Designing of Optimum Energy Aware Routing in WSN with HEED

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***Abstract* - The energy conservation of the sensor node is directly affected the way information transmitted to the base station or server. The less energy consumed by the node to transmit information larger the lifetime of the node. The transmission of information is considered as routing methods. Energy is the most prominent factor in wireless sensor networks because all the sensors are battery operated and the consumption of energy is inversely proportional to the lifetime of the sensor node. In this paper a more efficient energy efficient routing technique is proposed for the wireless sensor network. The energy of data aggregation in hybrid energy efficient distributed clustering (HEED) is kept lower to enhance the lifetime of the wireless sensor network (WSN). The proposed approach having better lifetime as well as throughput.**

***Keywords* - WSN, HEED, Energy Efficient Routing, Lifetime, Throughput.**

I. INTRODUCTION

Fast growing wireless technologies along with low cost embedded computation devices and contemporary design of communication infrastructure have resulted in rapid development of Mobile Ad hoc Networks. Such networks are self-organizing and their nodes communicate directly to each other using wireless transceiver along multi hop paths without the need of a fixed infrastructure (as opposed to cellular networks).

This distinguishing feature has shifted the focus of wireless community towards adhoc networks and they are considered as the technological counterpart of the concept of ubiquitous computing. Wireless Sensor Networks (WSNs for short) are a certain type of un-attended ad hoc network consisting of numerous small independent sensor nodes that are either deployed in the activity region or nearer to it. The sensor nodes in the network are self contained units containing advanced sensing functionalities, limited battery (energy), radio, and a minimal amount of on-board computing power. These sensor nodes exchange information in order to build a global view of the sensed region and the information is made accessible to the external user through one or more gateway node(s) [2]. Such networks are increasingly attractive means to enable a variety of applications and services. Some of the application domains include environment monitoring, health, military and home [3]. However these applications are delimited to a great extent due to the limited energy at the sensor nodes as it directly corresponds to network operational lifetime. In this context, since most of the energy is expended in transmitting the information between the sensor nodes rather than sensing, many academic and industrial efforts [4, 5, 6] focused on proposing energy-efficient routing protocols that involves several short-range multi-hop communication in lieu of direct long-range communication in relaying data between the sensor nodes. This routing strategy curtails the amount of energy spent by the sensor nodes but tends to increase the end-to-end delay involved in transfer of sensory data from the field to the sink.

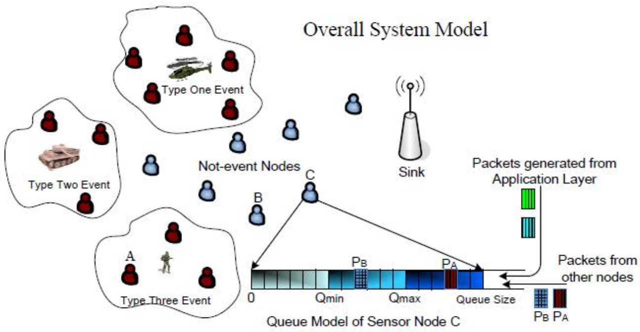

Figure 1.1: Wireless Sensor Network

Energy-Efficient Routing Problem:

Certain applications such as Volcanic Monitoring are highly delay sensitive, where sensor nodes are deployed to monitor the seismic activities and emission levels of volcanic craters and data should be transmitted to the control center within a prescribed delay in observance of any unusual activity [7]. Using power control or topology control, such sensitive delay requirements can be possibly met. In topology control, the nodes transmit the sensory data using long-range radio links to distant nodes. The transfer delay incurred in such transmission is lowered as the data is relayed in fewer hops to the sink node but with higher energy consumption. Every sensor node mainly consists of four components.

They are sensing unit, transceiver, processing unit and power source. Some sensor nodes also consist of optional components like location finding system, power generator and mobilizer. The sensing units generally consist of sensor and ADC (Analogue and digital converter).The ADC converts the analogue data to digital data so that node can process it before transmitting the data. Transceiver connects the node to the network. The processing unit consists of processor and memory. This unit is responsible for managing the task of sensor unit. Mobilizer is used to enable node movement.

