

A HEXAGONAL NETWORK DIVISION APPROACH FOR REDUCING ENERGY HOLE ISSUE IN WSN

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Abstract: Energy hole issue in wireless sensor network is a critical issue due to the energy discharging of the sensor nodes in a rapid manner which are very close to the sink. This is because of nearer sensor nodes sending their own information to the sink as well as information getting from other regions. After sometime these sensor nodes die and incapable to transfer data to sink despite the fact energy still remained for other region's nodes which further disturbs the network lifetime. In this article we propose Hexagonal Network Division Approach for solving energy hole issue. Initially network divided into concentric hexagon and each hexagon act as a different layer. Also each hexagon divided into six equal portions. In the subsequent stage larger layer will be selected among all other layers. Now to decrease additional energy discharging from this layer, numerous sensor nodes positioned. In the final phase to prevent the energy hole issue, a suitable directing and ordering have been done which further improves network lifetime.

Keywords: Wireless Sensor Network, Clustering, Energy hole, Hexagon Network, Layer

1. Introduction

Energy hole is a vital concern in wireless sensor network (WSN). Sensor nodes that are nearer to the sink lose their energy in a rapid manner compared to the sensor nodes which are far-flung from sink. Hence lifetime of those sensor nodes are less which further reduced the lifetime of over-all network. This singularity of irregular energy ingesting degrees is named as energy hole issue [1][2][3] that may outcome quick dysfunction of the whole network, although other portions of the system still have loads of energy [4].

Figure 1 reflects that nodes in the greyed region have been died because they are nearer to the sink and discharging their energy in rapid fashion. In the beginning energy hole issue for homogeneously

distributed network is identified by authors in [5][6] for which region is separated into the concentric haloes from the sink. Simulation outcomes display that, as soon as first halo disbursed all their energy, energy consumed through a sensor node in the 10th halo is only little percentage. Authors in [7] examine the issue of irregular energy ingesting in an out-sized course of many to one sensor systems [8]. They detected that, ordered positioning and traffic flow density could have optimistic belongings on the issue, although weighty sensor node compactness or extra data generations have petite or unwanted special effects on it. Non-uniform circulation technique [9][10] is offered to resolve energy hole issue. It has been revealed that uneven dissemination technique can deliver a composed energy ingesting ratio of the nodes.

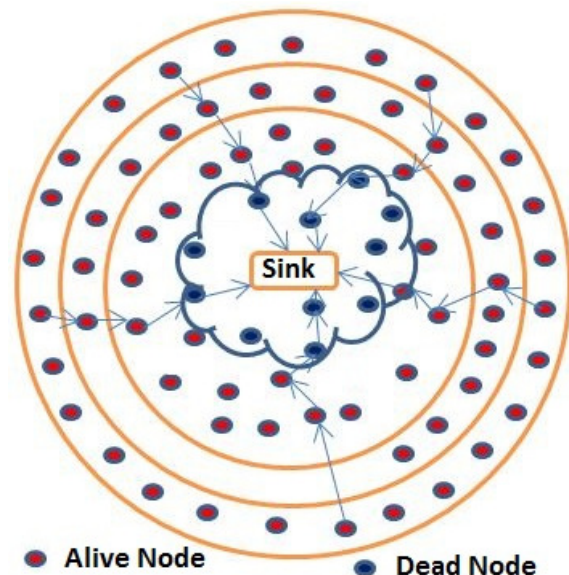


Figure 1. Energy Hole Issue in WSN

Moreover, energy hole issue in the system one or the other cannot relate unswervingly to the sink for the reason that of inadequate radio range or unswerving distribution of the data will bound energy and diminish over-all network lifetime [11].

2. Related Work

The sensor nodes that are nearby sink will come across by way of energy fall by growing traffic flow of nodes. As soon as sensor nodes do not work properly, over-all network functioning will be stop and hence this procedure will cause primary death in the network even if energy still remains in some of the sensor nodes, system will not work fine [12]. Authors in [10] for resolving the energy hole issue, deployed more number of sensor nodes nearby the sink. Authors in [13] for resolving energy hole issue, two sensor nodes with additional energy deployed in central region of system. Sensor nodes that are nearby to sink will transfer data straightaway to the Base Station (BS) once the clustering is done. The sensor nodes that are very far-off from BS will send data to these two sensor nodes. As energy of these nodes is reasonably high compared to the other sensor nodes in system then because of these two sensor nodes in the system, network generally does not fail, since these nodes work as a bond. Nearby sensor nodes meanwhile they are positioned in radio range will not ingest additional energy. Therefore energy hole issue will be prohibited in system. In [14] authors for solving energy hole issue, energy consumption in cluster as well as in Cluster head (CH) was very less.

