



Cluster Head Election with Node Heterogeneity and Recovery in WSN

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Abstract: *Wireless sensor networks (WSNs) refer to the collection of heterogeneous elements linked by wireless medium to perform distributed sensing and acting tasks. The realization of wireless sensor networks needs to satisfy the requirements introduced by the coexistence of sensors. In WSNs, sensors gather information about the physical world, sends the information to the cluster nodes that are able to take decisions and then perform appropriate actions upon the area, which authenticate a user to effectively sense and act from a distance.*

The cluster head nodes may fail for many reasons such as due to battery exhaustion, message overhead, hardware failure due to harsh environment etc and these failures may convert the connected network into several disjoint networks that reduce the capability of network.

Keywords: *WSN, clusterhead, Network Failure, Node heterogeneity, Recovery.*

I. INTRODUCTION

To supervise the physical and economical conditions such as temperature, sound, pressure etc. Wireless Sensor Network [1], [2], [3] (WSN) consists of self-governing sensors and depart the data through the network to the main location. The upgrading of wireless sensor network was driven by military applications such as battlefield supervision; today such networks are used in many manufacturing and consumer utilization, like process monitoring and determination, health monitoring [4], etc. Sensor nodes are like small computers that is very basic in their parts and there network. They are mainly consists of finite memory, limited computational power and limited processing unit. Every sensor node having the battery which is usually worked as energy source. The base stations may have one or more components of the WSN with infinite gauge energy and communication assets. They act as an entrance between sensor nodes and the end user as they typically forward data from the WSN on to a server.

II. CLUSTER HEAD ELECTION ALGORITHMS

LEACH Protocol (Low Energy Adaptive Clustering Hierarchy)

LEACH collects the data from distributed sensor nodes and transmits it to the base station. Some of the nodes choose themselves as a cluster heads. The chosen cluster heads collect sensor data from other nodes in the local area and transfer the collected data to the base station. The process of transferring data to the base station is very energy consuming. In LEACH [7] cluster head election based on the chosen percentage of CHs for the network. Each node elects a random number between the interval 0 & 1. If the produced random number is less than the threshold then the node become a CH for the current round. A round is a process of electing cluster head, Cluster formulation, and data communication at the same time. Each round consisting of two phases: -

- Set-up phase
- Steady state phase.

Set-up phase: In the set-up phase cluster head make a proclamation of its selection by sending message to all other nodes in order to form a cluster.

Steady state phase: cluster head creates a TDMA schedule for their member to transfer their data and acknowledges when it to transmit, nodes send data in the given period. Transmission of the regular nodes is switched off until their schedule is reached, to save the energy. Finally CH aggregates the collected data and sends to base station.

Problems in LEACH:

- Selection of cluster head is random and also not cares about the energy consumption of nodes. Because of this cluster head may die, if the CH dies the cluster became invaluable.
- Most of the time it fails to cover large area and not consistent in the distribution of CHs.
- It is unable to address the schedulability and predictability measures.

III. PROPOSED METHODOLOGY

Hybrid Election and Recovery Approach

For a wireless sensor network, the following criteria are followed for the implementation:

The base station (BS) is located far from the sensors and immobile.

- All nodes in the network are heterogeneous and energy-constrained.
- All nodes are able to reach BS.
- Nodes have no location information.
- Symmetric propagation channel
- Cluster-heads achieve data compression.

For cluster head election, the basic algorithm is followed named as leach approach. In this approach, the process is divided into two rounds. Each of these rounds consists of an election round and data transfer phase. During the election phase cluster-heads are elected and the clusters are organized. During the data transfer phase the transmission and reception of data to the base station occurs. These cluster-heads gather sensor data from other nodes in the network and transfer the collected data to the base station. Since data transmission to the base station acquires much energy, the nodes take turns with the transmission – the cluster-heads “rotate”. This rotation of cluster-heads leads to a balanced energy consumption of all nodes and hence to a longer lifetime of the network. Thus, the best election and selection of a cluster head for a cluster is needed to maximize the lifetime and throughput of network.

Election of Backup Cluster Head

Before selection of suitable backup node, first the election procedure is conducted by the sink node on the basis of remaining energy and healthy node is selected. A node with the most remains energy is selected for backup. An energy model is used to calculate the consumption of energy [18].

$$(RE) = b(E_{elec} + \epsilon_{FS}) d < d_o$$

$$b(E_{elec} + \epsilon_{MP}) d > d_o$$

RE= Energy dissipation of transmitting bits between two nodes situated apart by a distance d meters.

