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Improved Hybrid Energy Efficient Approach for Wireless Sensor Network

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Abstract**—***A wireless sensor network is a group of smart sensors, which are capable of sensing, processing and communicating data or messages whenever any event occurs. It also monitors physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and pass the data through the network to a main location. A sensor is a useful electronic device which converts objective quantities into a signal that can be used by end user. These sensor nodes communicate over short distance via a wireless medium and collaborate to accomplish a common task. This work mainly focuses on the multi hop routing in WSN. In WSN a smart sensors nodes deployed for monitoring and sensing the event. The amount of energy in every sensor node is fixed and limited which is non-replaceable and cannot be charged again. Proposed work focus on basic routing protocols which are based on this routing mechanism. We use the multi hop HEED protocol to check the energy utilization in proposed network. The research mainly focuses on maximization of energy in terms of round calculation using radio energy model. Clustering and design considerations are very important to minimize the energy consumption to prolong the life time of the WSN.*

Keywords:—*Wireless sensor network, sensor node, design factor, HEED, Clustering, and Routing.*

1. INTRODUCTION

The wireless sensor networks (WSNs) is one of the latest innovations in the field of wireless communication [1]. It consists of small battery, CPU and sensor which are main part of small mote or node. Wireless sensor networks enable low power, low cost, high performance networks usually small in its topology and with minimum range of distances for communication with other node network [1]. In Today‟s, sensor motes are extensively used by the military in the battle field as a means to closely monitor opponent activities. Sensor network are used in healthcare, temperature sensing and monitoring and various other house hold and commercial applications [2]. A diagrammatic components of WSNs is shown in figure below,.

Figure 1 represents number of WSNs components for example: sensor node architecture, base station (sink), deployment

area, and sensor nodes event region which are represented by various colors like green, white and blue. A sensor (node or mole) is a useful electronic device which converts an objective or tangible quantity into a signal that can be calculate and used by end user. It is useful in devices like motion detectors, thermometers, home appliances, vehicle tracking and monitoring system.

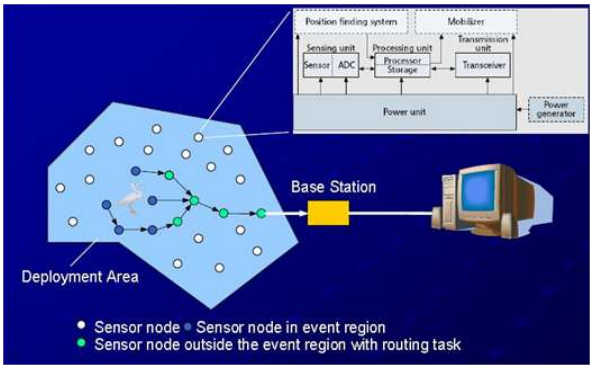

Figure 1: WSNs components overview [7]

Sensors have become a fast developing area for research and new application [2]. A sensor (node or mole) is a useful electronic device which is converts an objective or tangible quantity into a signal that can be calculate and used by end user. It is useful in devices like motion detectors, thermometers, home appliances, vehicle tracking and monitoring system. Sensors have become a fast developing area for research and new application [2].

Wireless Sensor Node: Each node typically consists of the four components: sensor unit, central processing unit (CPU), power unit, and communication unit. Each unit is assigned with different tasks [1]. The sensor unit consists of sensor and ADC (Analog to Digital Converter). The sensing unit is responsible for gathering information as the Analog to digital convertor requests, and returning the analog data it sensed [1].

Wireless Sensor Networks Architecture: A Wireless Sensor Network (WSN) is supposed to be made up of large number of sensors and at least one base station also called sink node. The sensors are autonomous small devices with several constraints like battery power, computation capabilities, and memory capacity and communication range [4].

Designing issues of routing protocol in WSN

In the WSN, for creating new routing protocol and changing the existing protocol in the sensor network, the developer and analyst firstly focus on the design issues and challenges.

Limited energy capacity: Every sensor node having limited energy for various operations. Sensor nodes use their energy for performing calculation, computation and transfer and receive information in a wireless network environment [4].

Sensor locations: sensor location is also important to create and manage network architecture. Location is also important design constraint of designing routing protocols for manage the current location of sensors [5].

***Limited hardware resources*:** sensor can vary in terms of their hardware and software properties. Apart from limited energy capacity, sensor nodes have limited data processing and data storage capacities for its processing data over the internet or sensor network.

2. EXISTING WORK

Study of various protocols

Direct communication*:* Direct communication is a type of flat routing algorithm where all nodes work equally. It is main advantage of this routing algorithm because all nodes share load equally but on the other hand flooding is the disadvantage of this routing algorithm, which is caused by duplicate message send to the same node. In direct communication, all nodes are directly connected to the base station and send data directly to the base station.

Minimum Transmission Energy: In Minimum Transmission Energy nodes route data through intermediate node, all nodes works as a router for the other node.

