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Fault Detection Scheme for Energy Efficiency in Wireless Sensor Network

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Abstract: Wireless Sensor Network (WSN) requires scalable and energy efficient communication protocols to minimize the energy utilization as much as possible. However, the duration of sensor network reduces due the unfavourable impacts caused by radio indiscretion and waning in multi-hop WSN. A cluster-based scheme is proposed as a solution for this problem. The existing scheme extends Alternate Clustering algorithm and enables multi-hop transmission among the clusters by incorporating the selection of two-way sending and receiving nodes. Fault detection searches the repairing points in clusters in a scattered mode and places a set of backup sensors at those points in such a way that still satisfies the engineering requirements. We enhance Energy based Fault detection scheme to deal with the case of sensor collapse ensuring energy efficient communication.

Key words: Cluster based scheme · Multihop · Energy Consumption

INTRODUCTION

A wireless sensor network (WSN) consists of sensor nodes capable of collecting information from the environment and communicating with each other via wireless transceivers. The collected data will be delivered to one or more sinks, generally via multi-hop communication [1, 2, 3]. The sensor nodes are typically expected to operate with batteries and are often deployed to not-easily-accessible or hostile environment, sometimes in large quantities. It can be difficult or impossible to replace the batteries of the sensor nodes [4, 5, 6]. On the other hand, the sink is typically rich in energy. Since the sensor energy is the most precious resource in the WSN, efficient utilization of the energy to prolong the network lifetime has been the focus of much of the research on the WSN [7, 8] as shown in Fig. 1.

Related Work: 2.1 Energy Efficient Communication Protocol For Wireless Microsensor Network ---> (W.R. Heinzelman, A. Chandrakasan, H. Balakrishnan). In this paper, author proposed a clustering protocol called LEACH in which CH election is based on optimal probability. The protocol works on periodic randomized rotations of CH within cluster range 0 and 1. Pros and Cons --This approach achieves a reduction in energy dissipation compared to direct communicate and transmission protocols. --It cannot guarantee an acceptable CH distribution and not suitable for larger region.

2.2Cluster Head Election Using Fuzzy Logic for Wireless Sensor Network:
---> (I. Gupta, D. Riordan, S. Sampali)--Applying type 1 fuzzy system in distributed protocols improves the

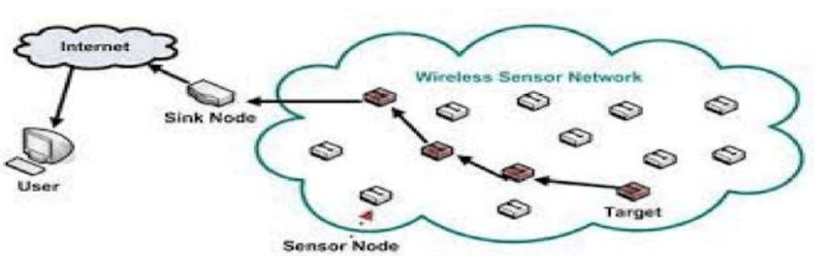

Fig. 1: Architecture diagram of WSN

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performance of the networks significantly.This paper deals with fuzzy logic to elect CH in order overcome the drawbacks of LEACH.

Pros and cons

- Efficiently increased the network lifetime.
- This centralized approach is not suitable for networks with a large number of deployed nodes.

2.3Chef: Cluster Head Election Mechanism Using Fuzzy Logic in Wireless Sensor Networks:

--> (J.M.Kim, S.H.Park, Y.J.Han and T.M.Chung.) In this paper author presented CHEF concept in order to overcome the drawback of centralized algorithms. Pros and cons--The protocols are capable of providing extended network lifetime.--It selects the nodes with less neighbour nodes nodes as CHs easily that destroys the balance of energy consumption.

2.4 Stochastic Distributed Energy-Efficient Clustering (Seek) For Heterogeneous Wireless Sensor Networks:

--> (B.Elbhiri, R.Saadne and D.Aboutajdine.)
--In this paper, the intraclusters transmission is reduced and energy efficiency is increased by making CMs into sleep mode.All the CMs are allocated a transmission time to transfer the data to Chrome CH receives the aggregated data CMs become deactivated.
Pros and cons

- Reduced energy consumption in the network.
- CH rotation and collection of data in the rotation process in not clear.