E_{elec} = Electronic Energy

ϵ_{FS} = Free space Energy

ϵ_{MP} = Transmit amplifier Energy

IV. HYBRID ELECTION AND RECOVERY APPROACH (HERA)

Pseudo code of ClusterHead election & Recovery Approach

Procedure of clusterhead election by counting

Input: C, no of clusterheads in a round

N, total no of sensors

- 1) no of clusterheads CH=0
- 2) while CH < C do
 - 2.1) if ($S_{id} = elect = tx = rx$)
 - 2.2.1) S is a clusterhead
 - 2.2.2) broadcast an advertisement
 - 2.2.3) increment CH by 1

Endif

Procedure election of backup node(S,RE)

- 1) if ($min_dis > d_o$)
 - S(i).E = S(i).E - ($ETX * (4000) + Emp * 4000 * (min_dis * min_dis * min_dis)$);
 - End
- 2) if ($min_dis \leq d_o$)
 - S(i).E = S(i).E - ($ETX * (4000) + Efs * 4000 * (min_dis * min_dis)$);
 - End
- 3) (RE) = $b(E_{elec} + \epsilon_{FS}) d < d_o$
 $b(E_{elec} + \epsilon_{MP}) d > d_o$
- 4) Select Active Node
- 5) broadcast an advertisement

Procedure recovery node (S, A)

- 1) wait to receive an advertisement
- 2) if (advertisement is received) then replace dead node to active node
- 3) increment CH by 1

V. RESULTS AND DISCUSSION

Table 1 : Performance Evaluation and Analysis

Type	Parameter	Range
Network	Network Size	(0,0) to (100,100)m
	Nodes	10-50
	Initial Energy	2 joule
	Sink	(0.5) (0.5)

	Threshold Value	0.1
	Packet Size	128 bits
	Communication range	10-50 m
Radio Model	E_{elec}	50Nj/bit
	E_{mp}	0.004pJ/bit/m ⁴
	E_{fs}	10 pJ/ bit/ m ²

This chapter focuses on result and its analysis based on the simulation performed in MATLAB. All the experimental results provided in figures gives variation in network nodes define the actor failures.

The actor nodes are randomly deployed in an area of 100m × 100m consisting of number of actor nodes (10–50) with fixed communication range (R = 50m) and variable range between 10 and 50m. After examining the cut vertex and non-cut vertex nodes; the backup actors are elected on the basis of remaining energy and healthy node is selected as a backup node for recovery.

Performance Analysis

Energy Consumption

Graph 1

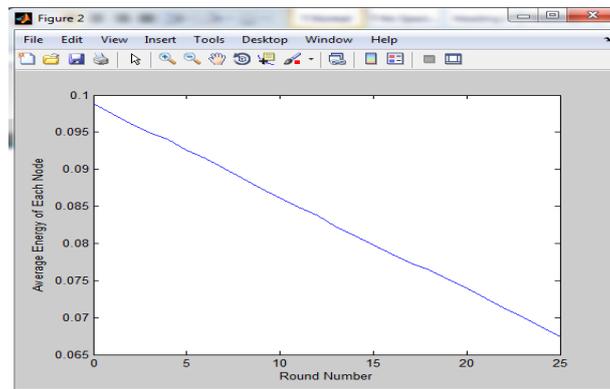


Fig. 1 Average Energy of cluster head while round number 25

After evaluating the proposed approach for cluster head selection, the results show that as there is less number of rounds to communicate the average energy of cluster head remains high or equal to the threshold value.

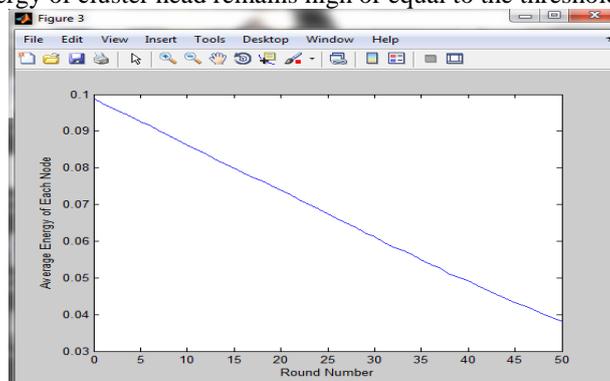


Fig. 2 Average Energy of cluster head while round number 50

As there is increase in round numbers to communicate such as we have taken the value 50, shows that the average remaining energy of cluster head to serve there cluster members remains equal to the desired threshold value.

