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Multi-hop Energy Efficient Routing in WSN to Maximize Network Life Time using Percolation Theory

*Priyanka Saxena [1], *U. Datta [2]

*[1]*Computer Science and Engineering Department, Maharana Pratap College of technology Gwalior.*
Putli Ghar Road, Near Collectorate, Gwalior-474006, Madhya Pradesh, India
*[2]*Computer Science and Engineering Department, Maharana Pratap College of technology Gwalior.*

***Abstract*- LEACH is the most famous and first hierarchical routing protocol in wireless sensor networks (WSN). Many improved algorithm based on LEACH have been proposed by many researchers and in these algorithm improvements of energy in certain extent. However an important problem is to determine the number of clusters present in a network. In LEACH cluster head selection is based on the random generated by each node in each round and cluster head directly transmit the data to the sink node so it works on small geographical area. A critical issue in WSNs is represented by limited availability of energy within network nodes therefore, making good use of energy is mandatory in modeling sensor networks , this paper proposes a multi-hop energy efficient Routing in WSN. The simulation results shows that the consumed is less so network life time increases.**

***Keywords*: LEACH, PAN (Personal area network), Percolation, WSN(Wireless sensor Network)**

1. INTRODUCTION

Leach is the first and most famous cluster based hierarchy routing protocol. It selects cluster head nodes randomly to distribute energy load to the whole network and network is partitioned in the form of cluster and each cluster there is a cluster head which can communicate to the other member node of the cluster. Cluster head also directly communicate to the sink node .formation of cluster head are on the basis of random number generated (between 0 and 1) by each node and the probability of node to get the cluster head. In LEACH[5] there are two types of phase one is Setup phase and other is Steady State phase, In Setup phase partition the whole wireless sensor network into small groups and these group are called cluster and each cluster having a cluster head so cluster head selection process in also going to happen in the setup phase. In Steady state phase several data frames are transferred from nodes to the cluster head and cluster head to the base station. The operation of LEACH [5] can be divided into rounds. Each round begins with a set-up phase when the clusters are organized, followed by a steady state phase where several frames of data are transferred form the nodes to the cluster head and on to the base station. During the set-up phase, each sensor node tries to select itself as a cluster head according to probability model. For selecting a cluster head, each sensor node generates a random number between 0 and 1. If the number is less than the threshold T(n), the sensor node selects itself as a cluster head for current round, the threshold is presented as follows

$$T(n) = \begin{cases} \dfrac{p}{1 - p \times [r \bmod(\frac{1}{p})]} & n \in G \\ 0, & other \end{cases}$$

where P represent the percentage or probability of cluster head in the sensor network and r is the current number of round in the round and G is a set of Nodes which have not been selected as cluster heads in the running round. T(n) can be seen that it is the average probability of the excess nodes being the cluster head in the round r.

2. RELATED WORK

In wireless sensor networks, intensive research works have been done to satisfy various types of service requirements. Exiting works in [8][9][10] proposed Percolation is a kind of random graph and Study and improvement on LEACH[5] protocol in wireless sensor networks .In [5][2][8],the authors presented LEACH[5] TEEN[2] PERCOLATION THEORY[8] which resembles the percolation theory in random graph which is converted into the network of sensor nodes in the form of clusters.

Percolation Theory

Percolation theory [8] is the simplest but not exactly solved model displaying a Phase transition. Percolation theory deals with the numbers and properties of the clusters formed when sites are occupied with probability P. A cluster is a group of nearest neighboring occupied sites F finite lattices L< infinite, it is intuitively clear that if the occupation probability P is small, there is only few chance of having a cluster percolating between two opposite boundaries (i.e., in 2D, from top to bottom or from left to right).For P close to 1, we almost certainly will have a cluster percolating through the system. The percolation threshold Pc is the concentration P at

which an infinite cluster appears for the first time in an infinite lattice(cluster). Note, that Pc is defined
with respect to an infinite lattice (cluster), that is, in the limit of L->infinite imagine a 1d lattice with an infinite no. of sites(nodes in wsn) of equal spacing arranged in a line. Each site (node) has a probability P of being occupied (ON) and consequently 1-p of being empty(not occupied ,OFF). These are only two states possible. Phase transition in a percolation model is a sudden change from a finite number of clusters to an infinite cluster when p increases to pc. A cluster that reaches from one side of the plane to the other is said to be an infinite cluster

Percolation threshold in different lattice.

Types of lattice	Degree of node	p_{cs}
Regular hexagon	3	0.696
Square	4	0.593
Regular triangle	6	0.500

3. METHODOLOGY

To model the scenario we are using mathematical based analytical model. Energy at time't' in wireless sensor network(WSN) is the energy after transmitting, receiving and sensing overhead is

E(t) = E(t)T + E(t)R + E(t)S

where,

E(t)T : Energy Remaining after transmitting.

E(t)R: Energy Remaining after Receiving.

E(t)S: Energy Remaining after sensing overhead.

$E(t)T = E/(N_T*d^2)$

$E(t)R = E/N_R$

$E(t)S = E/C$

E = Initial energy.

