Fault Tolerance Using Cluster in Wireless Sensor Network

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Abstract— Wireless sensor network, in which nodes are conversed with multi-hop to transmit the data and pass them to sink node. The group of nodes can be moulded as clusters; in which an explicit node is assumed to be cluster head. The head node pioneered based on its battery forte. Failure of a node affects rest of the communications in the cluster. To determine the node failure probability, the earlier node performances are examined and resultant can be revealed. That can be further evade the node failure and keep on track of every node such that they accumulate time and energy without interruption. In this paper we have concentrated on the head node performance in various clustering and minimizing the task of cluster head. A criterion is taken to identify faulty nodes using Poisson distribution that will observe the failure probability before the time of commencement.

Keywords—   Relay Node, Fault Tolerance, Poisson distribution, Clusters, and Wireless Sensor Network.

I.   INTRODUCTION

The fundamental nature of wireless sensor networks is, which consists of tiny nodes that are distributed spatially depends on user to sense the region. Those nodes will sense the environment and cooperate with each other and generate a value as global consequence that will passes the status to sink node in the network. This group effort requires limited processing on the region and communication between each node is determined as intermediate node. Network can be assumed in various environments and some of the nodes in the network may faulty or may not succeed through life time in it, this can be said as fault. The petite of sensor nodes, which consist of sensed data and communicating with other node with the sensed data, is the basic concept of sensor network. An added feature of sensor networks is the supportive effort in sensor network region. Built-in sensor nodes are fixed with on-board processor and transceiver that connects every separate node in the region as in [1].

II.   RELATED WORK

Ian F. Akyildiz et.al on Sensor network survey and they explained about fault tolerance and its issue, topology of the sensor network then its three phases, then power saving mode for the sensor node are elaborated [1]. In this paper Thomas Clouqueur et .al in [2] explained in the field of fault tolerance with fusion for the collaborative sensor network, two algorithms has been discussed as it named as decision and value fusion and decision is superior to value fusion with the ration of all over distributed as hierarchical agreement presented. It has approached for tumbling the statement overhead by involving exact agreement (FT IN CSN). Similarly the collaborative sensor fault detection by Tsang-Yi Wang at.al in [3][6] about unreliable local decision to perform distributed decision fusion, The resultant indicates the less complex criterion provides even better fault tolerance capability in normally operating sensors and finally concluded as CSFD-W (Collaborative sensor fault detection-wide). Wireless sensor network is energy constrained. It is important to intend a rapid algorithm in clusters to communicate information from all nodes to the processing centre. Where the organization of sensor network is clustered to minimize the energy of cluster head is depleted in communication the information of each other in [10]. Clusters are the executive unit for WSNs. The dense nature of these networks requires to broken down into clusters as simplify tasks such a communication between enormous node in a region have been explained in [11].Cluster heads are association leader of a cluster. They often are essential to organize activities in the cluster. These tasks contain but are not limited to data-aggregation and institute the communication schedule of a cluster to the cluster head. S.Bhatti et.al on cluster in [4] formation for the target detection, cluster is formed within its range of communication group of node in the region and some sensor node within the head node also formed.

III.   PROBLEM AND MODEL COMMUNICATION

A.   Fault-Tolerance:

In general, fault tolerance is illustrated as device that detects and responds for the some sort of input from the specific environment without failure intervention. Wireless sensor network scenario is about, when node goes down; the rest of the node should perform its task without any disruption or hold-up in transmitting the data.

B.   Fault Diagnoses:

Fault may occur in two ways i.e. Hardware and Software failure that will make node to misbehave. In some aspect the node may goes out of range and it is very common error and some of them down due to battery weakness. Following diagram consists of faulty nodes, In Fig-1: a sensing region consist of several node and a sink node, values are