II. ROUTING PROTOCOLS

To present efficient power management in WSN, researches have been focus on areas such as system-level power awareness like radio communication hardware, low duty cycle work and energy-aware MAC protocol [8]. Challenges encountered as a result of constrained energy supply and bandwidth in WSN when managing the network necessitates the need for development of energy awareness protocol at all levels of networking protocol stack. Also, it was observed that the network layer offers a better means through which reliable relaying of data and energy-efficient route setup within a network can help to maximize the network lifetime. It should be noted that routing in WSN has much distinguishable features compare to contemporary communication and ad hoc networks [8]. These features are as follows:

WSN cannot be built with global addressing (internet protocol address) scheme due to the enormous number of sensor nodes; There is significant redundancy in generated data because several sensors may gather the same data within a specified field. These redundancy bits need to be removed to increase the bandwidth utilization and also reduce energy consumption in the network; Transmission power of the system, processing capacity and storage are constraint factors to be considered when managing a WSN.

Clustered Architecture:

Hierarchical or cluster based routing methods are well known routing methods with a special advantage related to scalability and efficient communications. Hence, they are used for energy efficient routing in wireless sensor networks. In hierarchical routing, higher-energy nodes can be used to process and send the information, whereas low-energy nodes can be used to perform the sensing in the vicinity of the target. The creation of clusters and the assignment of special tasks to cluster heads contribute to the overall systems scalability. Nodes within a cluster lower the energy consumption by performing data aggregation and fusion, lowering the number of transmitted messages to the base station, thus prolonging network lifetime. Hierarchical routing is mainly comprised of two levels: one for the selection of cluster heads and the other for routing.

A clustered architecture consists of a cluster head, or Personal Area Network coordinator, which organizes sensor nodes, communicates for them to the BS and typically interfaces with another network. This structural design is well suited when data fusion is necessary. The cluster head fuses data gathered by member nodes and transmits the resulting information to the base station. A design of a clustered architecture is shown in Figure 2.1 In order for clustered networks for achieving the self-organization, the cluster formation and election process must be an autonomous, distributed procedure. This is achieved during network layer protocols, such as Low-Energy Adaptive Clustering Hierarchy [9, 10].

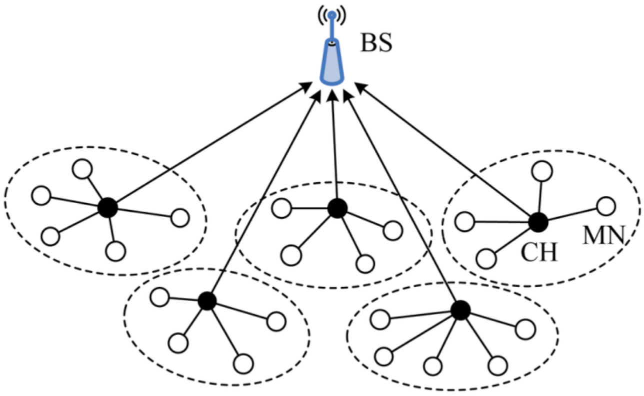

Figure 2.1: Data Aggregation Cluster Architecture

Low Energy Efficient Clustering:

Low Energy Efficient Clustering operates in two phases, setup and steady state. During the setup phase, *Low Energy Efficient Clustering* minimizes energy dissipation by randomly selecting and periodically reselecting nodes as cluster heads. In this way, the high energy consumption experienced by cluster heads is distributed all through the network, so assuring that all cluster heads eventually expend equal energy. Later than selection, the cluster heads advertise their selection to all network nodes. The nodes are in turn associate themselves with the nearest cluster head based on the received signal strength of the selection advertisement. A TDMA schedule is then assigned for node communication. The steady-state phase is extensive long in comparison to the setup phase in order to minimize the overhead of cluster formation. Data transmission takes place during the steady-state phase based on the TDMA schedule established during setup. Energy is conserved by local processing and data aggregation at the cluster head [10].

Ad hoc On-demand Distance Vector:

Ad hoc On-demand Distance Vector (AODV), as the name suggests is an on-demand protocol designed for mobile ad hoc networks [7]. This protocol responds quickly to changing link conditions and link breakages. The nodes mark the routes as invalid whenever there is a link breakage. AODV does not necessitate a node to maintain routes to destinations that are not in active communication. Loop freedom in AODV is ensured by using destination sequence numbers. These also allow nodes to use the most recent route to a target. The routing table information consist the destination address and the next hop address with the number of hops required to reach the destination. Also, the most recent destination sequence number associated with destination and lifetime of the route is stored in the table. If throughout the lifetime, the route is not used, the routing table entry is discarded.

HEED (Hybrid Energy Efficient Distributed Clustering):

In HEED [4] protocol all nodes use the initial and residual energy level to define the cluster heads. HEED estimate the ideal value of network lifetime to compute the reference energy that each node should expend during each round. In a two-level heterogeneous network, where we have two categories of nodes, m.N advanced nodes with initial energy equal to $Eo.(1 + a)$ and $(1 - m)$.N normal nodes, where the initial energy is equal to Eo. Where a and m are two variable which control the nodes percentage types (advanced or normal) and the total initial energy in the network E_{total} .

