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Enhanced Approach of Cluster Head Selection Using Rank and Weight Assignment in Wireless Sensor Network

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***Abstract*— With the evolution of wireless sensor network, the interest in their application have increased considerably. The architecture of the system differs with the application requirement and characteristics. Now days there are number of applications in which hierarchal based networks is highly in demand and key concept of such network is clustering. Some of the most well known hierarchical routing protocols are LEACH, TEEN, APTEEN and HEED. These different conventional protocols have diverse strategies to select their cluster head but still have some limitations. Based on the limitations of these conventional models, a new approach has been proposed on the basis of ranks and weights assignment. This approach will consider not only residual energy but also node's degree and distance of nodes with base station. The node which will have higher weight will be chosen as a cluster head. The objective of this approach is to have balance distribution of clusters, enhance lifetime and better efficiency than traditional methods.**

***Keywords*—Wireless sensor network, clustering, data aggregation, cluster head, weight.**

I. Introduction

Wireless Sensor Network (WSN) is entering a new phase of computer networks. Daily a new protocol comes in to market, resulting in improvisation for many applications. This new emerging trend is due to large connectivity leading numerous data exchange. The wireless sensor network consists of many autonomous devices called motes used for sensing, communicating and computing services. The sensor nodes collect the data and pass it to gateway or base station from where user can access the event information. Figure 1 illustrates this concept. The main components of sensor network are assembly of distributed or localized network, an interconnecting network; a central point of information clustering; and a set of computing resources at the central point (or beyond) to handle data correlation, event trending, status querying, and data mining [1].

There may be different ways of organizing the nodes. The one such can be the formation of clusters in which there is one arbitrary node to act as servicing node for several sensor nodes than each trying to reach Gateway node. This can extend network lifetime and bring down energy utilization considerably [2]. This process of choosing one node to act as servicing node for several neighbor nodes is known as 'clustering'. This servicing node is called cluster head and is responsible for data aggregation and fusion. The formation of clusters also leads to hierarchal routing. There are different protocols which uses different approaches to choose cluster head. Some of the traditional approaches are deficient in some respect.

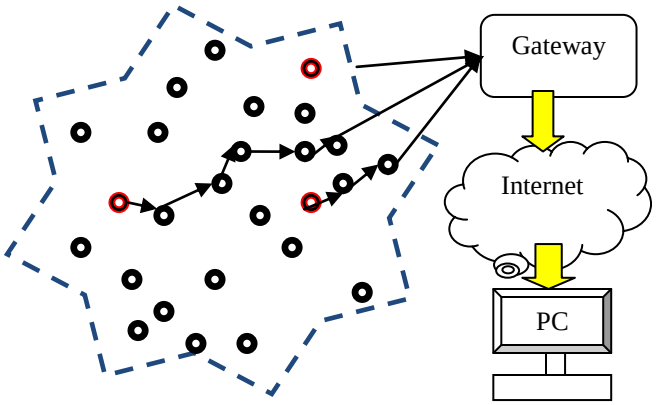

Figure1. Sensor Network environment

II. Background

The main aim of wireless sensor network is to gather large amount of data and to enhance the network lifetime with limited battery. In the conventional models like direct data transmission, each sensor nodes transmit its data to the base station directly. In [2] it is observed that if the base station is located far away from sensor nodes then it will drain off the battery quickly and reduces the network lifetime because each node will require large transmit power separately. Similarly, in minimum energy routing protocol where data is transferred to the base station with the help of intermediate nodes. Thus, nodes close to the base station are the ones to die out quickly because these routers have to transmit large amount of data. The hierarchal clustering is now formed the basis of many wireless routing protocol. The advantage of hierarchal routing is that it helps in saving large amount of energy particularly in large networks. The data is passed to the super node until a top level hierarchy is arrived which in turn leads to base station.