passed from one node to another with the help of multi-hop(multipath) and by last it held to the sink node. A node which is out of restricted region (in case of mobility nodes) will also not work and affect the entire node and data transmitting on the routing path will get exaggerated and not delivered to the next node. Likewise next fig-2 also consists of fault which is due to battery weakness or any kind of failure which leads to the node fault. One more factor is when the hardware system of the node goes down the enclosure will suffer brunt and depiction the hardware of the sensor node.
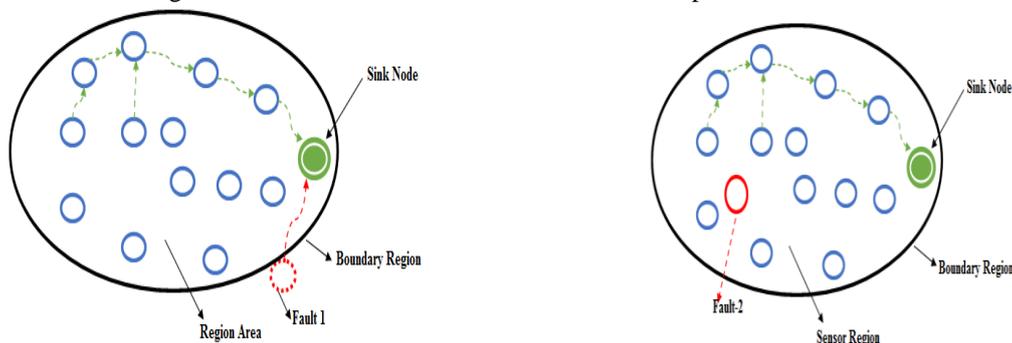
Fig 1: Fault if sensor nodes are slight the region   Fig 1.2: fault occurs when battery drain

C.   Problematic Scenario

In sensor network, clusters consist of numerous nodes and those nodes data send to cluster head and it will accelerative to nearby cluster head. Assume that five clusters with each cluster have more than 30 nodes and each of the clusters consist of one cluster head. If the cluster is far from the sink then it must pass the data to nearby cluster and it will forward to the sink. By doing this, the particular cluster head meets earlier battery drain.

D.   Model Communication

In our approach we contemplate to reduce the burden of cluster head and place relay node in between head and sink. The performance of relay node is better than the cluster node and cluster head. We have taken probability of cluster head and other nodes before transmission begins and predict battery life time of nodes then replace with higher energy available to act as cluster head.

E.   Relay Node

Generally relay node can be used in various fields and it has more battery strength then normal sensor. IEEE standard for this device 802.11 b/g and it consist of 16MB flash and 64MB SDRAM with 400 MHZ Linux system. According to [5], relay nodes arein charge for data packet fusion from sensor nodes which in charge of sensing data from their clusters and transmitting them to destination node via wireless multi-hop paths. In general term relay node is to receive the data from source node and then forward them to destination node which carried by RCS (Radio Communication Section) this section increase energy to do its task. Other sections are IRS (Information Recording Section) to store the information which received from the previous node and ICS (Information Conveying Section) is used to establish the next forwarding information (i.e. after the ICS the destination of the information are determined). These nodes are more self configuring for user that we needed for manual configuration.The relay nodes allocate the burden of sensor nodes for exchanging data packet and provide efficient role that needed in sufficient time.

Architecture for relay node explains how communication between the network topology i.e. from source to destination a data is carried out using relay nodes and transmits data to the sink node. By performing multi-hop communication, it will minimize power consumption of specific node which targeted to replace with relay node. Section [4] we will discuss on our proposal algorithm and flow chart for the algorithm.
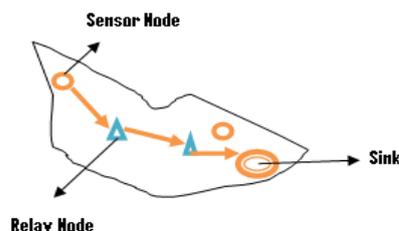
Fig 2: Simple Architecture for Relay node

IV.   POISSON FAILURE DENSITY ALGORITHM

Step 1: Assume sensor node S, Cluster Head CH, Sink Node K and Relay node as R.

Step 2: If $CH_{(i)}$ receives data from $CH_{(i+1)}$, Then search for relay node(R) and data transmission begins from $CH_{(i)}$➔R➔S.

Step 3: else $CH_{(i)}$➔ S.

Step 4: Estimate the Poisson failure rate density (FDR) for all cluster heads and choose the highest $CH_{(j)}$.

