Energy Efficient Dynamic Multicluster Routing Algorithm for Wireless Sensor Network

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ABSTRACT
Prolonged lifetime is the one of the important requirement in Wireless Sensor Network (WSN). As communication is the major cause of energy depletion in the network so designing of energy efficient routing algorithm is one of the key challenges that need to be address for extending life time of network. In this paper we have taken the deployed redundant nodes in to account which cover major fraction of energy depletion in the network. We presents energy efficient routing algorithm, Dynamic Multi-cluster based upon the frame work of LEACH. In LEACH there are several nodes they monitor the same event thus provide the redundant information which is discarded by the cluster head before transmit it base station. This will cause major fraction of energy depletion in WSN. This redundancy of deployed nodes can be used as an advantage for increasing network life time. To our presented scheme we simulate it using Matlab. Simulation results show that Dynamic multicluster had outperformed LEACH on the basis of Network life time.

Keywords
(WSN) Wireless Sensor Network, Limited Energy Design Challenges, , Routing algorithm, Redundant data, Network life time

I. INTRODUCTION

Sensing, Processing (Computation), Radio and Power are the four basic components of a Sensor node which normally operates in unattended mode. Mostly sensor Nodes are equipped with non-rechargeable battery that is not replaceable in most of the application. In sensor Node, the main energy dissipation factor is radio communication [2] [3]. Due to limited computational and power capabilities of deployed sensor nodes a lot of research is ongoing to design routing algorithms which are simple so that energy utilization of a sensor nodes remain as minimum as possible.

LEACH is a self-organizing, adaptive clustering protocol that uses randomization to distribute the energy load evenly among the sensors in the network. In LEACH, the nodes organize themselves into local clusters, with one node acting as the local base station or *cluster-head*. If the cluster heads were chosen a priori and fixed throughout the system lifetime, as in conventional clustering algorithms, it is easy to see that the unlucky sensors chosen to be cluster-heads would die quickly, ending the useful lifetime of all nodes belonging to those clusters. Thus LEACH includes randomized rotation of the high-energy cluster-head position such that it rotates among the various sensors in order to not drain the battery of a single sensor. In addition, LEACH performs local data fusion to "compress" the amount of data being sent from the clusters to the base station, further reducing energy dissipation and enhancing system lifetime.

In LEACH, Cluster -heads are randomly selected from deployed sensor nodes, biased by their experience in serving as Cluster -heads. It is a cluster based protocol adapting the stochastic model for randomized rotation of Cluster-heads for energy load balancing among sensor nodes in the network. It is based upon rounds in which sensor nodes transmit data to Cluster-head in their assigned time slot. Cluster-heads send aggregated data to Base Station by single hop transmission. The whole operation can be divided into two phases [1] set-up phase and steady state phase. The former is for clustering and the latter is for data transmission. The system repeats the clustering and transmission in every round.

A. Set-up Phase

During the setup phase, the CHs are selected based on an elective percentage of deployed nodes also by considering a factor that so far how many times an individual node performed the role of cluster-head. Each node from the set of deployed nodes chooses a random number between ***0*** and ***1***. If the number is less than a set threshold**,** the sensor node becomes a cluster-head for the existing round.

Once the percentage of nodes has elected themselves to be Cluster- heads they broadcast an advertisement message (ADV) . Each non cluster-head node decides its cluster for current round by choosing the Cluster-head that requires minimum communication energy, based on the received signal strength of the advertisement from each Cluster-head. After choose cluster, it informs the Cluster-head by transmitting a join request message (***Join-REQ***) back to the Cluster-head. The Cluster-head node sets up and broadcast a ***TDMA*** schedule to all member nodes. It completes the setup phase.

B. Steady State Phase

Steady Sate operation is broken into frames, where nodes send their data to the Cluster-head at most once per frame during their allocated slot. Cluster -Head sends the aggregated data to Base-Station (BS) in one hop manner. LEACH is based on rounds and system repeats the clustering and transmission for each round.