In this technique cluster is not identical and circulation of nodes is non-uniform in System. Authors in [15][16] proposed a new Algorithm based on multi-level concept and separating levels in two parts. In first part CH send the data to BS and in the succeeding steps Gauss elimination process is used for reducing energy consumption in system but one of main problem with this method is that selection of CH is done by BS. In [17] authors proposed a new algorithm HRTBR for which they construct rounded network and implement hierarchy synthetic routing. Simulation results display that energy hole issue has been reduced up to a certain amount. Author in [18] recommend a new type of method to solve energy hole issue, that uses generally mobile sensor to restore energy holes at the rate of very high cost. Authors in [14] recommend an uneven node circulation plan that can accomplish a sub-stable energy ingesting of the sensor nodes.

3. Proposed model

Constraint of WSN like energy, sensor nodes transfer information and transmit information received from extra sensor nodes of the system. Afterward a small period of time nearby the sink, sensor nodes will release their energy in a rapid way since these sensor nodes always transferring the data to the BS as well as to system from the BS. As a result energy hole issue arises in the network and over-all network dead only because of some sensor nodes died. We proposed Hexagonal Network Division Approach (HNDA) in order to avoid burden and uneven energy consumption nearby sink. These are the some steps that have been done in this proposed algorithm which further reduces the energy hole issue up to significant amount. Initially network divided into concentric hexagon and each hexagon act as a different layer.

Also each hexagon divided into six equal portions. In the subsequent stage larger layer will be selected among all other layers. Now to decrease additional energy discharging from this layer, numerous sensor nodes positioned. In the final phase to prevent the energy hole issue, a suitable directing and ordering have been done which further improves network lifetime. Selection of CH is done in terms of residual energy of node as well the node distance. It is supposed in the proposed algorithm is that the sensor nodes are dispersed haphazardly in first layer. Once the network formation is done, the sensor nodes with the help of GPS send their features and ID to the sink. Once they send their features and ID to the sink, sensors turn off their GPS to save their energy. After getting signals by BS the table will be updated automatically with new characteristics and ID of different nodes. Now clustering is completed in most of the layers and suitable node for transferring data to lower layer is selected by this info.

The last Cluster head transmits it to the nodes of 1st layer by bearing in mind closeness and residual energy of the 1st layer sensor nodes. After getting info and assembly their data, 1st layer sensor nodes will transfer their data straightaway to the sink. As there are many nodes in the 1st layer and its appropriate range, removing energy hole issue in system. Figure 2 represents the proposed HNDA algorithm where it is clearly seen that more number of nodes have been distributed near the sink to overcome the energy hole issue.

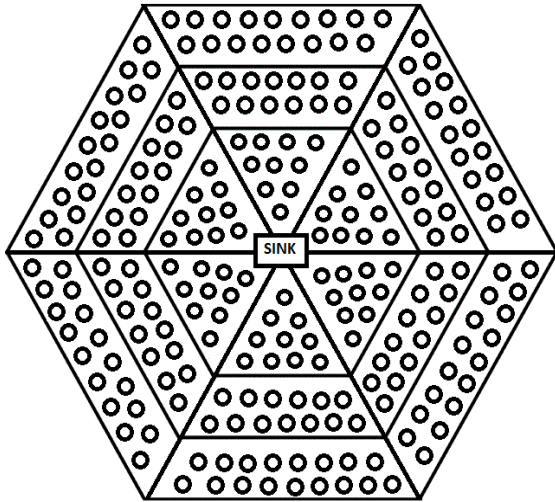


Figure 2. Proposed HNDA Algorithm

Following steps have been taken into consideration for designing proposed HNDA algorithm.

Step1: Surroundings are measured in area and measurement.

