Balanced LEACH protocol for WSN

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ABSTRACT

Abstract— In WSN, LEACH (Low Energy Adaptive Clustering Hierarchy) is a well-known architecture for selection of cluster head for making clusters. But in this architecture there is only simple formula which is used for selection of cluster head. That is it having simple unbalanced structure for selection of cluster head. Main thing is that to increase reachability over area where sensor node deployed in that practical case Load balancing required, so paper simply describe a load balancing at network level (MP-LEACH) as well as load balancing at cluster level (MG-LEACH). Residual energy important phenomena because this is cumulative energy of all sensor node which takes active participation in network function, which means that how much reachability of base station over sensor network.

Keyword : - *WSN (wireless sensor network), Mult-Path LEACH, Mult-Group LEACH, Residual energy*

1. INTRODUCTION

Wireless sensor network (WSN) is a network in which on field small sensor node is important component of sensor network. Because of WSN fresh area of transmitting message over distance electronically enabled like in disaster management large number of sensor dropped from helicopter. Sensor node is modest part of WSN. There is lots of work formerly done which take for granted that all sensors now are homogeneous means all sensor node having equal computation capacity work same battery life. Figure 1 shows architecture of sensor node consists sensing unit, radio unit, processing unit and power unit (battery unit). Base station (BS) is fixed and not movable in nature and it have supply of full energy means it is unlike sensor.[7].

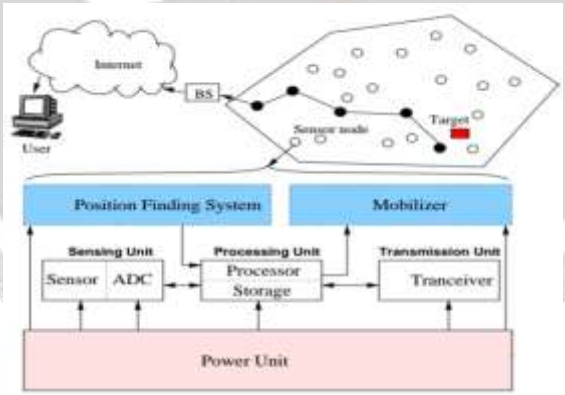

Fig. 1 Architecture of sensor node shows sensor subsystem

2. Related work

In direct transmission (DTS) scheme each node sends data to BS. Each node trying to talk with base station so value of total aggregated path is too much high which simply denotes that node earlier dies which placed at longer distance with respect to base station [6]. This is simple approach in which no any cluster formation as well as clustering technique is not used. It gives higher value for LND (Last node dead) but that node placed at very much closer to BS and it also shows very low residual energy as round goes on.

So there is another cluster based technique, Originally Low Energy Adaptive Clustering Hierarchy (LEACH), proposed by Heinzelman, Chandrakasan, & Balakrishnan, is renowned for its success in extending the lifetime of

Wireless Sensor Networks. LEACH architecture is a clustering based algorithm in which cluster is created and each cluster consist a cluster head (CH) [2]. But in this protocol, there is no any proper organization of cluster head selection other than simple formula which is as per follows. In LEACH protocol, there are two phase, first one is set-up phase and other one is steady state phase. And selection of cluster head purely based on random number and probability (p).[3]

$$T(n) = \begin{cases} \frac{p}{1-p*\left(r \bmod \left(\frac{1}{p}\right)\right)} & \text{if } n \in G, \\ 0 & \text{otherwise,} \end{cases}$$

Where T is threshold and r is number of current round

3. Load balance

There is simple selection of cluster head which makes clustering and each member of the cluster send data to cluster head and then it is forwarded by cluster head to base station. But in this technique there is drawback there is a possibility of election of two cluster head in same area, which is wastage of resource. In this paper try to utilize this limited resources efficiently there are two techniques which given as follows.