Redundant information is available in wireless sensor network which is subsequently cancelled during aggregation process performed by Cluster-heads. Our aim in the proposed idea is to utilize the redundant deployed nodes and take them as an advantage for prolonging network life t

II. LITERATURE SURVEY

DPM [2] is an effective tool in reducing system power consumption without significantly degrading performance. The basic idea is to shut down devices when not needed and wake them up when necessary.,

In [3] proposed a LEACH, a clustering-based routing protocol that minimizes global energy usage by distributing the load to all the nodes at different points in time. LEACH outperforms static clustering algorithms by requiring nodes to volunteer to be high-energy cluster-heads and adapting the corresponding clusters based on the nodes that choose to be cluster-heads at a given time. At different times, each node has the burden of acquiring data from the nodes in the cluster, fusing the data to obtain an aggregate signal, and transmitting this aggregate signal to the base station. LEACH is completely distributed, requiring no control information from the base station, and the nodes do not require knowledge of the global network in order for LEACH to operate.

In [6] proposed a two modified LEACH protocols: energy-LEACH protocol and multihop-LEACH protocol. Energy-LEACH protocol considers residual energy in the phase of cluster head selection. Multihop-LEACH protocol adopts multi-hop communication between cluster and sink. Using Simulation show that energy-LEACH and multihop LEACH protocols have better performance than LEACH protocol.

In [5] proposed an LEACH-TM with regard to defects of LEACH. LEACH-TM has three main advantages: The introduction of Trust and active Trust transmission mechanism. This provides an index for our using network efficiently and safely. The algorithm for producing cluster-heads. The establishment and usage of Multi-path. During the establishing node remaining energy, hop count and node Trust are all being taken into consideration, which will enhance the transmission reliability to a certain extent. In [7] on the basis of the LEACH protocol proposed the ACAER protocol by adding the energy constraint items, which can harness the residual energy of each node to share the node's burden, and by adding the coverage constraint items, which can apply the information of last turn coverage rate to adjust the cluster's selection proportion. Uses simulation results to suggest that improved algorithm can effectively abate the average energy consumption of each node, thus prolong the network's subsistence time.

III PROBLEM STATEMENT

Some of the defects of LEACH are as fallows**.**

1) Problem of communication between cluster-head and sink node

LEACH assumes that all nodes can directly communicate with sink node. When the network is very large, the communication between sink node and cluster-heads which are far away from sink node will abide by the model of multi-path attenuation, which may consume so much energy of the cluster-head that it would die out soon and the lifetime of network would be short.

2) The reliability of data transmission.

The cluster-heads directly communicate with the sink node. If there is something wrong with the channel, the data of this cluster wouldn't be transmitted in time. What's more, because of the limited anti-attack ability, some nodes may be captured by enemy. If these nodes be the cluster-head nodes, loss would be much greater

3) Does not take into account the location of nodes

In LEACH there is no assumption about the distribution or density of nodes, or about the placement area of nodes.

IV PROPOSED METHODOLOGY

A lot of redundant data is available in wireless sensor network due to widely deployed Sensor nodes. Our proposed scheme uses this redundancy of deployed nodes can be used as an advantage for increasing network life time

In LEACH "n" number of nodes deployed randomly is a part of a cluster represented here as S.

$$S= N_1+N_2+N_3\ldots\ldots N_n$$

Where: N_1 *to* N_n are the deployed nodes in an area A. In S there are several nodes that exist so closely in the adjacent area A_1 that they monitor the same event E_1 thus provide the redundant information which is discarded by cluster-head while aggregating the whole data collected from the member nodes before transmit it to Base Station (BS).

