

ENERGY EFFICIENT DATA COLLECTION IN WIRELESS SENSOR NETWORK

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Abstract

Wireless Sensor Network has wide range of applications in the field of networks. The sink nodes need to communicate effectively with other sensor nodes, for effective communication. The facts such as cluster size, energy and lifetime of the nodes should be considered to make the communication effective. While transmitting, the nodes are grouped in clusters with one head per cluster. The cluster, nearer to the sink nodes may run out of energy due to continuous utilization. So an intermediate node for communication is used, called as AGM node. The sensor nodes in the clusters, first send the information to their cluster head (chosen on the basis higher residual energy), the cluster head in turn sends the information to the AGM node whereas the AGM transmits it to the respective sensor node and vice versa. Selection of AGM among many nodes and the entire process is carried out on the basis of the maneuver algorithm, which has 6 phases like compact clustering, AGM selection, Interclustering, Load balancing and data distribution, Communication and replenishment and Reconcile algorithm. In this process the CH transmits data after eliminating redundancy in it. In case of massive damage, Reconcile algorithm is used for the efficient usage of available AGM nodes to regain from the relaxed network.

Keywords:

Sink Nodes (SN), Cluster Head (CH), Agreed Upon Mediator Node (AGM), Mobile Sink (MS), Residual Energy

1. INTRODUCTION

Wireless sensor network (WSN) is a smart environment, which proves to be beneficial for the upcoming generation. It is a self organized network, where the collection of data from each node in an energy efficient manner is ought to be the challenge. The sensor nodes are assigned with responsibilities, whereas they behave as masters and slaves. They could be distributed throughout, in a larger environment. These nodes consume certain amount of energy while transmitting the data. This work jots the methods for reducing the energy consumption without compromising the efficiency of the entire network. A node called AGM node is introduced which is selected by the cluster head, to act as the mediator between the Mobile sink and the cluster head. This in turn reduces the workload of the cluster head, which makes the nodes to prolong in the network thereby increasing the lifetime of the node. In case of failure of single AGM node, the replacement of the particular node will be done by the CH and in turn if a massive damage occurs, regaining of the network is done similar to the 1c spider web algorithm.[2]. This will lead to energy efficient network even after the damage of the network.

2. RELATED WORK

Wireless sensor nodes consumes energy while,

- 1) Transmitting data from one node to another node

- 2) Performing aggregation and refining data before forwarding
- 3) Moving from one location to other location
- 4) Performing election to assign responsibilities

Joint Mobility and Routing approach states that, the nodes which are closer to the base station are exposed to heavy load and work, since all other nodes transmit the data to it, while communicating with the sink node. Hence the nodes which are closer to the sink node depletes in energy. In order to avoid this, the sink node is moved throughout the network. So the nodes nearer to the sink node keep changing. The movement of sink nodes is kept optimum by moving it the shortest path [4]. Hence energy could be conserved and the lifetime of nodes could be increased. But, the path in which the sink should be moved is not addressed [4]. This may result in energy loss while moving in the network over a long distance. In Adaptive Sink Mobility and event driven approach the data is transmitted to other nodes only in an event driven fashion i.e. the data is transmitted only if it known that it is worth to transmit. Moreover, the location of the sink node is not predictable because it might be mobile. Hence the sink node is moved to the optimal location (in terms of shorter distance) and then data is transmitted. So energy could be conserved while transmitting data. This overcomes the drawback of the previous paper [2]. But the workload at each node and distance between the nodes will be greater, which decreases the lifetime of the nodes. Energy could be greatly conserved if data is transmitted over a shorter distance. Hence a mediator is introduced to transmit the data (here its MULE-sensor nodes mounted on common moving objects). MULE overcomes the drawback of the previous paper [6]. MULE operates with UWB (Ultra Wide Band) radio communication technology, which consumes lesser energy while communicating [6]. MULE collects data from the nodes which are closer in range, buffers it and then transmits the data to the respective sink node. Hence the lifetime of the nodes could be increased. But the data could be transmitted if and only if the MULE is present in the particular location. If MULEs are present then energy consumption could be greatly reduced.

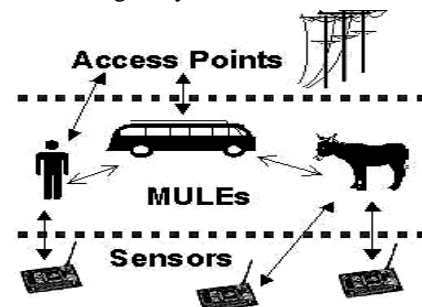


Fig.1. Data Mule

In clustering method, the nodes grouped into clusters with one node as its head, which is based on the maximum amount of residual energy. In unequal clustering method, the nodes which are closer to the base station are sized smaller, so that they consume only lesser energy while communicating within the cluster. The clusters which are farther away from base station will be of larger size [3]. It is obvious that smaller sized cluster will require lesser energy to communicate within the cluster than larger sized cluster. The energy that is needed to communicate within the cluster is conserved in case of small sized clusters to implement unequal clustering [3].