NT= No. of bits transmitted at distance 'd'.

NR= No. of bits received.

C= constant of sensing overhead.

$E(t) = E(C*N_R+C*N_T*d^2+N_RN_T*d^2)/(C*N_T*N_R*d^2)$

$E(t) = E/a$

where a= depletion rate.

4. CH SELECTION ALGORITHM

The objective of this section is to propose the cluster head selection algorithm for the given network. In leach protocol cluster head selection is on the basis of random number generated by node if the node tends to die but able to choose as a cluster head so we remove such problem by choosing the cluster head on the basis of ratio of remaining energy to the initial energy.

Algorithm 1: CH selection

Data: Any node is able to select as a cluster head

Result: CH select

begin;

If CH remain <= Ethers Than

Select New node as a cluster head by selection procedure()

else

No need to change the cluster head selection procedure() calculate the ratio of remaining energy to the initial energy of all the nodes.

$r = E_{remaining}/E_{initial}$

Threshold T(n) of the current round can be calculated as

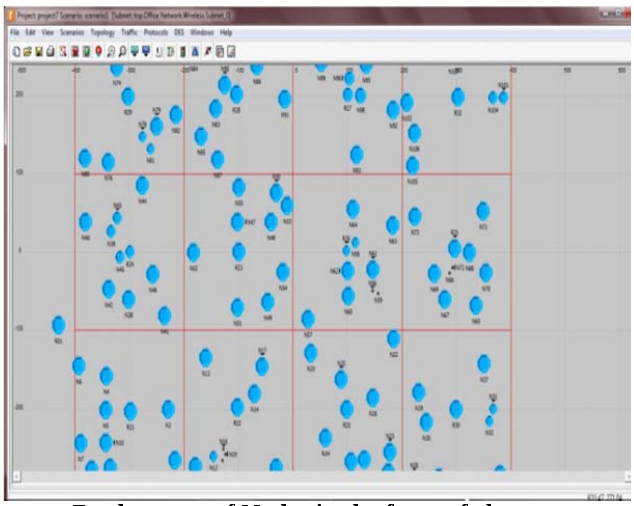
$$T(n) = \begin{cases} \dfrac{p}{1 - p \times [r \bmod (\frac{1}{p})]} & n \in G \\ 0, & other \end{cases}$$

where p is cluster head probability.

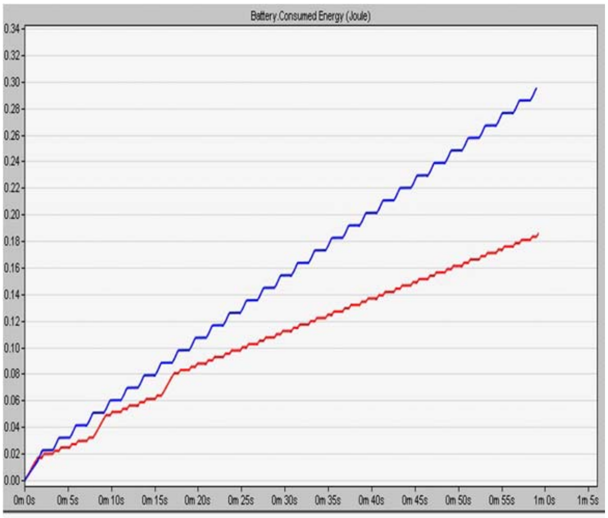
If the value of r if greater than threshold T(n) the node selects itself as a cluster head for current round .End

5. SIMULATION RESULT

In this whole network is partitioned in the equal size of cluster so that it will balance the load in the inter cluster lattices. In this network there are nearly 220 nodes are deployed in the whole region and the whole network is partitioned in 20 cluster such that each cluster is having 11 nodes in which at any time 1 cluster head and the remaining is the cluster member. Since all the clusters are equal spacing and equal no. of nodes are deployed then we can say that load of all the clusters are balanced. Each cluster head sends the data packet to the other cluster heads so data is passes through hop to hop and then to the sink node. So that the network works efficiently in the large geographical region.



: Deployment of Nodes in the form of cluster



Comparision of overall consumed energy by LEACH and our algorithm.

Here overall cummulative consumed energy by our algorithm is less as compared to leach protocol hence minimize the use of energy so we can say that maximize the network lifetime. Since in our algorithm clusters ON/OFF. At any instant of time nearly 60 percentage clusters ON and remaining are OFF so overall energy consumed by the whole network is less. Here the graph shows that the consumed energy is cummulative so when the time increases the difference in the consumed energy would be more in our approach to the leach protocol. Finally we can say that our approach minimize the energy and increases the network lifetime approximatly 23 percentage.

CONCLUSION AND FUTURE WORK

In this work, we use percolation theory in which at any instant of time nearly about 60 percentage of clusters are ON or we can say that they are in working condition and remaining 40 percent of clusters are off so that the overall consumed energy in the LEACH protocol is much more than our proposed approach and hence nearly 23 percent of network lifetime increases.

In the future work, we can improve our algorithm for including variations in the selection of cluster head and routing methods.

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