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W. R. Heinzelman, A. P. Chandrakasan and H. Balakrishnan [3] in 2000 proposed a protocol called Low Energy Adaptive Clustering Hierarchy (LEACH) which later turned to be the most popular algorithm in the hierarchal routing for sensor nodes. It is a dense network of sensor nodes grouped in to clusters and utilizes randomized rotation of clusters. These local cluster heads act as a router to send information or knowledge to the base station. Other advantage of LEACH includes it incorporates data fusion into routing protocols; amount of information to the base station is reduced; 4-8 times effective over direct communication in prolonging network lifetime; also the clusters forms grid like area. But the election of cluster head node in LEACH has some deficiency. Like sometimes very big clusters and sometimes very small cluster may exit at the same time. There is unreasonable cluster head selection while nodes have different energy; once the energy of the cluster head node depletes all other nodes fails to function; the algorithm does not take in to account location of nodes, residual energy and other information which may lead cluster head node rapidly fail. Another protocol called HEED [4] works on the basis of cluster head probability which is the function of residual energy and neighbor proximity. The protocol aims to have balanced cluster, works better both for uniform and non-uniform node distribution; required low message overhead but increase in iterations results in complex algorithm. The decrease in residual energy leads to low cluster head probability. HEED outperforms several generic protocols but is deficit in some parameters. Similarly Threshold sensitive energy efficient sensor network [5] protocol is a hierarchical protocol designed to be responsive to sudden changes in the sense attribute. The cluster head broadcast two types of threshold; hard threshold to allow the nodes to transmit only when the sensed attribute is in the range of interest and soft threshold to reduce the number of transmission if there is little or no change in the sensed attribute. APTEEN is an extension of TEEN and captures both periodic data and time critical events [5]. The energy dissipation and network life time is better than LEACH but the main drawback of TEEN and APTEEN are the overhead and complexity of forming cluster head at multiple levels and implementing threshold based function and dealing with attribute based naming of queries [5].

III. Proposed Approach

In the field of wireless sensor network, daily a new approach is putted forward by the researchers to have a good cluster head selection strategy in order to prolong network lifetime. To have a global view their basic categorization lies from the following questions like what is the parameter to decide the role of sensor node, which sensor node initializes the cluster head selection, does the load is evenly distributed, does the network require single hop transmission or multi hop transmission. The main aim of different approaches is to reduce the energy consumption and enhancement of network lifetime. For balanced distribution, the protocol requires that after particular time interval the role of the cluster head is given to different sensor node.

There are different protocols which uses different scheme to choose the cluster head. In the proposed approach the basis of cluster head selection is not the threshold values like LEACH and not only residual energy like SEP [6] and energy aware routing [7]. The proposed approach takes the following parameters in to consideration like-

Node Degree: It is defined as the total number of neighboring node of a specific node. The node degree is one of the important metric to check the connectivity in the wireless and also ad-hoc networks [8]. It can also be defined as to how many nodes the specific node is directly connected or how many nodes are in the range of that particular node. The higher the degree, the better will be the connectivity of the node with other nodes and hence large amount of data can be aggregated at one place.

Distance of node from base station: It has been seen that the energy consumed in transmitting the data is much more than processing it. Larger the distance higher will be the communication cost. This was the reason that for larger distances direct communication does not go up to the mark. In our proposed approach we are choosing the node which have low communication cost. Thus, in this approach there is consideration of location of nodes.

Residual Energy: The lifetime of the network is all about the energy contained in the nodes [9]. The higher the energy remained in the sensor nodes more will be the lifetime. If the cluster heads itself deplete from energy then all other sensor nodes communicating through it also die because of cascading effect. The role of the sensor nodes should be properly defined to have a balanced rate of energy in every grid of nodes.

IV. Simulation Scenario

Firstly the nodes in the network are randomly deployed in a 100mt*100mt area then those nodes is differentiated on the bases of grids. For every round of transmission there will be assignment of weights to the nodes. Each node is given a weight on the basis of above parameters like node degree, distance and residual energy.

These nodes are placed at different locations and have different energy level shown in figure 2. The BS in the figure is representing Base station which is positioned in between the sensor nodes. The nodes belonging to one cluster or grid send their information regarding node degree and its distance from base station to the base station (supervisor node). The base station on receiving the data assigns the rank. For example if there are ‘n’ nodes in the grid then a rank for distance D(i)= n is given to node who is most close to the base station. Similarly D(i)=1 if the node is farthest from the base station. Likewise the rank N(i)=n which is having higher number of degree and N(i)=1 which is having the least degree. Since for transferring these data some amount of energy is consumed therefore after this process the nodes send their residual energy status. The base station assign the rank E(i)=n to the