2.5 The Steady Clustering Scheme for Heterogeneous Wireless Sensor Networks:

---> (J.J.Liaw,C.YDai ,Y.J.Wang.)
--In this paper all the deployed nodes are clustered into different groups based on their initial energy. In this centralized approach, BS broadcasts a massage, called GHR(Group Head Request) to obtain local information of all the nodes. Then the senior nodes send back an acknowledgement includes Adman initial energy information of the nodes. After that BS finds and informs Group Heads for each group.Finally, each CH defines its cluster members

Pros and cons

- The results in this study show that the stability and energy consumption are increased.
- The traffic overhead in the network is quite high as it is a centralized approach.

2.6 Gateway and Cluster Head Election Using Fuzzy Logic In Heterogeneous Wireless Sensor Network:

--> (S.Ben Alla, A.Ezzati and A.Mohsen.)
--In this paper authors have used two fuzzy based elections to evaluate the chance of sensors to become a gateway and CH. In the first election the qualified nodes are selected based on their energy and distance to the BS. Then, in the second election, residual energy of each node and cluster distance are used..

Pros and cons

- Simulation results show that the proposed approach enhances the energy efficiency in the network.
- This paper does not consider the overhead rate and CH failure.

III. Backup Cluster Head: In the existing system, Cluster mechanism is used where in the sensor nodes are formed as clusters. For each cluster a CH is elected and all the remaining sensors are called as CMs. The CMs senses information and transmits it to its CH. The CH will transmit the data to the nearby CH or to the BS. All the CH collects data from CM and transmits it to the BS. The CH election is based on the estimation of quality of the sensor nodes. The quality includes Energy, Node Centrality and Local Distance. Based on the quality a weight is assigned to all the nodes. The node with the higher obtained weight is elected as CH.As the energy of CH drains out quickly than other nodes it is prone to fail. Therefore a Backup Cluster Head is chosen to act as CH if the CH fails. This BCH is nothing but the next highest energy CM.A list is maintained which is sorted out based on the weight with the highest CM on the first and least CM at the last. So there is always a BCH to replace the failed CH. [2]

Disadvantages

- Increased delay rate
- Control Overhead
- No Coverage Preservation
- Data loss.

IV. Proposed Scheme: We propose Energy Based Fault Identification Scheme which uses Clustering mechanism. Cluster formation is based on LEACH K-MEANS algorithm. The sensor nodes broadcast a HELLO message frequently which contains its Energy and Distance information. Based on the distance, clusters are formed and the node with the highest energy is elected as Cluster

Head (CH). We are replacing the CH with the next higher energy CM before its failure by setting a predefined threshold level. When the CH reaches the threshold level handover takes place and the Cluster Member (CM) with the next higher energy becomes CH now. So there is no data loss. When this CH reaches the threshold level, the neighbour nodes intimate this information to the Base Station (BS). On receiving this alert message BS sends a Backup sensor node to act as CH for that cluster. If any node is out of the range of the cluster or faraway from the CH it is called as isolated node. In order preserve the coverage area in the network, this node must also be able to transmit its data efficiently. For this it chooses the nearby CM through which it transmits the data to the CH using Route Cluster algorithm.

Advantages

- Reduces delay rate
- Less control overhead
- No data loss

4.1 K- Means Clustering Algorithm: K-means algorithm is based mainly on the Euclidian distances and cluster head selection depends on residual energies of nodes. So here the central node collects the information about the node id, position and residual energy of all nodes and stores this information in a list in the central node. After getting this information from all nodes it starts performing the clustering algorithm (k-mean).

Algorithm

1. If we want to cluster the nodes into 'k' clusters, take 'k' number of cencroids centriods initially at random places
2. Calculate the Euclidian distance from each node to all and assign it to centric nearest to it. By this 'k' initial clusters are formed. Suppose there are n nodes are given such that each one of them belongs to Rd. The problem of finding the minimum variance clustering of this nodes into k clusters is that of finding the k cancroids { my }k j = 1 in Rd such that,

(1/n)*($\Sigma min_j d^2(X_i,m_j)$, for i-1 to nor i=1 to n, where $d(X_i, m_j)$

denotes the Euclidean distance between Xi and mj. The points {j} k i = 1 are known as cluster cancroids or as cluster means.
3. Recalculate the positions of cancroids in each cluster and check for the change in position from the previous one.
4. If there is change in position of any centric then go to STEP 2, else the clusters are finalized and the clustering process ends. By this the clustering of nodes into 'k' number of clusters is done and the cluster heads in each cluster are to be chosen.

