ISSN:0975-9646

Low Energy Consumption in WSN with Different Aggregation Energies using SEP

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Abstract - The energy aware wireless sensor networks are the need of today's wireless generation of information communication. The sensor networks are the specific type of wireless networks. The basic fundamental to reduce the energy consumption of the particular sensor network is to optimize the collection pattern of information from the nodes to base station or server. The conservation of energy is also important due to all the WSN nodes are battery operated. The battery has the limited source of energy and this limitation is also motivation to develop efficient routing technique. In this paper we have proposed modified routing algorithm stable election protocol(SEP) and optimize the pattern of cluster head election probability. The simulation has been done for 4500 rounds and the network live longer more than 4500 rounds and throughput is around 4.03x10^4.

Keywords - Energy Efficient, Routing, WSN, SEP, Cluster Head, Election Mechanism, Probability, Wireless Networks, MANET.

I. INTRODUCTION

A wireless sensor network (WSN) is a wireless ad hoc network consisting of a large number of small low cost devices called sensor nodes or motes. A sensor node is a self-contained unit typically consisting of a battery, transceiver, micro-controller and sensors. These sensor nodes are tiny resource constrained devices with the limitations of low battery power and communication range and small computation and storage capabilities. They are usually deployed in open environments where they collaboratively monitor the physical and environmental data such as temperature, pressure, vibration etc., and report/relay the sensed data to other sensor nodes over a wireless network. [3]

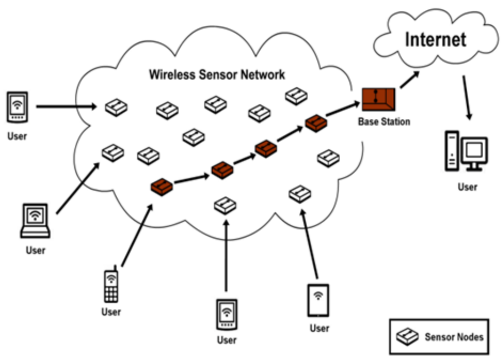

Figure 1: A Wireless Sensor Network

1.1 Routing in Wireless Sensor Network

Routing technique plays a vital role in the wireless sensor network. It is extremely difficult to assign the global ids for a large number of deployed sensor nodes. Thus, traditional protocols may not be applicable for WSN. Unlike conventional wireless communication networks (MANET, cellular network, etc.), WSN has inherent characteristics. It is highly dynamic network and specific to the application, and additionally it has limited energy, storage, and processing capability. These characteristics make it a very challenging task to develop a routing protocol. In most of the scenarios, multiple sources are required to send their data to a particular base station. The nodes near to the sink depleted more energy and hence eventually die. This causes partitioning of the network; consequently, the lifetime of the network gets to reduce. The main constraint of the sensor node is energy. [3]

1.2 Issues and Challenges for Routing in Wireless Sensor Networks

In the highly dynamic and energy constraint network, it is a challenging task to develop a routing protocol. The design of the routing protocol can be affected by various challenges possessed by WSN, which are discussed below: [15]

Energy constraint:

The sensor nodes are battery-powered devices, hence have limited energy. A large amount of energy is consumed during data transmission. Furthermore, a significant amount of energy is consumed during the route discovery and its maintenance phase. The lifetime of the network directly depends on the total energy consumption by each node. [15]

Bandwidth constraint:

Generally, WSN consists of a large number of sensor nodes, which makes the bandwidth allocation for each link very challenging. Moreover, in the process of route discovery and maintenance, an enormous amount of control packets has to be broadcasted among the sensor nodes. [15]

Limited hardware constraint:

Sensor nodes are tiny embedded devices having limited processing and storage capacity. Therefore, the researchers have to design a *light*-weight routing protocol that does not have complicated computing procedures and functions. Hence, the sensor nodes can process and store the data efficiently. [15]

Crowded center effect:

The data communication from source nodes to a sink in WSN is the many-to-one relationship. In the multi-hop environment, each sensor node forwards the data to the sink through intermediate sensor nodes. The sensor nodes near the sink always relay a large number of data. Therefore, they consume more energy than the remaining nodes and finally die. [15]