We assume that if the whole Square field is divided in to large number of smaller areas $A=A_1+A_2+A_3\ldots A_N$ then such redundant information is a major fraction of energy depletion in the Wireless Sensor Network. We have used this deficiency as a support in our proposed algorithm Dynamic multi-cluster. In Dynamic Multi-cluster, deployed nodes are divided in to Sub cluster ($S1\ldots S_k$) depending upon their locations. Number of cluster are mainly depends upon Node density. These clusters are created by the Base-Station at the time of deployment and after every **"*x*"** rounds. This is an additional step used in our proposed algorithm before setup phase and steady state phase and known as Set building phase.

Dynamic Multi-cluster is comprises of three steps. Two of them are the same as used in LEACH e.g. Setup phase and steady state phase. Before set up phase, set building phase is used at the time of deployment and after every **"*x*"** rounds by BS.

At the time of random deployments of node, each node that is equipped with GPS sends location information to BS directly. BS will use the provided information for every Set building phase. As it has been done only once so it does not consume too much energy.

Set up phase and steady state phase is same as used in LEACH and works in every cluster separately. These clusters do not work simultaneously but on alternate basis e.g. one at a time as per set duty cycle by BS. If Network comprised by Sub cluster ***S1*** is working Nodes of Sub cluster **S2** will be in sleep state. The duty cycle is set by BS at the time of Set-building phase. Minimum group of nodes construct at the time of deployment is two but mainly depends upon node density in the entire network.

We have simulated the Dynamic Multi-cluster and find it much more efficient than LEACH. We have checked the performance by taking different initial energy of deployed nodes .Dynamic Multi-cluster is performed much better than LEACH as increased Network lifetime considerably. We can use this proposed algorithm with any variant based on LEACH [5] [6] [7] in which set threshold has been modified either by addressing the shortcomings in the form of considering residual energy as well as other paramete

4.1 ALGORITHM:

Step1: Initialization

Xmax=1000; ymax=1000; x=[]; y=[]; Nsensors=300; sinkx=500; sinky=500; E0(i)=0.5J,2J; T=100,200;

Step2: Randomly find the x and y of sensor nodes

For (i=1: nsensors)

Xtmp=randi (xmax); Ytmp=randi (ymax);

X(i)=xtmp; y (i)=ytmp;

Step3: calculate the distance between every node to other node using the equation

ds=sqrt ((x1-x2)^2+ (y1-y2)^2);

Step4: select cluster head near the sink

ds=inf ; firstcluster=[];

For (i=1: nsensors)

Sink2allnodes(i)=ds;

If(ds<small)

Small=ds; firstcluster=i;

Step5: Each cluster haed selects other cluster cluster heads toward outer direction

Level++

If level>5 go to next step

If level<5 go to step4

Step6: Each node can transmit data during their allocated time slot t

Step7: Update energy of the each sensor node using the equation

Ekd=Pktize*Ef*d^2; E0 (i) =E0 (i)-Ekd;

Where Ekd=node radio energy consumed in transmission; E0(i) = initial energy of each sensor node;

Step8: All rounds over go to next step otherwise go to step5

Step9: stop

V. SYSTEM AND ENERGY MODEL

Consider a system including ***N*** sensor that are uniformly deployed in an area ***A***. We make some assumptions about the sensor nodes and the underlying network model: For simulating Dynamic Multicluster, Consider a system including 300 sensor Nodes that are randomly distributed in a square area 1000 x 1000. 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 deployment.
2. The Network is static and nodes are distributed randomly
   There exists only one base station, which is placed in the middle (500,500)
3. The Energy of sensor nodes cannot be recharged after deployment of network.
4. Sensor nodes are equipped with GPS so aware about their location
5. No power and computational constraints in Base-Station (BS)
6. Deployed Nodes can use power control to vary the amount of transmission power, which depends on the distance to the receiver

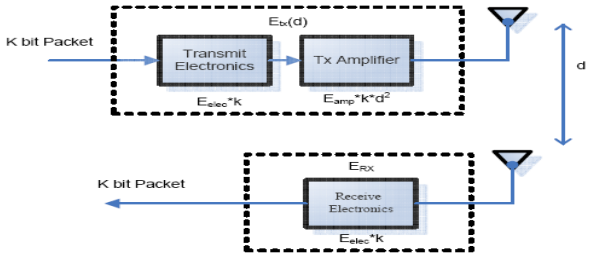


Fig-I

We have used the same Radio energy model as use in [4] block diagram is presented in Fig-I, which uses a 914 MHz radio. The node radio energy consumed in transmission is