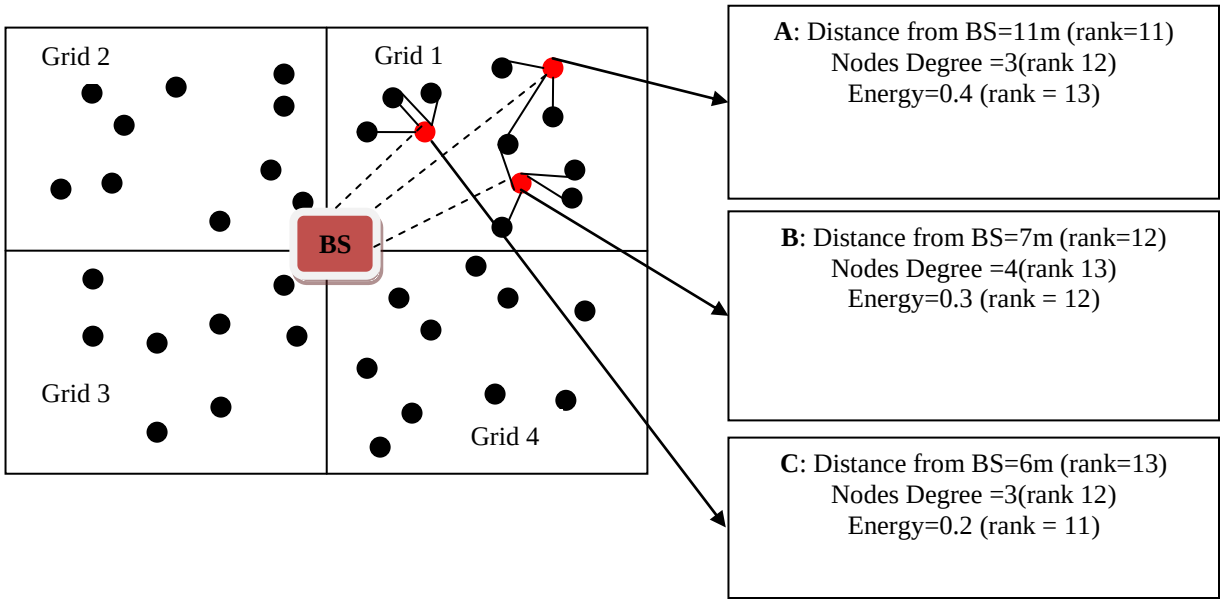

Figure3. Example of Proposed approach

node which is having higher energy. In case if the nodes have the same value of parameter, the same rank is given to those nodes. After assignment of ranks the weight is calculated by summing up all the ranks.

i.e. W(i)=D(i)+N(i)+E(i). (1)

For example, There are total 13 nodes in the grid 1.Consider only 3 nodes A, B, C. Considering node C, the distance of node is minimum therefore it is assigned high rank equal to number of nodes and then to node B then Node A. Similarly the degree of node B and energy of node A is high. With the help of equation 1, the weight of these 3 nodes is calculated as:

For node A= W (A) =11+12+13=35

For node B= W (B) =12+13+12=37

For node C= W(C) =11+12+13=36

Thus weight of node B is largest therefore it is selected as cluster head for the round. The data flow diagram is shown in figure 4.

v. Conclusion

The approach described in this paper is used for selecting cluster head on the basis of three criteria i.e. residual energy, distance of node from the base station and the degree of nodes. The proposed approach tries to optimize the balanced cluster head numbers. The objective is to improve the lifetime of the network and to have significant energy saving.

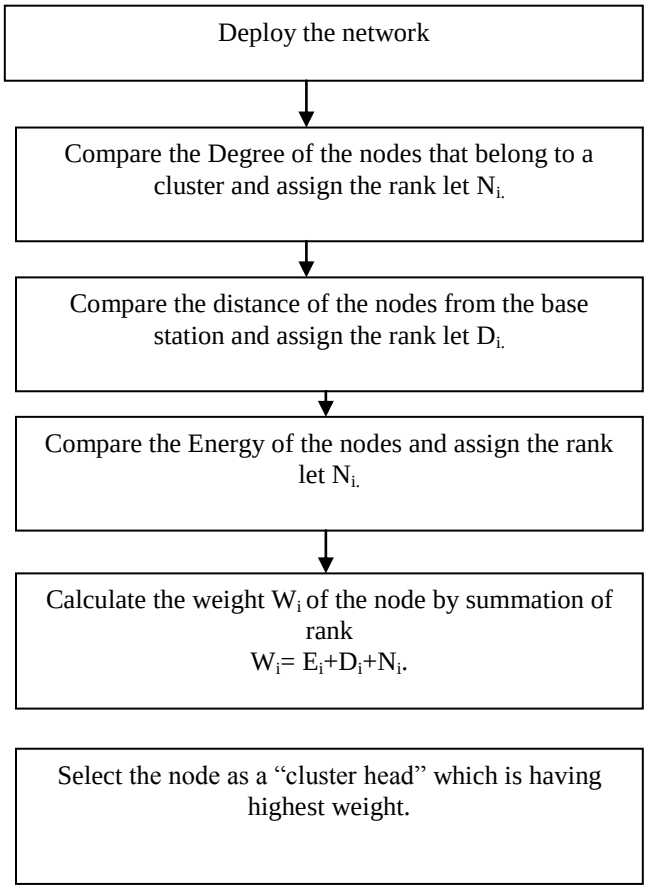

Figure 3. Data flow Diagram of Proposed approch

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