Node deployment:
The sensor node deployment entirely depends upon the applications. In some applications, structured deployment is required whereas, in some scenarios, random deployment is needed. In the random deployment, the node location is not predefined and generally, thrown from an aircraft in the hostile or unattended area. The node deployment highly affects the network performance. [15]
Sensor node location:
The geographical location information of the sensor nodes is required in many applications like tracking, monitoring, event detection, etc. It is not possible to enable the GPS in every single node. Instead; unknown nodes can find the location using the methods like triangulation based positioning and GPS-free solutions. [15]

II. PROPOSED METHODOLOGY

The wireless sensor network, which is a subset of mobile ad-hoc network has lot of challenges to reduce the energy consumption of sensor nodes or wireless nodes to live longer in network and keep communicating with the network. Here we have to work out main areas by which a node can live longer and i.e. either make batteries (source of energy) equipped with nodes having larger in size or the material having larger charges saving capability but this approach having limited capabilities because the larger battery size make sensor node more bulk which is not feasible in any case, and to find out the material has larger charge storing capability is also tough task to do. Instead doing above things another method is to make transfer of information on network more efficient.
SEP: It is used for selecting the Cluster Head in Clusters of Wireless Sensor Networks. It uses the basic principle of selecting the Node with the current Maximum Energy left as the Cluster Head, so that it can perform its operation for longer time or can have longer life time.
PROPOSED ALGORITHM:

1. Create the Simulation Environment and specify different aggregation Energies
2. If (Node_Count <= 100) then GOTO 4
3. Else EXIT
4. Define the Position and Energy of all Active Nodes (Node_Count <= 100)
5. Now START Transmission Rounds (Round_Count <= 5000)
6. If(Round_Count <= 5000) then GOTO 8
7. Else EXIT
8. Select the Node with Maximum Size and Maximum Energy that can have the Maximum Life Time in the Cluster
9. Now, this Node will be treated as Cluster Head (CH)
10. Now, on behalf of the Cluster, CH will communicate with the Base Station (BS)
11. Now again identify all the Live Nodes and calculate their Energy left.
12. Now, if Nodes of this Cluster want to communicate with Nodes of other Cluster, they can communicate via the CH
13. Repeat Step 11 and 12 until there will be no Live Node left in the Cluster or Round_Count is exhausted
14. Now, if Round_Count is exhausted, then calculate Number of Live Nodes and Dead Nodes left in the Cluster and calculate their Energies
15. Display the Result
16. END