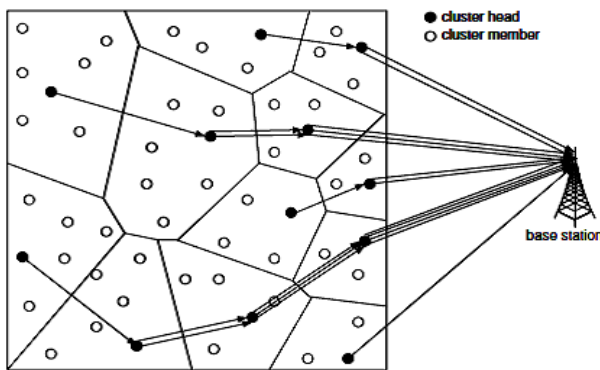


Fig.2. Unequal clustering

3. THE MANEUVER PROTOCOL

In this protocol, we assume that the location of the sink nodes is unaware and each node has fixed energy levels. Only an adequate number of nodes are assigned as the AGM, so as to replace in case of failure of the AGM. The main assumption with this paper is the nodes which are closer to the sink node could communicate in the easier way. The sink node considered in this paper is mobile; the presence of the sink node is indicated to other nodes by sending BEACON messages. Later this is considered as one of the important parameters for the protocol implementation. The entire process is carried out in two phases namely, enrollment phase and steady phase. The setup phase deals with the overall settings that is done by three process and the allegiance phase performs the committed role and deals with reselection of AGM nodes and/or cluster heads in case of energy exhaustion done by two process [1].

3.1 COMPACT CLUSTERING

3.1.1 Need For Clustering:

Wireless sensor network is a large scale deployment area where the data must be aggregated to necessitate the efficient organization of the network. Hence clustering proves to be an efficient technique, which leads to

- Balanced load across the network
- Prolonging the network life time
- Reduced channel contention
- Reduced packet collisions

While clustering the nodes, the above factors are achieved and it leads to increased throughput. Hence, the concept of clustering is implemented [1].

3.1.2 Clustering Parameters And Its Need:

The parameters needed for clustering and its needs are explained below,

3.1.3 Cluster Size:

Size of the cluster is one of the parameters which need much of concentration. The cluster is a collection of nodes with its own cluster node as its lead (cluster head), whereas the cluster head has to communicate with its own cluster members, the AGM node and other cluster heads. Communication with other cluster heads and AGM nodes are inevitable, where it requires a certain amount of energy. But the energy spent while communicating within the cluster could be minimized considerably, by reducing the size of the cluster.

3.1.4 Selection Of Cluster Head:

Once the cluster size is determined, a lead for the cluster (cluster head), should be appointed. The cluster head is selected on the basis of the amount of residual energy it possess and the proximity of the cluster head from the sink nodes. The cluster head selection and the size of the cluster are on the basis of Compact clustering algorithm. The cluster head collects the data from its cluster members. Then it performs data aggregation, so that energy spent while transmitting the redundant data could be reduced. Once it aggregates the data, it then forwards the data to the respective destined nodes. More over if the node which is elected as the cluster head is nearer to its destination node, the energy spent in transmitting the data (regarding distance) could be conserved.

3.1.5 Selection of cluster members:

Once the cluster head is selected, the cluster head in turn should select its own cluster members. This is based on the amount of residual energy they possess, while electing. If the residual energy of the cluster members is greater, then the node prolongs in the cluster. The proximity of the cluster members to the sink node is also considered. The nodes which are closer to the sink nodes are elected as its cluster members, so that the energy spent in the transmission of the data could be reduced considerably.

3.1.6 Transmission Range:

The transmission range should be determined while electing the cluster members. This depends upon the maximum and minimum distance between the sink node and the node to be elected as the cluster. A detailed description of this competence calculation is given under unequal clustering [3].

3.1.7 Residual Energy:

It is the amount of energy, a particular node possess after transmitting the data i.e. the current energy level after transmission. Since the sensor nodes are deployed in wide environment charging the nodes are less possible, so maximum utilization of the nodes with the available energy should be done. If the residual energy of the node is greater, the node lasts for long time in the network [1].

