorithm

Figure 3 is the comparison of FND and HND between LEACH and I-LEACH.

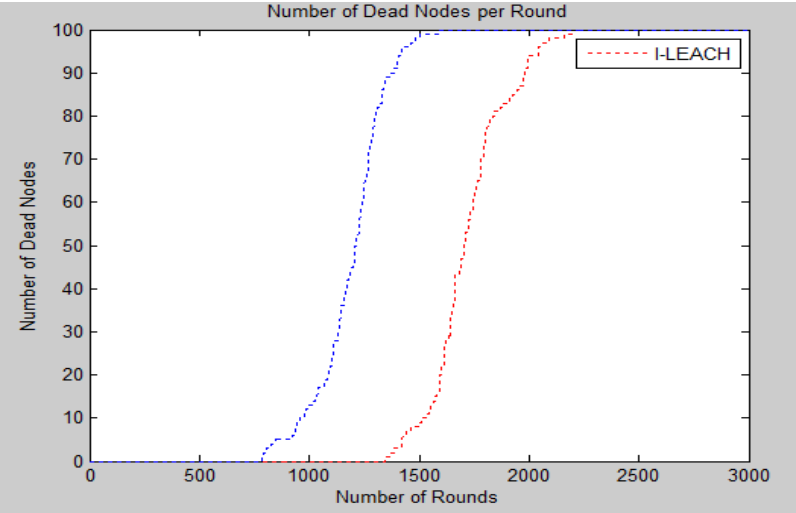

Figure 2: Comparison of Dead nodes between I-LEACH and LEACH

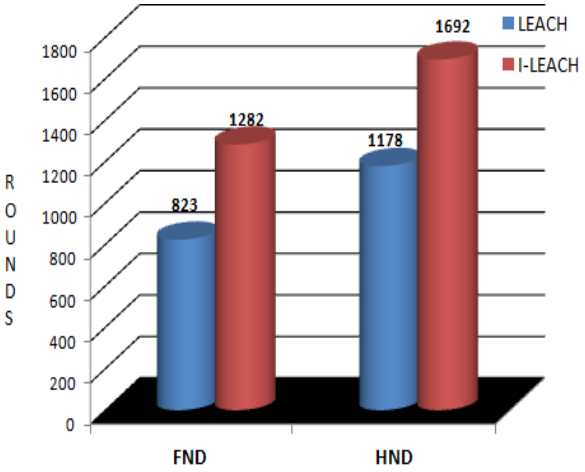

Figure 3: Comparison of FND and HND

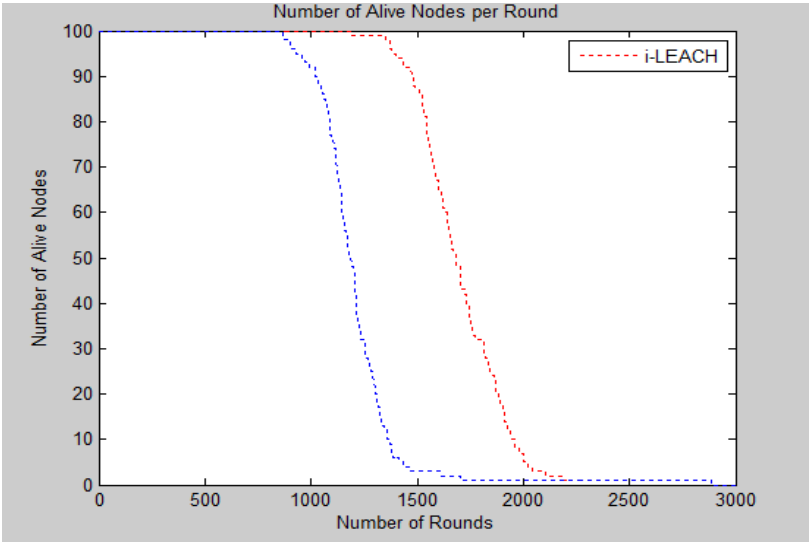

Figure 4: Comparison of Alive nodes between LEACH and I-LEACH

If the system lifetime is defined as the number of rounds for which the first node dies, I-LEACH algorithm can reach 1282 rounds, whereas LEACH only reaches 823 rounds. Therefore we can say, system lifetime is improved by 55% of I-LEACH algorithm than LEACH.

VII. CONCLUSION

In this paper, we showed that I-LEACH act as a remedy to both of the shortcomings of LEACH protocol. I-LEACH solves the problems of LEACH as it works on the residual energy concept instead of probability. In I-LEACH improves the network lifetime over LEACH.I-LEACH outperform LEACH with 459 more rounds which estimated around 55% better network lifetime with 0.5J/Node energy over a network area of a 100m×100 m

VIII. FUTURE WORK

Conceptual advantages of PEAGSIS [8] and I-LEACH can be combined together to make a new better performing protocol for WSNs. Concept of Chain formation from PEAGSIS protocol and concept of residual energy and certainty of CHs formation of I-LEACH protocol if can be implemented together will perform far better and can be implemented in WSNs.

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