Low Energy Adaptive Clustering Hierarchy

LEACH is a clustering protocol, that minimize energy dissipation in sensor network, LEACH operation is divided into two part, first is setup phases and second is steady state phase.

Setup Phase **:** In this phase Clusters are organized and cluster heads are selected,

Sensor node choose a random number between 0 and 1, which is less than a threshold value, T (n), and that node become a cluster head for the current round,

$$T_1(n) = p / 1-p*(r \bmod 1/p)$$

Where p =Predetermined fraction of nodes

r = random number

Steady state phase: In this phase data is transferred to the sink node. It is longer than the duration of the setup phase in order to minimize the overhead. In this phase the sensor node can initiate sensing and transmitting data to the CHs. After receiving all the data, CHs nodes start aggregation before sending it to the BS.

Advantage :It can localize the route set up within the cluster and thus reduce the size of the routing table stored at the individual sensor node. [17]

Disadvantage: It is based on single hop routing, In this each node can transmit data directly to the cluster head and the base station. Therefore, it is not applicable to large network. [19]

HEED Protocol

Hybrid Energy Efficient Distributed Clustering is a cluster based protocol, in this protocol cluster heads are elected on the bases of residual energy and node degree. The proposed algorithm, select cluster heads on the bases of two parameters, first is their residual energy of each sensor node and second parameter is the inter cluster communication cost.

$$CHprob = Cprob \frac{E_{residual}}{E_{max}}$$

Where

$E_{residual}$= is the current energy in the sensor

E_{max}= is the maximum energy is only used to limit the initial CH announcement and has no direct impact on the final cluster structure.

Clustering Modeling:

Clustering is mainly used where the network having large number of nodes. In the large sensor network it is difficult to manage the node energy and due to this result is loss of more energy

1. Single Hop (One - hop) cluster model
2. Multi-hop cluster Model
3. Clustering-based Hierarchical Model

The main problem in previous work in the WSN is the data is transfer between sources nodes to destination like between nodes to node. If distance between the node is large than intermediate route or nodes is used. Various drawbacks are coming out if intermediate nodes lose battery or loss the energy during data transfer. Due to this WSN recovery, aggregation and routing protocol which are highly efficient and reliable. Scalability and energy maximization and utilization is always important and challenging terms in WSN.

For handling such issues in WSN we need adaptive routing protocols and also need improvements in existing routing protocol like single hop (HEED) protocol. Apart from the various design factor the integration of wireless sensor network are still challenging task for routing protocol to provide the energy

efficient routing with maximum utilization of the network. In the literature review we can see that lots of work has been done for handling the energy, clustering and routing issues.

3. THE PROPOSED WORK

Our main objective is to Design energy efficient routing algorithm in which we have to use various design constraints of routing algorithms of WSN. In the proposed work we have apply one relay node or intermediate node between source node and destination if the distance between the source node and destination node is far. We are using improved heed protocol for wireless sensor network by using multi level hierarchy in network.

Design Factors in Proposed Work

Table 1: Design issue (factors) used in Proposed work

Node deployment	**Random**
Total no. of Nodes	Fixed (varies in model)
Routing approach	Hierarchical with Clustering
Scalability	Good
Node Type	Heterogeneous node
Data model	Hybrid (single-hop and multi-hop)
Mobility of sink location	Outside at (0,0)
Data aggregation	Possible
Power usage	Minimum
Security	Possible
Topology	Self organizing

First Order Radio Energy Model

The clusters are used for transmitting data to the base station (sink) which gives the advantages of small transmit distances for most nodes, it require only few nodes to transmit information from far distance node to the base station. Extensive research in the area of low-energy radios is done in First order model.

3.3 Operation of HEED

Hybrid Energy Efficient Distributed Clustering is a cluster based protocol, in this protocol cluster heads are elected on the bases of residual energy and node degree.

The proposed algorithm, select cluster heads on the bases of two parameters, first is their residual energy of each sensor node and second parameter is the inter cluster communication cost.

$$CHprob = Cprob \frac{E_{residual}}{E_{max}}$$

Where

$E_{residual}$= is the current energy in the sensor

E_{max}= is the maximum energy is only used to limit the initial CH announcement and has no direct impact on the final cluster structure.

3.4 Proposed Work

The existing algorithm which is used here is HEED. In HEED it focus on heterogeneous node and used for reactive purpose with single hop and multi hop concept.

Algorithm for Network Deployment and Energy Computation

Algorithm is divided into 2 phase first phase [18, 14] is deal with set-up phase in which we are used design parameters, node properties and network area for random deployment of sensor nodes. Second phase is deal with data delivery between various nodes.

Set-Up Phase:

Step 1: Deployment of base station (sink) at position (0, 0) in area 500*500 m^2.

Step 2: Random Deployment of sensor nodes in the area of the define field.

Step 3: Selection of Cluster Heads (CHs) firstly on the basis of their centralized position.

Step 4: Switching the transmitting range of Cluster head (CHs) to 2X and X for the rest of the sensor nodes.

Step* 5*: Forming a distance matrix for each sensor node.