3.1.8 Compact Clustering Algorithm:

The nodes competing for cluster head election will be in a particular range. This range is called as Competing range (R_i). If a cluster head is elected (say S_i), then no other cluster heads are

allowed in the range R_i . The clusters are sized smaller based upon the competence value and the residual energy.

Parameters:

R_0 is the maximum competence range which is predefined. Using this R_0 , the maximum and minimum competence range for a particular node (say i) is calculated.

$$R_{i(\min)} = (1 - c)R_0$$

$$R_{i(\max)} = (1 + c)R_0$$

where, c is the constant value ranging from 0 to 1.

Probability of ordinary nodes becoming Cluster Head = T (threshold value).

$d(S_i, BS)$ = the distance between the particular node(S_i) and the base station (BS).

Competence range,

$$(R_i) = (1 - c)(d_{max} - d(S_i, BS))/(d_{max} - d_{min})R_0$$

d_{max} = Maximum distance between the sensor node and the base station.

d_{min} = Minimum distance between the sensor node and the base station.

Working:

The sensor nodes participating in the cluster head election will be elected as the Cluster head based on the competence range. Each node will forward its own COMPETE_HEAD_MSG (Competence range, Residual energy), to all other nodes in the network. Each node participating in the election will also have the information about other nodes. This information is stored in S_{ch} . Now each node (say S_i) compares its competence value and residual energy with the information it has in the S_{ch} . If it finds its own residual energy to be greater and competence range is lesser than all other nodes, it declares itself as cluster head and informs to all other cluster heads by sending FINAL_HEAD_MSG (Competence range, Residual energy). If the value of S_i is not greater, then it sends QUIT_ELECTION_MSG to other nodes. Once this message is received all other nodes removes the information about S_i in its own information counter. After the selection of Cluster Head, the elected cluster head (say S_i) will now elect its cluster members. The cluster head broadcasts CH_ADV_MSG to all other nodes. Once this message is received by all other nodes, the sensor node sends JOIN_CLUSTER_MSG (Competence range, Residual energy) to the cluster head. Now the cluster head elects its cluster members, which are closer to the base station based upon the Competence range. It is obvious that nodes which are closer to the base station will be smaller in number and they are clustered together in smaller size.

3.2 AGM NODE SELECTION

The cluster heads will be overloaded by performing operations such as communicating with its cluster members, base station and with the sink nodes. Moreover cluster head has to perform data filtering upon the raw data exploiting the data redundancy. For these obvious reasons, cluster heads may run out of energy and hence we elect a node among the cluster as AGM which acts as a mediator between the cluster head and the sink node. This selection is done based on the Mobicluster

technique [1]. The second module of the Mobicluster is used for AGM selection.

3.3 INTERCLUSTERING

All the cluster heads will have the information about other adjacent clusters in its information counter. If a cluster head doesn't find any AGM within the cluster, then the cluster head will attach itself to the cluster head which is located nearby, based upon the information it has. This type of overlapping of one cluster with the other is called as intercluster overlapping. This technique is described in the third module of Mobicluster technique [1].

3.4 LOAD BALANCING & DATA DISTRIBUTION

The data accumulated at individual source nodes are sent to local cluster heads with a time period of T_c . Upon receiving the data from the nodes, the cluster head process the data to remove the redundancy by using the following algorithm. If the data is further forwarded to its remote cluster (in case of cluster attachment), data filtering could happen twice. This is done by data distribution algorithm as in Mobicluster technique [1].

3.5 COMMUNICATION AND REPLENISHMENT

In order to notify the contact time, we make use of an acknowledgement based protocol between AGMs and sink nodes (MS). To indicate the presence of sink node and if it's idle (not receiving any packet) the sink node transfers a POLL packet. This packet is transmitted at fixed intervals T_{poll} . When an AGM receives this packet, it starts transmitting the data. After each transfer of data, the AGM waits for the acknowledgement from the sink nodes. The AGM clears the data from its buffer after receiving the acknowledgement for the previous data transferred. The AGM enrolment may change periodically. If the energy level of the AGM falls below the threshold level, it request the cluster head to engage another node as AGM, in order to avoid the relapsing of network [1].

3.6 AGM NODE PLACEMENT – THE VANTAGE POINT

If the AGM node runs out of energy, the cluster head will replace it, by referring to its S_{ch} counter. But, if a massive damage occurs because of natural calamities or through combat reconnaissance the entire network will get segmented. In such cases, the remaining AGM nodes should be placed effectively. The AGM node possesses more energy, and it will be in a better communication range, when compared with other sensor nodes in the field. AGM nodes are mobile and they will perform data aggregation and forwarding. For these valid reasons AGM nodes are claimed to be expensive. Hence the number of AGM nodes employed in the field must be minimized and should be effectively placed.