ETx (k, d)=k*E(elec)+k*Efs*d^2 if d < d0
ETx (k, d)= k*E(elec)+k*Emp*d^4 if d > d0

Where, ***k*** is the number of bits transmitted, ***d*** is the distance between transmitter and receiver and d_o is the constant referred as crossover distance. Depending on the transmission distance both the free space E_{fs} and the multi-path fading E_{mp} channel models are used.

For receiving the K bit message node radio consumes

ERx (k)=k*E(elec)

As communication cost is considered to be much larger than computational cost, so the contribution of computations to the energy consumption is considered to be negligible in this analysis. The assumed energy required for running the transmitter and receiver electronic circuitry E(elec) is 0nJ/bit and for acceptable SNR required energy for transmitter amplifier for free space propagation E_{fs} is 100pJ/bit/m^2 . The crossover distance d_o is assumed to be 200m. All important parameters of simulation have been specified in table

Efs=100pJ/bit/m2	Transmit amplifier energy dissipation of free space model
EDA=5nJ/bit/signal	Data aggregation energy dissipation
Pidle=0J	Energy dissipated in Idle mode
Psleep=0J	Energy dissipated in sleep mode
do=200m	Crossover distance
Eo=0.5& 2J	Initial energy of deployed noes
Pktsize=4000 Bytes	Data packet size
rmax=8000	Max number of rounds

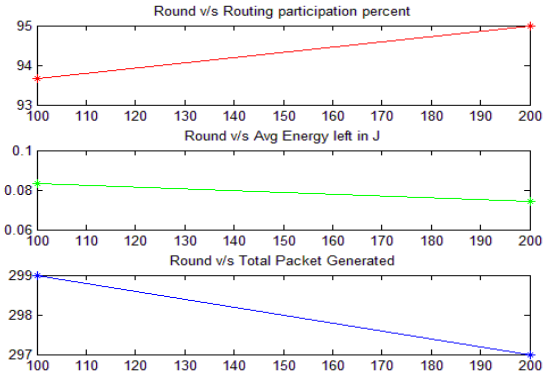
Table-I

VI. SIMULATION RESULTS AND ANALYSIS

We simulate Dynamic Multi-cluster algorithm in MATLAB to set up a comparative analysis both for LEACH and Dynamic Multi-cluster proposed in this paper. For the experiment, the random network of 300 Nodes is used. The Base-Station was placed in centre at, location (x=500, y=500). The bandwidth of the channel was set to 1 Mbps. Each data message was 4000

bytes long along with header packet which is 25 bytes long. The radio electronics energy was set to 0 nJ / bit. For performing computations to aggregate data was set to 5 nJ / bit / signal. These parameters are recapitulated in Table-I. In order to get improved and quite accurate comments of the algorithm, we establish the same simulation scene for both LEACH and Dynamic Multi-cluster. For energy model, we assume that each node begins with equal energy and an unlimited amount of data to send to the base station. Once a node runs out of energy, it is considered as dead and can no longer transmit or receive data. Initial energy for each node used in simulation is 0.5 Joule, while the experiment is repeated with 2 Joule energy both for LEACH and proposed Dynamic Multi-cluster.