III. PROPOSED METHODOLOGY

The wireless sensor network 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.

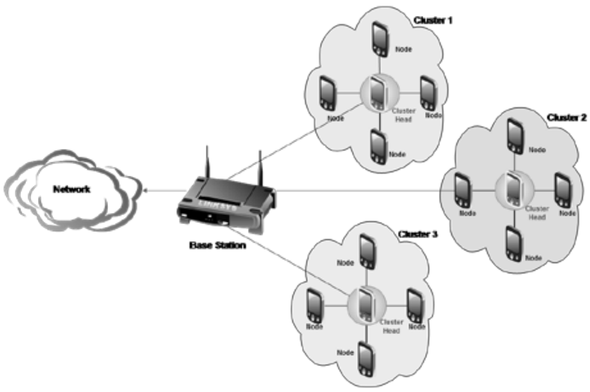

Figure 3.1: Network Diagram of Proposed Methodology with LDAE-HEED

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 finding out the material has larger charge storing capability is also tough task to do.

Here we are making changes in one of the routing protocol i.e. hybrid energy efficient distributed routing (HEED), where changes are being made in the information aggregation energy. The proposed approach is to have the lower data aggregation energy and the energy can be conserve for such frequent changes in the network. The proposed diagram of network is presented in Figure 3.1.

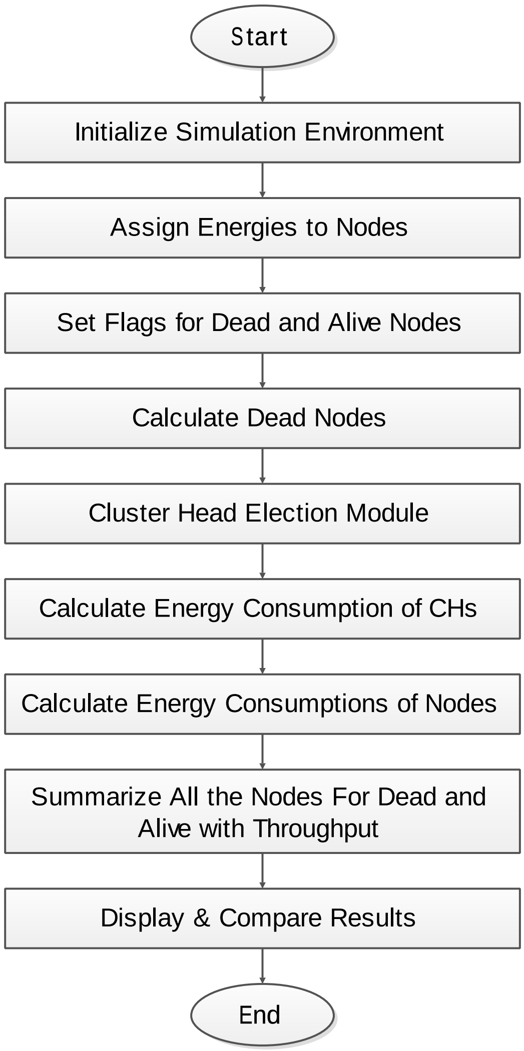

Figure 3.2: Flow chart of Proposed Routing Scheme

Table I: Network Simulation Parameters

Operation	**Energy Consumed**
Transmitter / Receiver Electronics	*Eelec = Etx = Erx = 50nJ/bit*
Data aggregation energy	*EDA = 1/5/10-nJ/bit/signal*
Transmit amplifier (if d to BS < do)	$E_{fs} = 10pJ/bit/4m^2$
Transmit amplifier (if d to BS > do)	$E_{mp} = 0.0013pJ/bit/m^4$

Instead doing above things another method is to make transfer of information on network more efficient. For this many routing protocols has been given as we discussed in the previous sections.

The above mentioned proposed routing strategy is implemented and its step by step execution is shown in Figure 3.2 flow chart.

IV. SIMULATION RESULTS

Wireless Sensor Network (WSN) is having lots of research areas to work on and here we have chosen routing protocol to make network lifetime more than the previous work. The simulation performed on hybrid energy efficient distributed clustering (HEED) which is based on reducing the data aggregation energy.

The simulated outcomes are in terms of number of alive nodes and number of dead nodes versus number of transmission rounds and throughput curve.

In the previous work lifetime of the network with density controlled divide and rule scheme (DDR) is calculated up to 2490 transmission rounds.

