SIMULATION OF SECTOR BASED ENERGY EFFICIENT ROUTING PROTOCOL

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ABSTRACT

Wireless Sensor Networks have been increasingly used with the advent of advanced methods to develop these kinds of networks in various fields like biometrics, weather monitoring, military applications etc. In most of the cases the sensor nodes have to be largely dependent on the fixed non rechargeable batteries. Thus it is for utmost importance to save the energy as much as possible and preserve the network energy and hence its lifetime. There have been several routing protocols designed and all are primarily focused to provide maximum network lifetime by ensuring the efficient use of sensor node energy. Among these protocols the clustering based protocols such as LEACH, TEEN, EICCP, SEP etc. are the most widely used and are extensively researched to devise new routing protocols to preserve the network energy. In this research, a novel router based technique has been proposed and simulated.

Keywords: Wireless sensor Networks, Routing, Clustering, LEACH, network lifetime

I INTRODUCTION

Wireless sensor networks (WSNs) are increasingly used in many applications, for sensing ,collecting data and forwarding it to the control center which can be a base station having almost the same circuitry but more powerful. Typical uses of Wireless Sensor Networks include areas such as volcano and fire monitoring, urban sensing, and perimeter surveillance. Sensor nodes can aggregate the sensed data over a period of time and can relay it to the nearest base station themselves. This is called direct delivery. Though this is the most common approach but using this method leads to heavy traffic in the network and as the nodes are limited with energy, this decreases the lifetime of the network. The sensor network comprises of sensor field, where the sensor devices or nodes are scattered in this field. With the help of multi-hop techniques and router based infrastructure, a significant amount of energy can be conserved in the long run of the network. The dynamic parameters which are present in this type of network are constrained following are few of the parameters which might change dynamically depending on the application:

- Power availability.
- Position (if the nodes are mobile).
- Reachability.

- Type of task (i.e. attributes the nodes need to operation)

In this paper we suggest a novel approach of dividing the network area into a number of intelligent sectors, and decentralization of the communication over network by employing a router node at the center of the network.

II RELATED WORK

Clustering techniques have been devised to deal with energy management issues in WSNs. Low Energy Adaptive Clustering Hierarchy (LEACH) [8] is a pioneering work in this respect. LEACH is a clustering-based protocol, using randomized election and rotation of local cluster base station (so-called 'cluster-heads' for transferring data to the sink node) so as to evenly preserve the energy among the sensors in network. The rotation of cluster head is also a means of fault tolerance [1]. The sensors organize themselves into clusters using a probabilistic method to randomly elect themselves as heads in an epoch. However, the LEACH protocol is not heterogeneity aware, in the sense that when there is an energy difference to some threshold between these nodes in the network, the sensors die out faster than a more uniform energy setting [12]. In Distributed Energy- Efficient Clustering algorithm (DEEC) [10], a probability based clustering algorithm has been proposed. DEEC elects cluster heads based on the information of the ratio between residual energy of each nodes and the average energy of the network. This knowledge however requires additional information about energy consumption to be shared among the sensor nodes. Stable Election Protocol (SEP) [12] is another heterogeneity-aware protocol. It does not require energy knowledge sharing but is based on assigning weighted election probabilities of each node to be elected cluster head according to the irrespective energy. This approach ensures that the cluster head election is randomly selected and distributed based on the fraction of energy of each node therefore assuring a uniform use of the nodes energy. H-DEEC and MH-DEEC[17], routing protocol have been proposed as energy aware adaptive clustering protocols for heterogeneous networks. In H-DEEC, the network is divided into two parts on the basis of initial and residual energy. Normal nodes elect themselves as cluster heads and Beta nodes collect data from cluster heads and send it to Base station using multi-hopping. Unlike SEP and DEEC, H-DEEC and MH-DEEC perform better in a heterogeneous wireless sensor network. Moreover, it also considers the problem of locating base station outside the network.