LEACH



Dynamic Multi-cluster

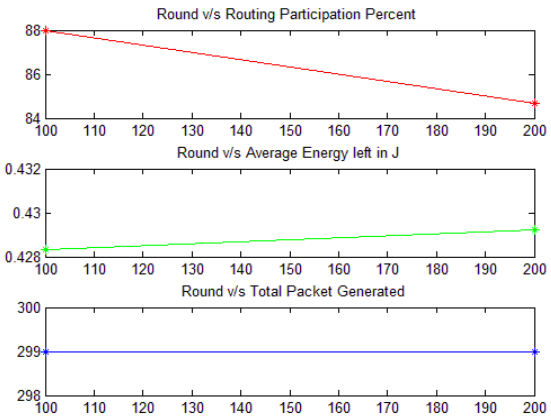


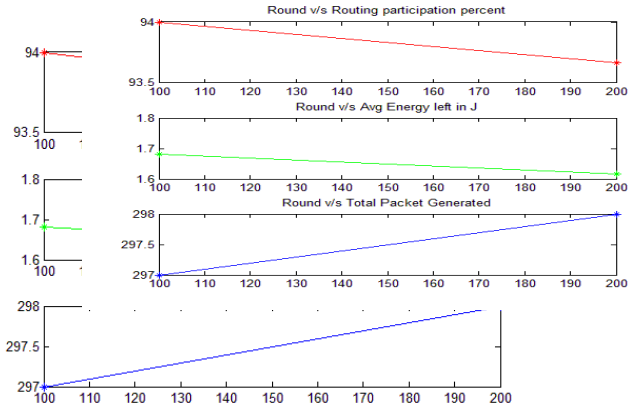
FIG-II

Fig-II illustrates the simulation result that demonstrate relative behaviour of both LEACH and Dynamic Multi-cluster algorithms with parameters values n =300, E0= 0.5 J. It demonstrates Routing participation percent, Average energy left in J, Total packet generated that is taken at y-axis for different time stamps (Rounds) that is taken on x-axis. Dynamic Multi-cluster performs significantly better than LEACH by extending life time of network.

Fig-III provides behaviour of both LEACH and Dynamic Multi-cluster routing algorithms, when the values of used parameters is set to ***n*** =300, ***E0*** =2 J. Fig-III illustrates Dynamic Multi-cluster consumes less energy as compared to LEACH. Hence Dynamic Multi-cluster performs significantly better than LEACH by extending life time of network.

From the Table –II we can see that average energy left in Dynamic multi-cluster is more as compared to LEACH for 200 rounds. We can conclude that Dynamic multi-cluster will increase the network life time as compared to LEACH. It is an effective way of enhancing the network life time by utilizing redundant nodes present in the network.

LEACH



Dynamic Multi-cluster

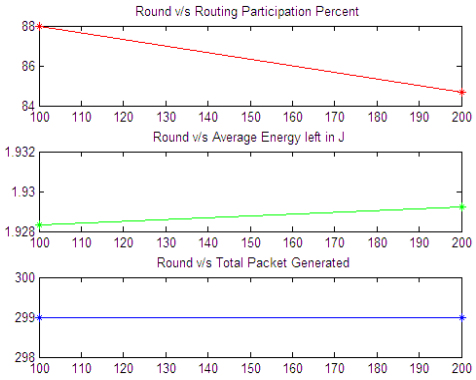


FIG-III

Initial energy Of all nodes		Average energy left in J after 200 rounds
0.5J	LEACH	0.07
	Dynamic multi-cluster	0.429
	LEACH	1.620

Table-II Comparative analysis of average energy left in J for 200 rounds

VII. CONCLUSION

Energy is the one of the major parameter in Wireless Sensor Network. Routing consumes the largest amount of energy in WSN so used routing protocol should be energy efficient. Number of variants which based upon frame work of LEACH has been proposed in the last decade. In all these cases, shortcoming of protocol for enhancing network life time. Lot of redundant information is available in WSN due to widely deployed nodes. In LEACH there are several nodes monitoring the same event thus provide redundant information which is discarded by cluster-head before forwarding it to Base-Station. Proposed Dynamic Multi-cluster is using same redundant nodes present in the system that locate in the same region for enhancing life time of the whole network. Simulation results shows Dynamic Multi-cluster will consume less energy as compared to LEACH thus it will increase the life time of the network then LEACH.

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