***Step 6*:** Connecting all the CHs present within the transmission range of „2x" using the distance matrix.

Step 7: connection of one cluster head to another cluster head which is near to base station.

Steady State Phase:

Step 1: Use of more comprehensive first order radio energy model.

Step 2: Calculate energy of each node for ***data*** delivery for example transmission energy, receiving energy, aggregation and encryption and decryption energy gives the total energy of each node.

Step 3: Calculate the total number of rounds for node until it dies.

Step 4: Change of CH within a cluster if the first CH dies i.e. runs out of energy.

***Step* 5:** Set-up phase for CH selection is repeated if cluster head dies in the existing connected network.

***Step 6*:** Sensing, communicate and processing in data continues until the lifetime of the network till the last node die of the network.

3.5 Proposed Algorithm for Round Calculation

Algorithm for Network model deployment **and Energy** computation

Set-Up phase for network deployment:

Step 1: Take initial design parameters and assumption values of node, sensing network field and radio energy model.

Step *2*: Random deployment of sensor nodes with the help of coordinate values(x axis, y axis) in define area.

***Step* 3:** Deployment of the SINK node (base station) at fixed position (x=0, y=0) in the network area.

***Step* 4:** Find the sensor node within the transmission range of Base station (sink node).

***Step* 5:** Find the total number of links between nodes in our network.

Above step 5 is required because we are applying single hop and multi-hop clustering approach, for this we have to decrease the number of links by keeping the same transmission range and connection of each node with base station.

***Step* 6:** In single hop clustering all the cluster head are connected to base station directly. Whereas in multi hop communication cluster head which is near to base station are connected to it and cluster head which is far away is connected to base station through other cluster head, which is worked as relay nodes also.

***Step* 7:** Selection of Cluster Heads (CHs) firstly on the basis of their centralized position.

***Step* 8:** Switching the transmission range of cluster head to 2X and X for the rest of the sensor nodes.

***Step* 9:** Forming a distance matrix for each sensor node.

Step 10: Connecting all the CHs present within the transmission range of "2x" using the distance matrix.

Step 11: A CH is now responsible for discovering other cliques and sharing information within the clique.

Steady State Phase:

***Step* 1:** Use of more comprehensive first order radio model.

Step 2: Calculate energy utilization of each sensor node which includes transmission energy and receiving energy. It's give the total energy consumption to perform setup of node and network and data delivery between nodes.

***Step 3*:** Calculate total number of rounds after which each node dies.

***Step 4*:** Change of CH within a cluster if the first CH dies i.e. runs out of energy.

***Step 5*:** Set-up phase for CH selection is repeated.

Step 6: Sensing occurs until the lifetime of the *network.*

The algorithm is mainly focus on data delivery between various nodes to base station for single hop and multi-hop communication. The algorithm is mainly used for comparison of number of rounds in various models for understanding and analysis of energy utilization for data routing over the existing network.

The flow graph shows the data delivery in the existing network single hop and multi hop communication with clustering concept.

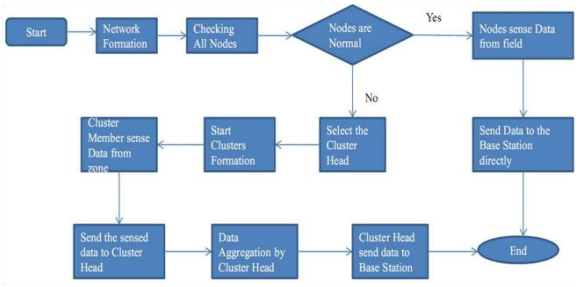

Figure 2: Flow graph of data sensing, computing and communication

4. CONCLUSION AND FUTURE WORK

Clustering and routing in wireless sensor networks is a challenge for researchers. Review of clustering and routing techniques in wireless sensor network gives the idea about routing mechanism for various applications area and its network node deployment. Application requirement in routing and model for data transmission both have the common criteria for minimize the energy consumption and increase the lifetime of the WSNs. We have seen the single hop and multi hop model, which are used to extend the life time of the sensor nodes and WSNs by using the different parameters. This Thesis report put forward a method for energy efficient data transfer mechanism for wireless sensor network with various design parameters. The proposed work is design for random deploy wireless sensor network with fixed node and sensing area. Suggest algorithm is mainly deal with heterogeneous node for reactive routing purpose. we propose a evaluation of energy efficient routing protocol for IMPROVED HEED routing design constraints with existing routing model of HEED protocols. We have examine the single hop HEED approach and multi hop IMPROVED HEED with all nodes which is random deployed at selected area.

After the deployment of senor node, we can calculate the number of rounds in the single hop and multi hop clustering approach. If number of rounds is large than it means the more energy is utilized in the network for data sensing, storage and delivery with each other and towards base station.

In the future work Security based Routing protocol is used for various applications. Current routing protocols optimize for the limited capabilities of the nodes and the application specific nature of the networks, Enduser need to be ensure that unauthorized users cannot access the data from the sensor network. Therefore security is also major consideration for various application and still needs various improvement.

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