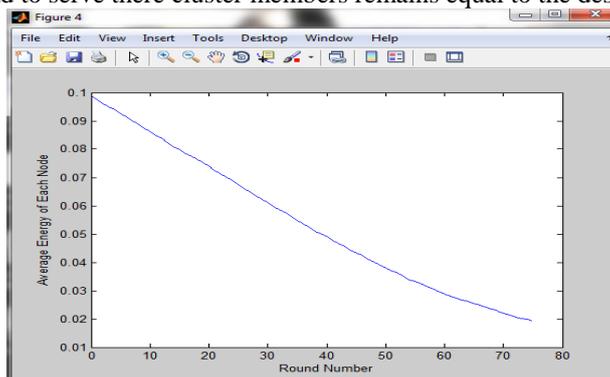


Fig. 3 Average Energy of cluster head while round number 80

The increased value of round numbers doesn't hinder the energy level of cluster head in a large network, shows that the proposed approach for cluster head selection is efficient for the optimal selection of cluster head for a large cluster with large number of cluster members.

Failure accusation probability Graph 1

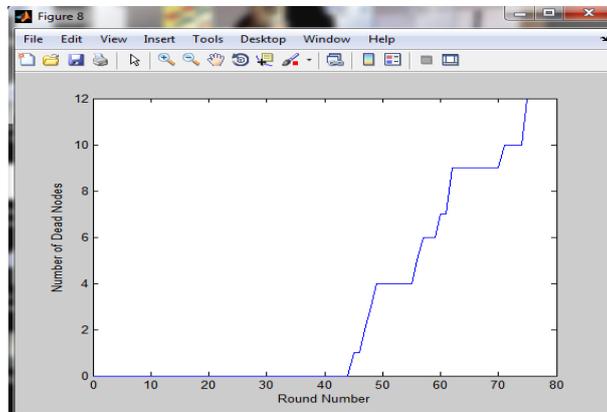


Fig. 4 Number of failure nodes while round number is 80 per nodes

The proposed approach results into less number of failures as the round number increases to 80 per node.

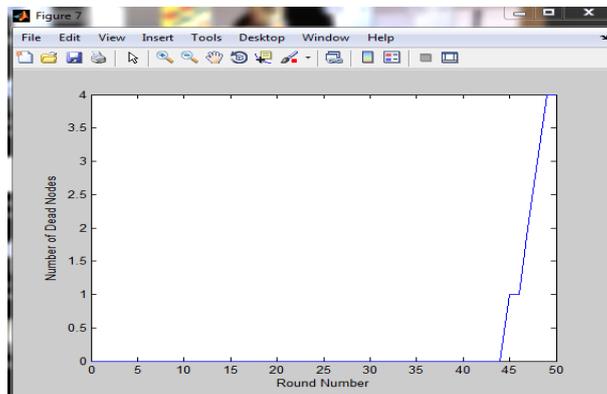


Fig. 5 Number of failure nodes while round number is 50 per nodes

With the decrease in round number as 50 per node, the ratio of dead nodes are also decreased, with less amount of data loss.

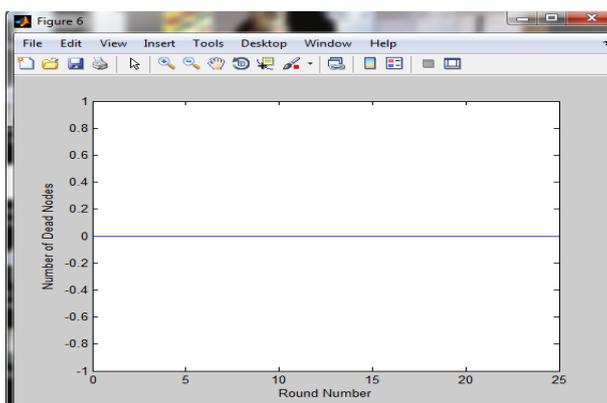


Fig. 6 Number of failure nodes while round number is 25 per nodes

Through this proposed approach, the network finally comes in stable state with zero dead nodes with round number 25 per node.

VI. CONCLUSION

WSN networks become very popular to many applications in today's world like forest resource management, mining, military, health and soon. In WSN, the clustering approach is always adopted as it provides the optimal solution for the arrangement of sensor nodes in an area. In such clustered network, the failures of one or more nodes may disturb the

communication network, loss of communication links, partitioning of network. Therefore, WSN's should be fault tolerable as well as self recoverable while using clustering technique. In hybrid approach, the efficient election of clusterhead is pursued in order to increase the efficiency of the network and to decrease the packet loss delay. Existing approaches only identifies the single failure of clusterheads at a time but this approach supports multiple failures of clusterheads in different clusters at a time and restore the connectivity with less message overhead.

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