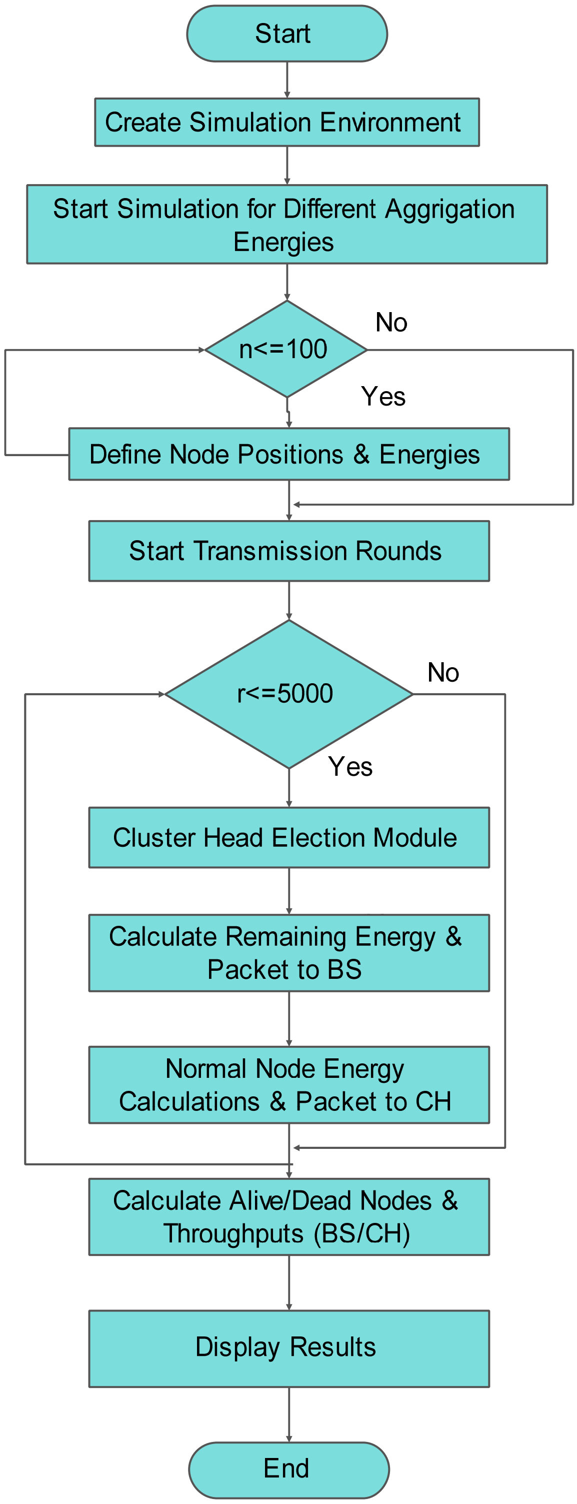

Fig.2: Flow Chart of the Proposed Methodology

III. RESULT AND ANALYSIS

Wireless Sensor Network (WSN) is having lots of research areas to work on and here we have chosen routing protocol to make network life span more than the previous work. The simulation performed on stable election protocol(SEP) which is based on reducing the data aggregation energy. The simulated results are in terms of number of alive nodes and numbers of dead nodes versus number of transmission rounds and packets sent to base station and packets sent to cluster curves.

In existing work life span of the network is calculated up to 3500 transmission rounds. If the network sustain for more number of rounds means life span of the network is going better. In proposed approach the life span of the network reaches more than 4500 rounds in 400x400 network, which is greater than the previous work.

AVERAGE ENERGY

Let, E_A be the Average Energy of a Node, E_T is the Total Energy of a Node, r be the current round, r_{MAX} be the total number of rounds and n be the total number of Nodes, then Average Energy,

$$E_A = [E_T * (1 - r / r_{MAX})] / n$$

ELECTION FACTOR

Let, P be the probability of Election, n be the number of Nodes and E_i be the Energy of Node. Let, E_T be the total Energy of a Node and E_A be the average Energy of a Node, then Election Factor,

$$P_i = (P * n * E_i) / (E_T * E_A)$$

DISTANCE BETWEEN TWO NODES

Let, (A_1, B_1) be the coordinates of first Node and (A_2, B_2) be the coordinates of second Node, then distance between these two Nodes will be given as:

$$D = [(A_2 - A_1)^2 + (B_2 - B_1)^2]^{1/2}$$

ENERGY CONSUMPTION

Let, E_C be the Energy Consumption of a Node, E_{TX} be the Transmission Energy required for sending 1 Packet, E_{AGG} be the Aggregation Energy, E_{MP} be the Amplified Energy, D be the distance between Node and Cluster Head and DATA be the message to be transmitted in Packet, then Energy Consumption of a Node can be given as:

$$E_C = [(E_{TX} + E_{AGG)} + (E_{MP} * D^4)] * DATA$$

TABLE 1 Simulation parameter

Parameter	Value
Simulation Area	400x400 m^2
Sink Position	Center of Network
Number of nodes, n	100
Energy of normal nodes	E_0=1j
Probability of node to become CH	0.1
Electronics energy per node, Eelec	50nj/bit
Amplification Energy(CH to BS)(d<=do)	Efs=10pj/bit/m^2
Amplification Energy(CH to BS)(d>do)	Emp=0.0013pj/bit/m^4
Amplification Energy(Node to CH)(d<=do1)	Efs/10=Efs1
Amplification Energy(Node to CH)(d>do1)	Emp/10=Emp1
Data Aggregation Energy, Eda	1,5,10,15,20 nJ/bit/report
Th	E_0/2
th1	1pj