If the network sustain for more number of rounds means lifetime of the network is going better. In proposed approach the lifetime of the network increased up to 3263 rounds in 100x100 network, 3547 rounds in 134x134 network, 3224 rounds in 150x150 network and 2957 rounds in 200x200 with data aggregation energy which is greater than the previous work. And throughput is 6.857×10^4. Table II shows comparison of the network lifetime with existing work.

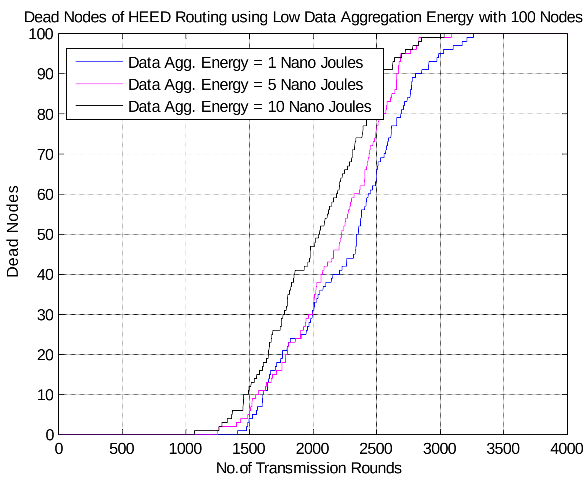

Figure 4.1: Network lifetime in terms of dead nodes versus no. of rounds

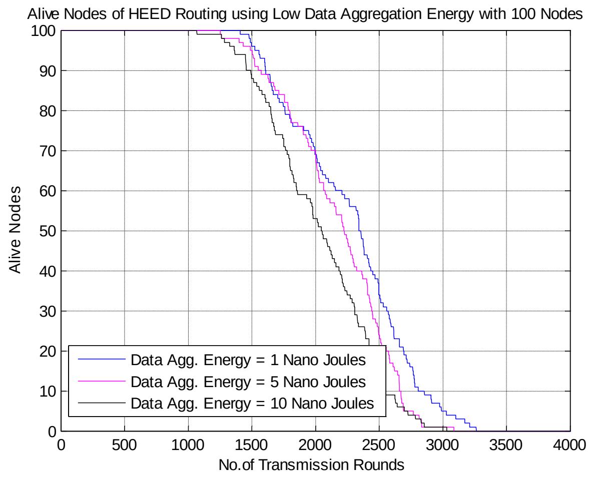

Figure 4.2: Network lifetime in terms of alive nodes versus no. of rounds

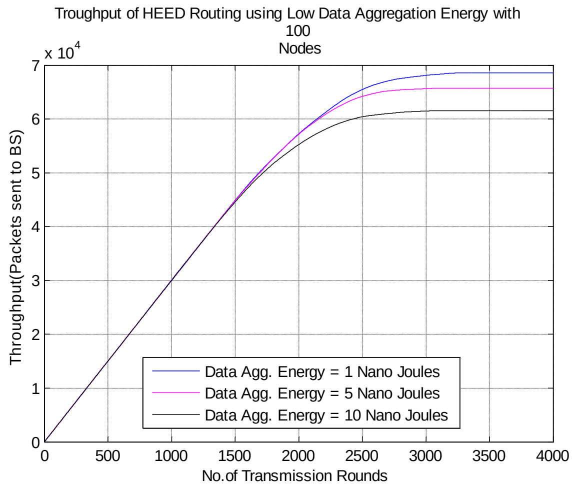

Figure 4.3: Throughput versus no. of rounds

The dead nodes versus no. of transmission rounds graph is shown in the Figure 4.1 and alive node versus no. of transmission rounds graph is shown in Figure 4.2 the Throughput is also shown in the Figure 4.3. The results are given for 100x100 network size and the network lifetime is also shown for other network sizes in Table II.

Table II: Comparison of Proposed and Existing Work

Routing Technique	**Network Size**	**Number of Nodes**	**First Node Death Round**	**Last Node Death Round**
Proposed Approach With HEED	***100mX100m***	***100***	***1410***	***3263***
	134mX134m	***134***	***1235***	***3547***
	150mX150m	***150***	***1230***	***3224***
	200mX200m	***200***	***888***	***2957***
Previous Work	100mX100m	100	1496	2490
	134mX134m	134	1460	2459
	150mX150m	150	1424	2388
	200mX200m	200	1204	2270

V. 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 data aggregation energy of information in the hybrid energy efficient distributed clustering (HEED) 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 data aggregation energy and found longer network lifetime (the sensor nodes survived to more number of transmission rounds) with better throughput. With the analysis of other network 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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