3.1 Load balancing at cluster level

This this technique, it utilizes advantage from location based approach, in this base station knows exact location of sensors and BS broadcast the advertising message that selection of cluster head. This decision taken by respective sensor which having enough range for making communication between clustered head. In this approach multiple groups are form and this technique combines with LEACH which forms MG-LEACH that is multi group LEACH.[1]

AS shown in figure 2, establishing multiple groups that is G1, G2, G3,……., Gn formation done in set-up phase by knowing location of sensors which straightly reported to sink node. Where all groups belonging to natural number system members in the group does not talk with other cluster head and this makes it special [8].

$$G = G_1 + G_2 + G_3 + \cdots \ldots \ldots + G_n \qquad \text{where G, n} \forall \text{ N}$$

3.2 Load balancing at network level

Above approach having only one disadvantage is that extra transmission problem. In order to figure out the extra transmission problem, by doing modification in the set-up phase of the LEACH algorithm. In this phase, once choosing of cluster heads over, the other sensor nodes do not needed to select the closest node. If such a cluster head does not exist, it will not be the member of any clusters and will send its data directly to the BS [4].But this case is consuming lots of energy because lots of calculation happened here. As shown in figure 3, combining approach of MG-LEACH with multiple hops it gives new changing in LEACH that is multipath LEACH (MP-LEACH) [5]. It simply means that decision of electing cluster head at sensor stage and formation of chain starting from base station that decision taken at cluster head stage. It simply looks like OSI reference layer model in that proper routing decision should be taken at various level and each level knows its own functionality which provides services to lower level. This simple fundamental is used here to reduce the aggregated path with increase in residual energy which shows extended network reachability than other protocol.

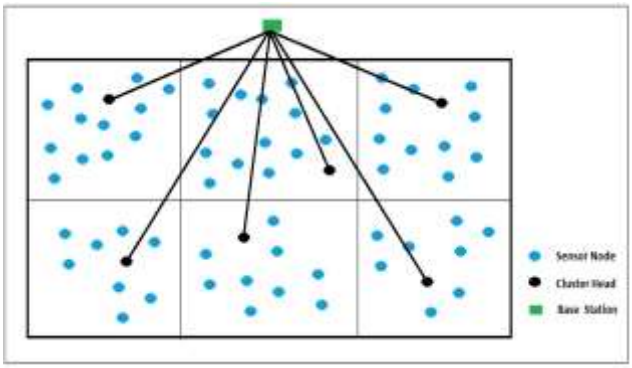

Fig -2 Load balancing at cluster level

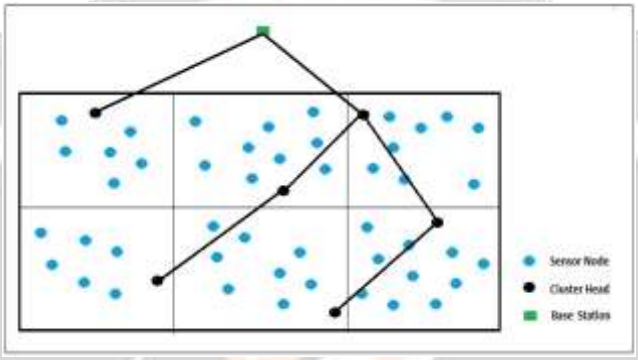

Fig -3 Load balancing at network level

4. Simulation environment

In MATLAB simulation environment, N number of sensors uniformly deployed in area of A*A. For making simulation done assume the following network model. We make some assumptions about the sensor nodes and the underlying network model:

1. The Network is homogeneous that all nodes have equal initial energy at the time of distribution.
2. Nodes are circulated randomly
3. There is only one base station, which is placed in the middle
4. The Energy of sensor nodes cannot be recharged after deployment of network.
5. Sensor nodes are equipped with GPS so aware about their placement
6. No power and computational constraints in Base-Station
7. Deployed Nodes can use power control to change the amount of transmission power, which depends on the distance to the receiver.

The node having energy consumed in transmission is

$$E(k,d) = \begin{cases} \mathrm{k} * \mathrm{E} + \left(\mathrm{k} * E_{fs} * d^2\right) & \text{if } \mathrm{d} < d_o, \\ \mathrm{k} * \mathrm{E} + \left(\mathrm{k} * E_{fs} * d^4\right) & \text{if } \mathrm{d} < d_o, \end{cases}$$

Where k is no. of bit transmitted d is the distance between transmitter and receiver and do=87 unit is the constant referred as crossover distance. Depending on the transmission distance both the free space Efs and the multi-path fading Emp channel models are used.

For receiving the k bit message the node radio consumes

$$E_{RX} = k * E_0$$

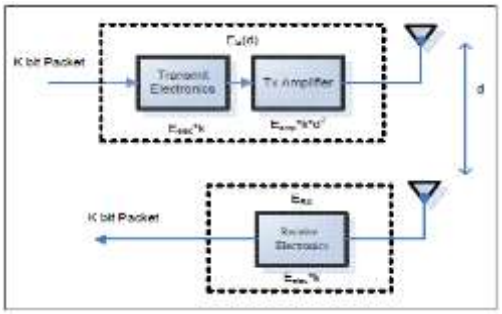

Fig -4 Energy model for simulation

Following parameters are assumed and respective meaning of variables are explained in following table.