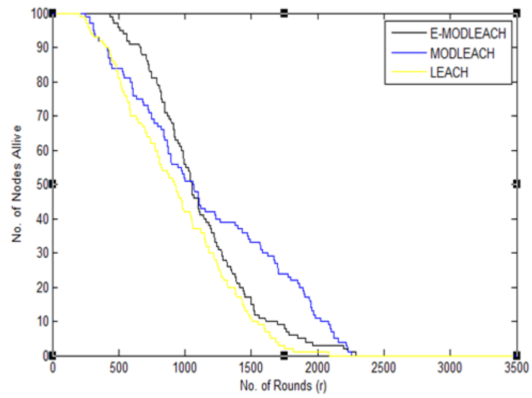

Fig.3 Network Life Time (Alive Nodes vs Rounds) of E-MODLEACH

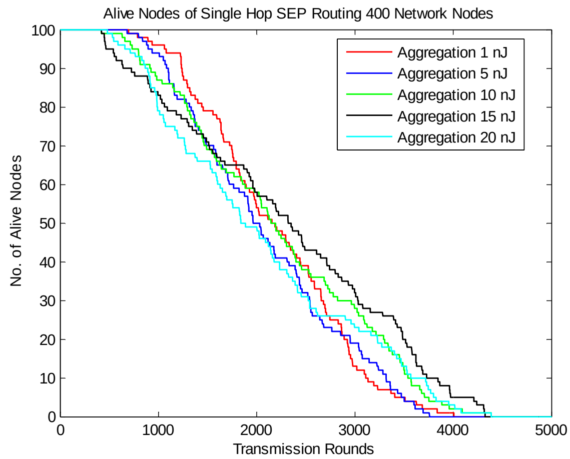

Fig.4 Network Life Time (Alive Nodes vs Rounds) of Proposed Methodology

TABLE 2 Number of Alive Nodes vs Rounds

No of Rounds	E-MODLEACH	Proposed	
		20 NJ	15NJ
1000	100	79	83
2000	50	49	58
3000	21	23	32
4000	0	3	5

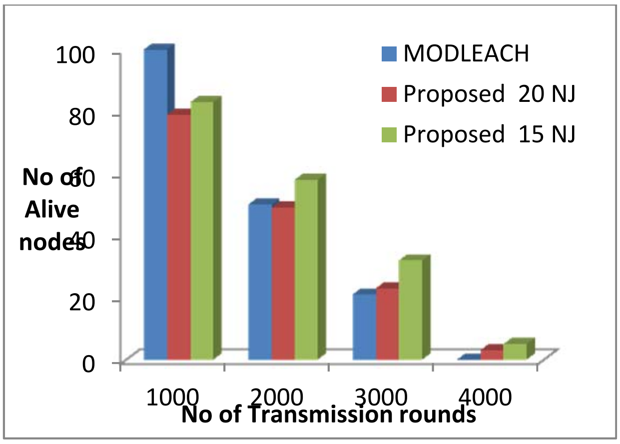

Fig.5 Graphical Representation of Number of Live Node v/s Rounds

Table 2 shows the comparison between Enhanced MOD LEACH Algorithm and the Proposed Algorithm on the basis of ***Number of Live Nodes v/s Rounds***. In E MOD LEACH Algorithm, Nodes are active in the network upto 3000 rounds. But in our algorithm, we have improved the life time of Nodes. Now, Nodes are active till atleast 4000 rounds.

Figure 5 shows the graphical representation of the ***Number of Live Nodes v/s Rounds***.