3.6.1 Reconcile Algorithm:

The reconcile algorithm concentrates on fixing the multimode failure and to employ optimal positioning. The core idea of this algorithm is to balance the number of hops, by placing the AGM towards the Center of Mass (CoM). The procedure is given as follows.

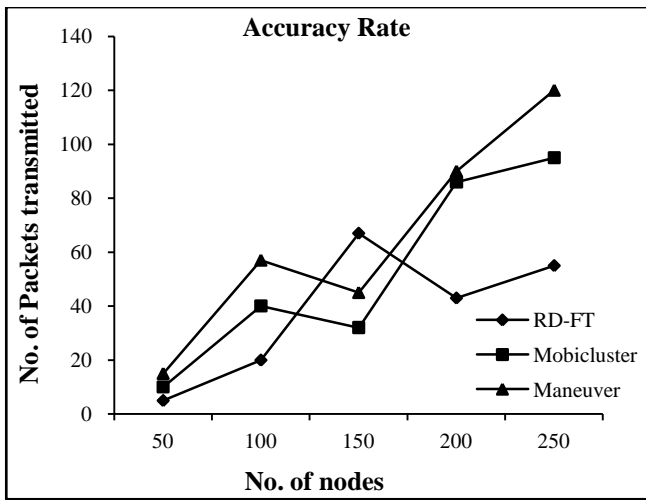


Fig.4. Accuracy rate of Maneuver protocol when compared with RD-FT and Mobicluster

4.3 PACKET TRANSMISSION RATE

The transmission rate at which the packets are transferred is greater when compared with RD-FT. The energy spent in transmitting the packets is less and the packets are transferred in the more efficient manner.

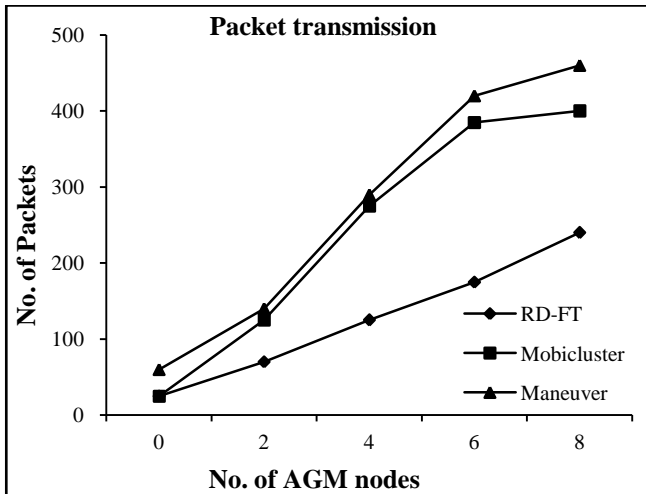


Fig.5. Packet Transmission rate compared with RD-FT and Mobicluster

4.4 ENERGY LEVEL OF AGM NODES

The implementation of Maneuver protocol yields better residual energy for AGM nodes, when compared with the previous technique, RD-FT and Mobicluster. For every 10 nodes, the residual energy is calculated and it is proved to be greater for maneuver.

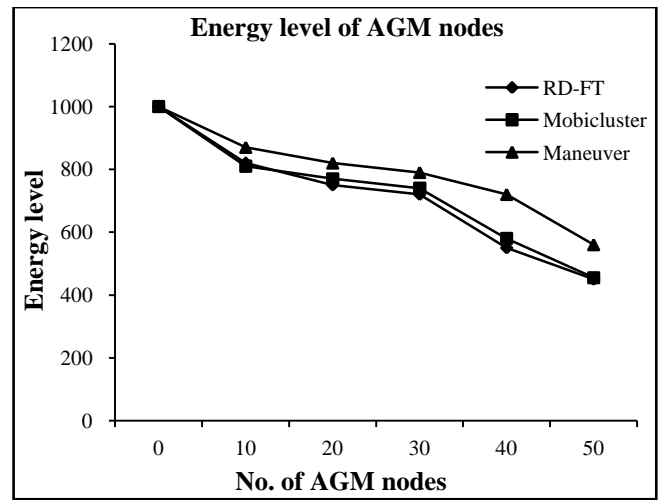


Fig.6. Average Residual Energy of AGM nodes when compared with RD-FT and Mobicluster

5. CONCLUSION

Introduction of AGM nodes along with maneuver protocol will enhance the efficiency of the network and eliminates the draining menace. The damage to the network resulting in single AGM node failure or a massive damage causing multi AGM node failure could be recovered by using this technique. The work for comparing the QoS parameters, to prove that the proposed technique is efficient, is being carried out.

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