2.1 Mathematical Model

The first order radio model is used in many researches on wireless sensors networks. Energy is dissipated while transmitting and receiving the data and energy consumption for short distance communication is d2 when propagation is in line of sight and d4 for the long distance due to multipath fading propagation. It works on the route measurements and sensing takes place constantly resulting in steady volume of data being transmitted to the sink. The following assumptions are considered in an analytical implementation:

1) Base station is fixed: Wireless sensors are densely deployed and are static. Number of clusters is predetermined for the WSN. They will pass the data on the predefined path in which clusters, the cluster heads are numbered according to their distance based on received signal strength (RSS).

2) Some sensors are farther away from the base station that is why the cluster head will consume the d4 energy for transmitting l bit data in direct transmission. So data is passed through multiple hops and reach the base station by cluster very near to the base station

3) Links are symmetric i.e. same level of power is required for the communication between any two nodes. No changes in the topologies and the load are considered.

Thus, to transmit a message of length to a distance d, the energy is given as:

$d_0 = sqrt(E_{mp}/E_{fs})$ (1)

if $d<d_0$

$Et_x(k,d)=E_{elec}*k+E_{mp}*k*d_4$ (2)

if $d \geq d_0$

$E_{tx}(k,d)=E_{elec}*k+Emp*k*d_4$ (3)

Reception Energy:

$E_{rx}(k)=E_{ele}c*k$(4)

Where Eelec is the energy dissipated in transmission and reception, Efs and Emp are free space and amplifier enegy respectively.

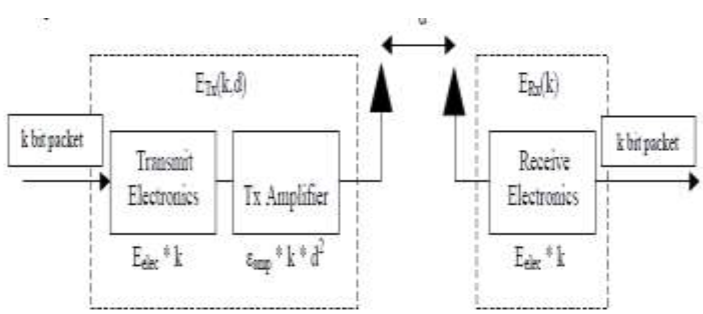

Fig 1:The First order radio model

The above diagram shows a pictorial representatipon of a first order radio model. The transmitter and receiver use the same kind of electronics circuitry and thus their energies are accumulated as Eelec, for each data bit transmitted. The sensor nodes are thus symmetric to each other.

2.2 Proposed Work

The proposed protocol in this research takes the basics of LEACH protocol, but uses a more deterministic way of cluster head selection, so as to provide efficient use of energy. In the original leach, the cluster head selection is probabilistic, where the cluster head are selected on comparing the energy of all the nodes. It is always on for receiving data from cluster members, aggregate these data and then send it to the base station that might be located far away from it. The cluster head will die earlier than the other nodes in the cluster because of its operation of receiving, sending and broadcastingh. When the cluster head dies, the cluster will become useless because the data gathered by cluster nodes will never reach the base station.

In this protocol the network area is divided into sectors, with each sector having a definite number of nodes. This division is done on an intelligent basis based on a distance threshold as explained in the below algorithm. A router node is located at the centre of the Network, which is used to relay communications between nodes and base station as per the requirement of the nodes.

if	$N_{dtoBS} < d0$	Sector 1
if	$N_{dtoR} < d0$	Sector 2
if	$N_{dtoBS} > d0$ & $y_n >= y_{BS}$	Sector 3
if	$N_{dtoR} > d0$ & $y_N <= y_R$	Sector 4 (5)

The nodes in sector 1 are nearer to the base station and in direct line of sight of communication path so these nodes does not require any clustering and communicate directly to the base station. Similarly, the nodes in the vicinity of router node are in direct line of sight of communication with the router node. The fringe nodes however, i.e. belonging to sector 3and 4 are not in direct range of either the router or base station, thus a clustering is performed.
This kind of dividion helps in improving the network lifetime as it requires less energy to be dissipated by nodes which are in line of sight with either the base station or the the router.