Route Cluster Algorithm:

Step1: Multi hop data gathering
Step2: S -) s1, s2, s3…….son (Number of Sensor Nodes); WC-> w1, w2, w3...wn (Weighted count)
Step3: If (s wants to send the data to BS)
{
Select a multi hop route for data forwarding
}
If (route failed)
{
Again search next available route for data forwarding
}
Step4: In multi hop communication, we have create RP--> R
Step5: RP can collect the data from sensor, when RP within the transmission range
If (Energy > Threshold level)
{
Send data to RP
}
Else
{
Send it Seneca
}
Step 6: Sensor travelled through RP
1. Analyze all weighted count i.e., w1=30,w2=45,w3=50
2. Analyze distance from RP to Base station via
[Expr serte sqt (por pow(($x2-$x1),2)+por pow(($y2-$y1),2))]
Step 7: Data transfer arte iceie, DT
Step 8: Sorting occurs depending on
if (WC>max && distance>long&&data rate >higher)
Step 9: Depending Ranking collector can move and collect data

4.3 System Architecture: The Cluster Members (CMs) senses data and transmits it to the Cluster Head(CH).The CH transmits the collected data to the Base Station (BS).When the CH reaches the predefined threshold value the next higher energy CM acts as Backup Cluster Head(BCH) for that cluster. Now the CMs will transmit data to the BCH. When this BCH reaches the threshold value Backup sensor node from the Base station acts as CH for that cluster upon intimation of the neighbor nodes to the Basify a node doesn't come within the range of the backup sensor node it is called as isolated node and it transmits data to the CH via nearby CM.

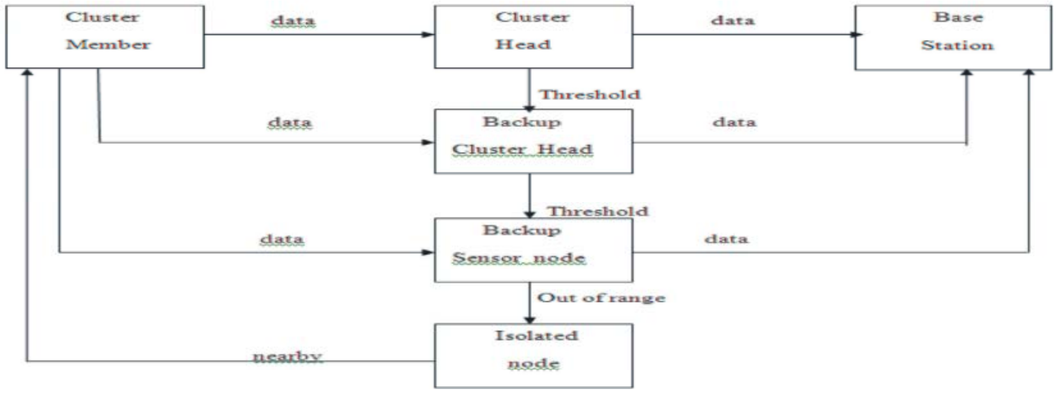


Fig. 2: Architecture diagram for Proposed System.

4.3.1 Cluster Construction: The sensor nodes are deployed over an area. Each sensor node broadcast a hello message (hello message=distance, energy) containing distance and energy information. Based on the distance clusters are formed.

4.3.2 Cluster Head Election: By using the energy information in the hello message, the node with the highest energy is elected as CH(Cluster Head). The hello message is broadcasted frequently and therefore the energy of all the sensors are updated periodically. The CH collects data from CM and transmits it to the BS by assigning TDMA to the CMs.Therfore there is no collision and interference as CMs transmit data to CH on its given time frame. Also the energy is consumed much efficiently by making the CM into sleep mode whenever it is not transmitting data.