Step 5: Now estimate the FDR for all cluster members in corresponding $CH_{(j)}$ and choose the minimum density node, let it be $n_{(i)}$

Step 6: Replace $CH_{(j)}$ by $n_{(i)}$

When cluster head of I receive data and it can be incremented with i+1, as the data receive extends then search for relay node(R) then start data transmission via relay node. Else transmit data generally to sink node, Estimate FDR for all cluster head node and pick lowest density to replace with $CH_{(j)}$ and replace with highest FDR with normal sensor node and change it as $n_{(i)}$.

A. Logical Flow for Poisson Failure Density
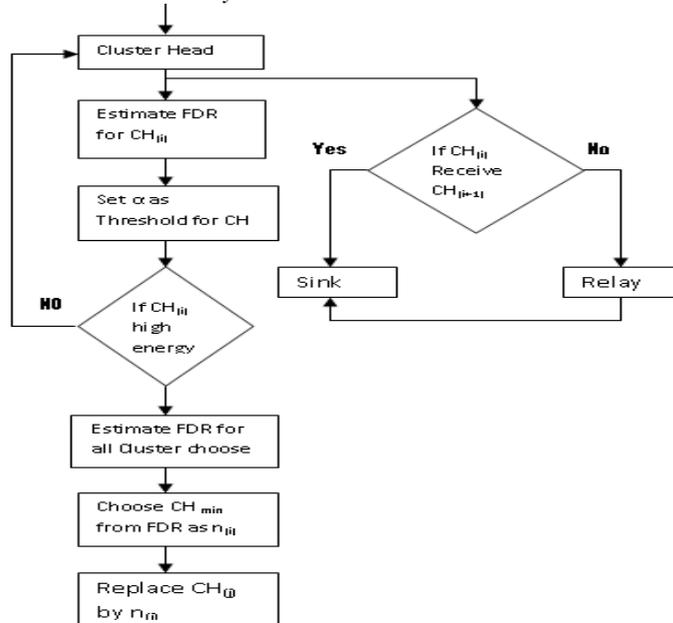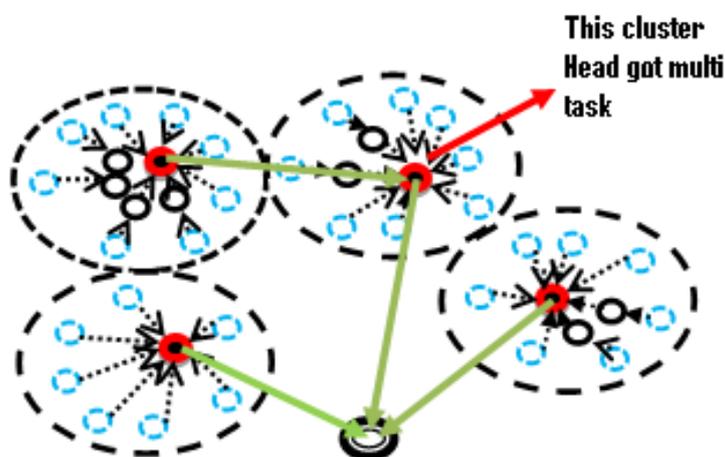

V. ARCHITECTURE

Fig 3: Fault Occur in Cluster head 3

- Sensor node
- Intermediate node
- Cluster Head
- Sink

Fig 3 explains how cluster head gets its task, because cluster head2 must forward data to cluster head3 as it is not in range to communicate with sink node directly. By this way cluster head3 gets overhead and the battery is dried out soon compared to others. To overcome this we have illustrated with diagram.
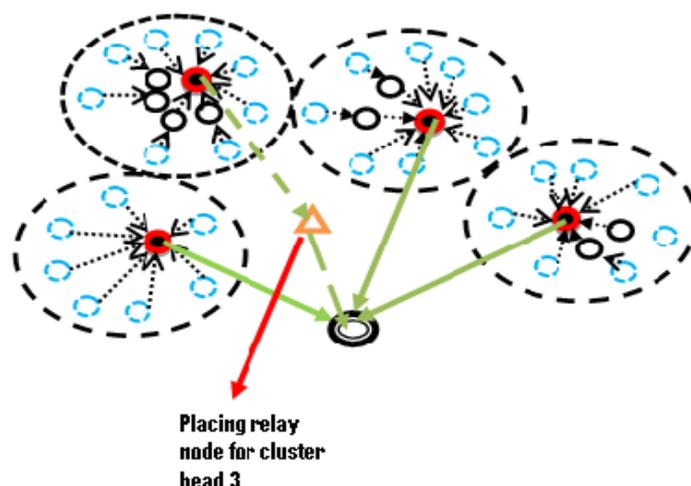
Fig 3.1 placing relay node for cluster head 2

By placing relay node as intermediate between clusters and sink, then this will reduce the task cluster head for transmitting and the performance of relay node is superior then the general nodes.