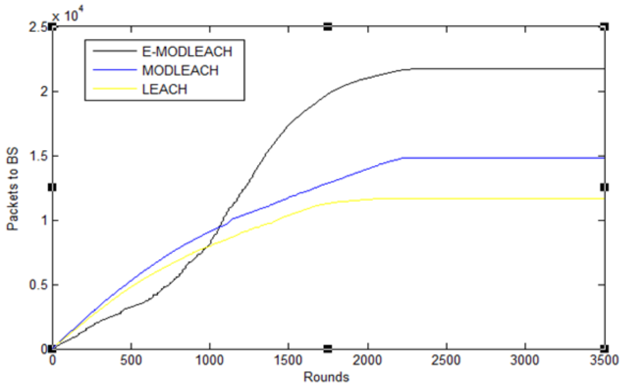

Fig. 6 Packets Sent to Base Station of E-MODLEACH

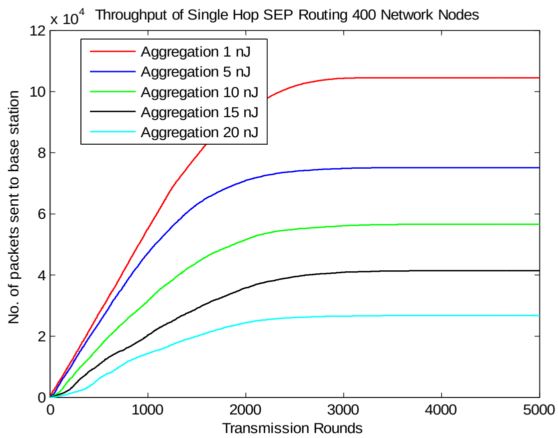

Fig. 7 Packets Sent to Base Station of Proposed Methodology

TABLE 3 Number of Packets to Base Station

No of Packets to Base Station			
No of Rounds	E-MODLEACH	Proposed	
		20 NJ	15 NJ
1000	8000	14000	20300
2000	21000	24000	35800
3000	21900	26000	40800
4000	0	26700	41400

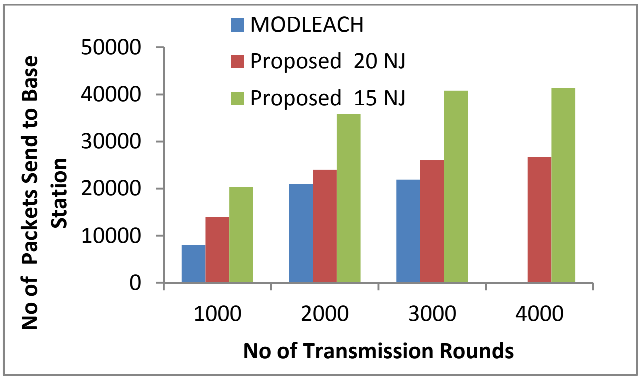

Fig.8 Graphical Representation of the Number of Packets sent to the Base Station

Table 3 shows the comparison between Enhanced MOD LEACH Algorithm and Proposed Algorithm on the basis of ***Number of Packets sent to Base Station***. In E MOD LEACH Algorithm, a maximum of 22, 000 packets can be transmitted to the Base Station from the Cluster Head in its entire Life Cycle. In our approach, we have achieved approx. 41, 000 packets to be transmitted to the Base Station by the Cluster Head in its Life Cycle.

Figure 8 shows the graphical representation of the ***Number of Packets sent to Base Station***.

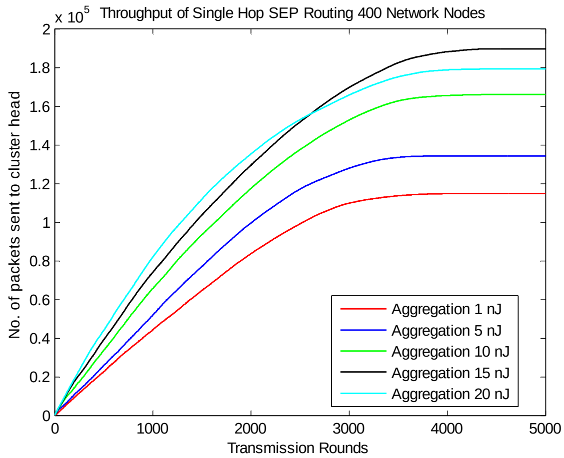

Fig. 9 Packets Sent to Cluster Head of Proposed Methodology

Figure 9 shows the ***Number of Packets sent to the Cluster Head by the Nodes*** in their Life Cycle.

IV. Conclusion And Future Scope

The wireless sensor network (WSN) is need to be sustain longer to stay with the network, and from the proposed methodology and its simulation results analyzed that with the lower election probability of cluster head in the stable election protocol(SEP) routing will have longer network lifetime which is higher than the existing methodologies. During simulation of proposed methodology number of dead nodes versus transmission rounds are calculated and the same for alive nodes and throughput i.e. packets send to base station also calculated for different probabilitiesand found longer network lifetime (the sensor nodes survived to more number of transmission rounds) with better throughput. With the analysis of other network parameters like network area, initial energy etc. researcher will make out something more robust routing protocols which have lower energy consumption and higher network lifetime.

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