Step2: BS is positioned in middle of the network for relaxed retrieving to sensor nodes and small energy feeding.

Step3: Split measured surroundings by concentric hexagon as seen in Figure 1

Step4: Layers is achieved by separating furthest sensor node to BS.

Step5: Layer is separated in six identical portions of hexagon.

Step6: Selection of CH head is done in all the layers except 1st layer based on remaining energy and distance of sensor node.

For the selection of CH between 'n' numbers of nodes average distance of each node with another node from same cluster is achieved by equation (1) which is given below

$$\varphi(n) = \frac{d_1 + d_2 + d_3 + d_4 + \dots + d_{n-1} + d_n}{n} \quad (1)$$

Where d_i is the distance between any two neighboring node which is calculated by Euclidian formula given in equation (2)

$$d_i = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (2)$$

Where (x_i, y_i) and (x_j, y_j) are the co-ordinates of the nodes.

So probability of any node to become CH is given by equation (3)

$$P = \frac{E_n}{\varphi(n)} \quad (3)$$

Where E_n is the residual energy of the nodes.

In this procedure, certain sensor nodes are designated as a CH. Further on the basis of TDMA schedule, CH assign specific time to their member nodes to send their data to the CH. Once the data is gathered by CH, the gathered data is sent to the lower layer CH and a CH is designated again for lower level clusters [6]. 3rd layer CH after assembly the data from 3rd layer transfer data to 2nd layer. CH of 2nd layer accumulates data of 2nd and 3rd layer. Again Selection of CH according to the residual energy as well as distance of that node and hence data transported to that node. Sensor nodes of 1st layer direct data to BS and also different nodes of 1st layer transmit their specific data as shown in Figure 3.

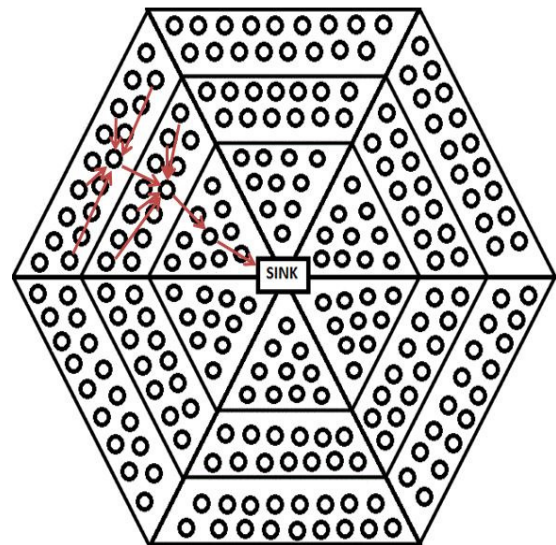


Figure 3. Flow of data in Proposed Algorithm

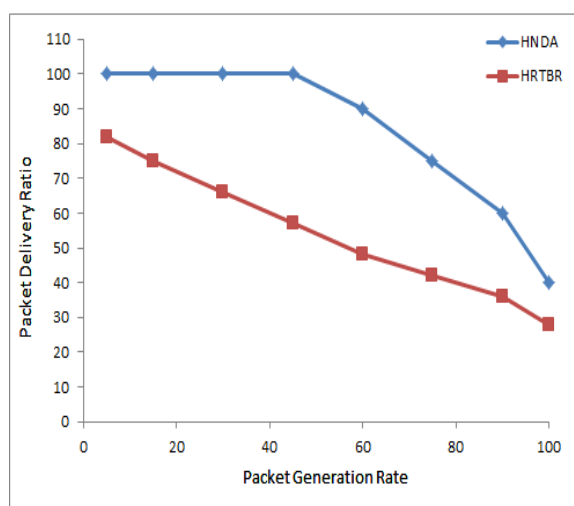
4. Simulation and Results

Simulation of proposed algorithm HNDA has been done using MATLAB and compared with existing algorithm HRTBR. Various parameters have been analysed during simulation like delivery ratio, average residual energy of nodes as well as number of lost packet. Simulation variable and its value is listed in Table 1

Table 1. Simulation Variables

Simulation Variable	Set up values
Network area	150m × 150m
No. of sensor nodes	200 nodes
Initial energy of nodes	1J
Sink location	(50m, 150m)
Simulation Round	5000

Figure4 shows the plot of packet delivery rate. Simulation outcome reflects that packet delivery rate is more in proposed HNDA algorithm compared to the existing algorithm. This is only because of consumption of energy in first layer is less compared to the existing HRTBR algorithm. Also when packet generation amount rises in system then data delivery amount rate keeps reducing.