III SIMULATION RESULTS

In order to evaluate the performance of the proposed protocol, we simulated our protocol using MATLAB software tool. We consider a wireless sensor network with 100 nodes distributed randomly in 200m X 200m field. A router node is deployed at the center of the network area. The BS is located far away from the sensing field. Both router node and BS are stationary after deployment. We consider packet size of 4000 bits. We compare our protocol with LEACH protocol. To assess performance of our protocol with LEACH, we ignore the effects caused by signal collision and interference in the wireless channel.
The below figure shows, the division of network area into various sectors as mentioned.

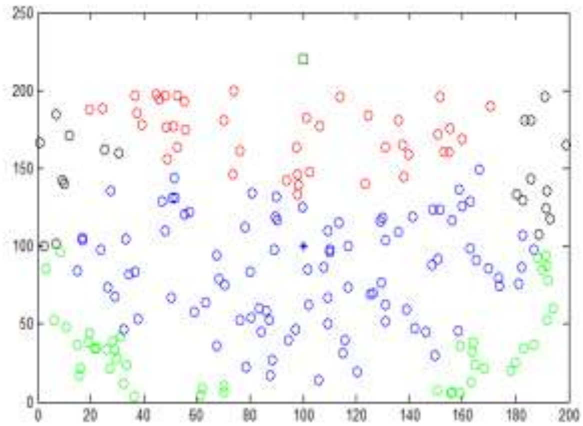

Fig 2:The Sectors of Network area

The above figure shows the network area after the division of the sectors. The nodes shown in red are in sector1, the nodes shown in blue are in sector 2, the nodes shown in black are in sector 3 and nodes shown in green are in sector 4. The base station is shown at a distance as a square box, while router node is placed at the centre of the network area at (100,100). The network configuration parameters are are shown in the below table:

Table 1: Simulation Parameters

Parameters	Values
Sink	At (100,220)
Router	At(100,100)
Threshold distance, d0	sqrt(E_{fs}/E_{mp})
Energy consumed in the electronics circuit to transmit in or receive the signal, E_{elec}	50 nJ/bit
Energy consumed by the amplifier to transmit at a short distance, E_{fs}	10 pJ/bit/m_2
Energy consumed by the amplifier to transmit at a longer distance, E_{mp}	0.0013 pJ/bit/m_4
Data Aggregation Energy, E_{DA}	5 nJ/bit/signal
Message Size	4000 bits
Initial Energy, E_0	0.5 J

No. of Rounds	5000

The below graph shows a comparison of proposed work and LEACH protocol. AS shown in the graph, the number of dead nodes after various rounds has shown a considerable increse in our proposed method as compared to that in LEACH, which clearly indicates the increase in energy efficiency and network lifetime as a whole.

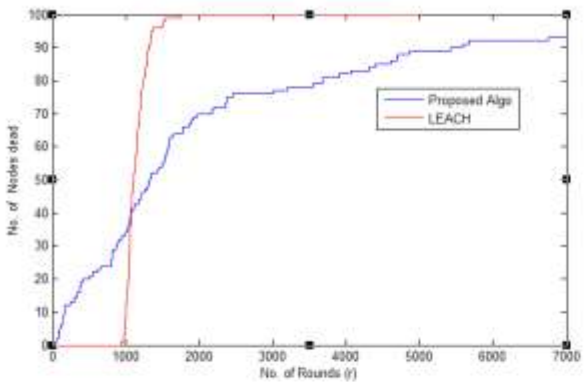

Fig. 3: No. of Dead Nodes

IV CONCLUSION

The proposed work focusses on an intelligent selection of network area and accordingly deploying the sensor nodes into different sectors. This method allows most of the nodes to be in direct line of sight communication with either base station or the router node, thus saving considerable enrgy in long-hop and multi-hop communication. The algorithm was simulated using a standard set of network parametrs and the numbe rof dead nodes has been compared against the LEACH protocol and the results show that the proposed protocol network stays alive for a much longer time than the standard LEACH protocol.

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