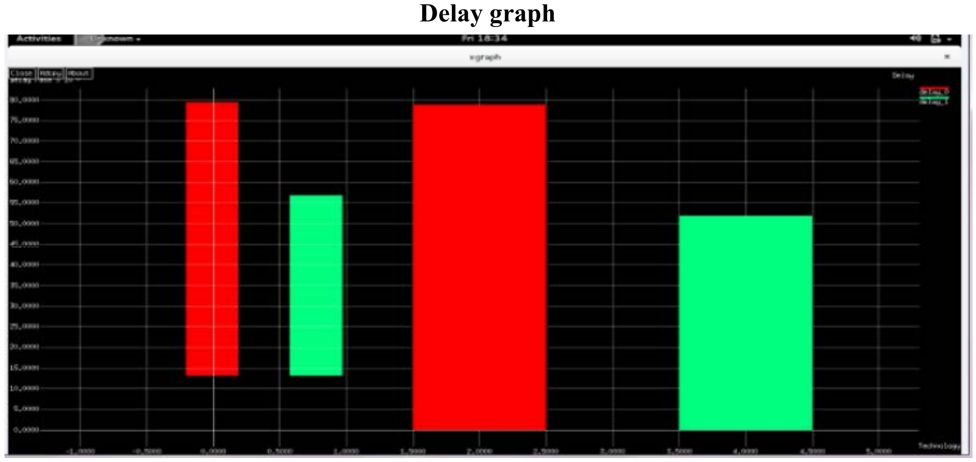
4.3.3 Backup Cluster Head: A predefined threshold value is set to all the CHs.When the CH reaches the threshold value; it is an indication that the CH's energy is draining out to fail.So,handover takes place with the next higher energy CM which acts as a Backup Cluster Head. Now the CMs will transmit the data to the BCH and the older CH will become a CM now.

4.3.4 Backup Sensor Node: If the BCH reaches threshold value, the neighbor nodes will intimate this to the BS through alert message. On receiving it, BS will send a Backup Sensor Node to act as CH for that cluster. The BCH will become a CM after handover and all the CMs in that cluster will transmit their data to the Backup Sensor Node.

4.3.5 Isolated Node: If the Backup sensor Node does not cover the entire sensor in the cluster one or more nodes will become isolated. These are called as isolated nodes. In order to preserve the coverage area the isolated nodes will choose the nearby CM as its intermediate node and transmits data to the Backup Sensor through this CM.Thus there is no need to form a new cluster or re-cluster.

5. Experimental Results

Delay graph



For the above graph,
X axis is unit time
Y axis is packet size (energy)
The graph shows the delay between the existing and the proposed system.
The Existing system uses alternate clustering algorithm is and the proposed system uses Leach K–means algorithm.
For 1 unit of time existing system causes 78X10 degree delay rate but our proposed system causes only 52.5X10 degree delay rate.

Packet Delivery Factor graph

For the above graph,
X axis is unit time.
Y axis is packet size (energy).
The Existing system uses alternate clustering algorithm and the proposed system uses Leach K-Means algorithm. The proposed system provides a constant packet delivery factor compared with the existing system delivering 110X10 degree packets for 200 units of time .

Throughput graph

For the above graph,
X axis is unit time.
Y axis is packet size (energy).
The Existing system uses alternate clustering algorithm and the Proposed system is uses Leach K-Means algorithm. The existing system provides only 1.0500X10 degree packet rate for 1 unit of time. But the proposed system provides 1.1500x10 degree packet rate for 1 unit of time.

6. Conclusion and Future Work: The proposed Energy based fault identification scheme identifies fault with the Cluster Head before its failure preventing packet loss and efficient consumption of energy. It also preserves the coverage area by identifying isolated node and providing connectivity for efficient transmission of data. In this paper we propose a new Energy based fault identification scheme that ensures preventing packet loss and minimized energy consumption by replacing the Cluster Head when it reaches threshold value. The Control overhead is also minimized as all the CMs will not act as BCH. The delay rate and packet loss is also much reduced since CH is replaced before its failure. We have also concentrated on preserving the coverage area by providing connectivity to the isolated node.For the future work, give importance to security because Backup sensor mobility is not secure to the network. If the backup sensor is malicious it will gather all information from cluster and hence is vulnerable to network.

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