Table -1: Simulation Parameter

Parameter	Description
Eo= 0.5 J	Initial energy
Efs= 100 pJ	Free space energy
EDA=5 nJ	Data aggregation energy dissipation
Rmax= 10000	Maximum number of round
p=0.1	Probability for choosing CH
Pctlength=4000	Packet length
Sink(x,y)=(50,50)	Position of base station

5. Simulation result and analysis

For simulation purpose, N=100 sensor nodes are deployed area 100*100 rectangular area. All sensor nodes having initial energy of Eo= 0.5 J. Figure 5 and figure 6 shows comparison between MP- LEACH, MG-LEACH, LEACH and DTS for 100 nodes with probability p=0.1 with initial energy 0.5 J. In figure 6, DTS looks better than LEACH and MG-LEACH. But depending on area coverage and reachability concern as per figure 5, DTS having minimum residual energy it simply means that it covers small area around base station , nodes present at longer distance gets earlier died. So DTS scheme is impractical for many cases and it having worst performance than other protocols.

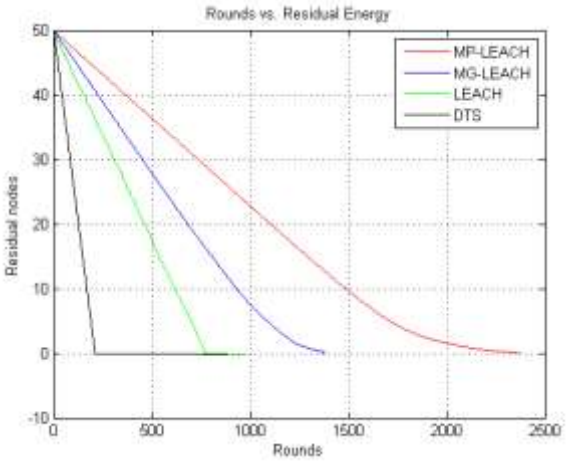

Fig. 5 Residual energy vs. Rounds

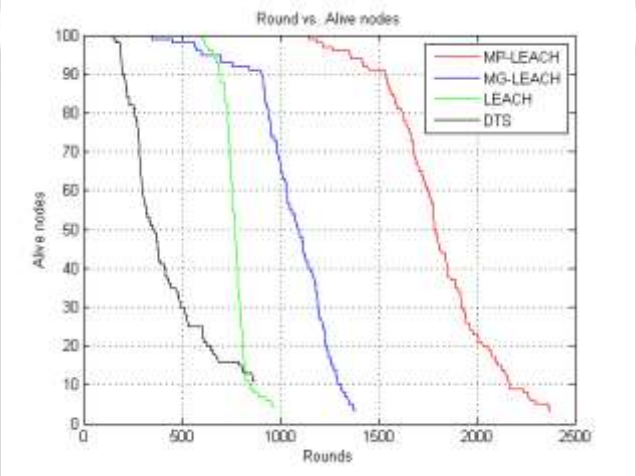

Fig. 6 Alive nodes vs. Round

Table II gives comparative study regarding FND (First Node Dead), HND (Half Node Dead) and LND (Last Node Dead).

Table-2: Comparative analysis

Protocol	FND	HND	LND
DTS	256	349	927
LEACH	612	767	928
MG-LEACH	390	1172	1387
MP-LEACH	1168	1756	2383

From table II and Figure 5 & 6 conclude that, MP-LEACH having best result than other three protocol which shows highest residual energy curve as well as FND and LND value.

6. Conclusion

The LEACH is one of the algorithms for routing the data in the network. In the LEACH it having respective disadvantages like extra communication problem and, not having load balancing structure and many others. Modifying the flowchart of LEACH, try to make more efficient routing protocol. In Multigroup LEACH the cluster head of each cell (groups) will communicate with the sink and CH selected from position based selective information by reducing the aggregated path. In Multipath LEACH, where the area is divided into cells and each area is having a cluster head, so the nodes of that area will communicate with that cluster head only. So now cluster head of each cell will connect each other and hence finally sends to sink node then to the base station.

7. References

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