**Figure 4.** Packet Delivery Ratio

Average of residual energy with influence of packet generation amount rate and with influence of node's initial energy have been shown in Figure5 and Figure6 respectively. Simulation results show that sensor nodes residual energy in proposed HNDA technique is more compared to the HRTBR algorithm. As in HRTBR algorithm, every singlenode and subsequent sensor nodes interchange control messages by means of query message assured of existence of afterwardsensor nodes in a detailed period.

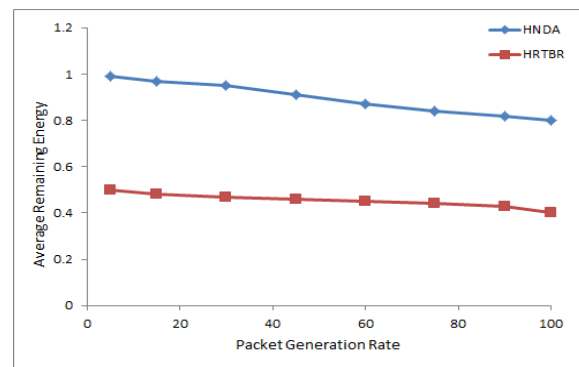
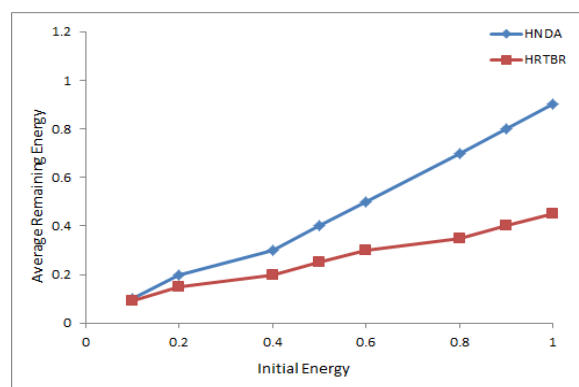
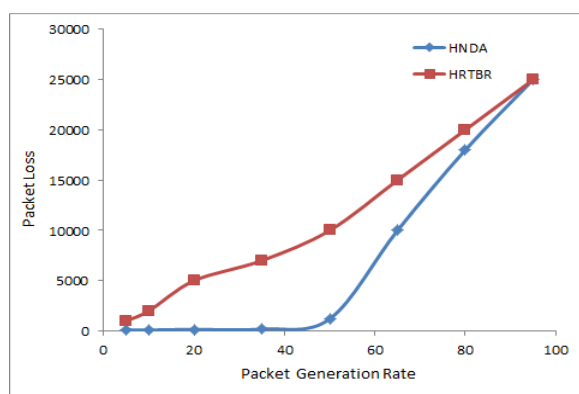
**Figure 5.** Average of remaining energy with influence of packet generation rate**Figure 6.** Average of remaining energy with influence of nodes initial energy**Figure 7.** Lost Packet

Figure7 shows the lost packet in the network. Simulation results shows that number of lost packet is less in proposed algorithm compared to the existing algorithm. This is only happening in the network because

of data delivery rate is more in proposed algorithm. Consequently, by reason of growing data delivery rate in system, most of the generated packet is transmitted to the sink. It is also clearly seen from the graph that when packet generation rate increases then lost number of packet in the network are almost nearer to each other this is only happening for the reason that of when data generation rate rises in HRTBR algorithm then alive nodes decrease in network.

5. Conclusion

In this work, a new HNDA algorithm has been recommended and simulated using MATLAB tool to overcome energy hole issue in the network. Network performance has been measured in terms of various parameters like delivery ratio, average residual energy of nodes as well as number of lost packet in the network. Simulation results reflect that proposed HNDA algorithm is performing well in all the parameters compared to the existing HRTBR protocol. Further results may be enhanced with different kind of concentric structure and with division of network in different layers.

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