VI. ENVIRONMENTAL SETUP

TABLE I: ENVIRONMENT SETUP

Parameter &Setup	Types & nos
Protocol	AODV
Propagation Type	Propagation Media
Layer Type	Link Layer
Queue Type	Drop/Tail
MAC	802_11
Access Point	1
Cluster Head	4
Sensor Nodes	100
Access Point Coordinate	50,50,0
Scenario Size	100 x 100

Assortment of cluster head is measured adequate to cover entire region, each sensor identified with unique IP address belongs to it.Similarly the above environment is taken for computing performance in relay node. In four cluster heads we consider fourth cluster head as nearer to the sink node which forward data to sink. Third cluster head will pass its data to fourth cluster head by mean of this work load for fourth cluster head increases gradually and its battery life time decreases very soon. Our scenario places the relay node among other cluster heads. Relay node acts as intermediate node to transmit data from source node (cluster head node three) to the destination node(Sink node).

This section consists of energy level module of the common sensor node, head node and sink node. Common node energy ec=10joule, sink node energy κ=100joule and cluster head is determined as ch with threshold value. Poisson distribution is used to predict the energy level of the each node in the cluster; $e^{-\lambda}\lambda^{\kappa}/k^{\lambda}$ we assume firm level for each node that is in the process. When nodes perform their task continuously, then the node energy will gradually decreases. If the energy level of cluster head reaches below the threshold that would be called as critical then the probability of the remaining node is examined. The Higher energy node is replacing the battery drained node based on density failure rate.

VII. PERFORMANCE METRICS

A. Normal Distribution for intermediate nodes

$$Y = \frac{1}{\sigma\sqrt{2\pi}}$$

Deriving the equation to get intermediate node performance we get $e^{-(x-\mu)^2/2\sigma^2}$

$$\sigma^2 = \frac{(x-\bar{x})^2}{n} \tag{1}$$

σ is the standard deviation for nodes
μ is mean of total intermediate node performance.
From the above equation we calculate the individual node energy level within cluster. μ is generalized with intermediate node that can also be vary as sensing node if the strength of the node level is higher and σ represent existing node performance in the cluster.

B. Poisson distribution for cluster head

$$P_x = e^x \, \lambda^k / x! \qquad\qquad (2)$$

λ is threshold value specified for the cluster head node.
x is probability of head node failure.
First we obtain FDR of the each node with respect to λ and values which are low rate are considered as the low density can prolong in the region with respect to the value given.

Number of node (x)	Failure rate of node
P(x=4)	0.689
P(x=3)	0.502
P(x=2)	0.288
P(x=1)	0.105

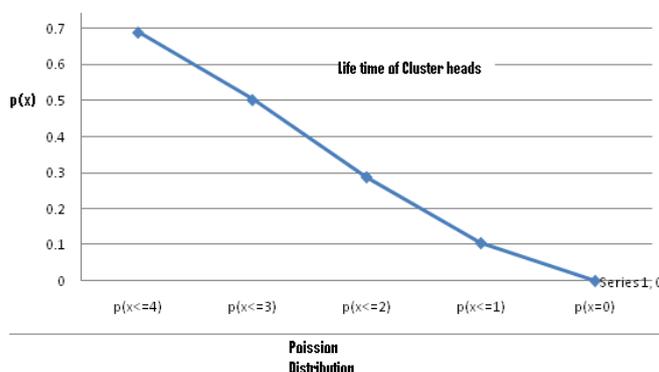Table II: FDR for Cluster Head

Fig 4: Graph for at most (n) nodes failure

From the above mentioned, we characterize the node failure probability either all the nodes cannot be failure at once or single node might fail. With the help of Poisson distribution, initialize 0 to 4 nodes which can be at most failure with low level energy. The failure rate of each node is pointed out in the given table.
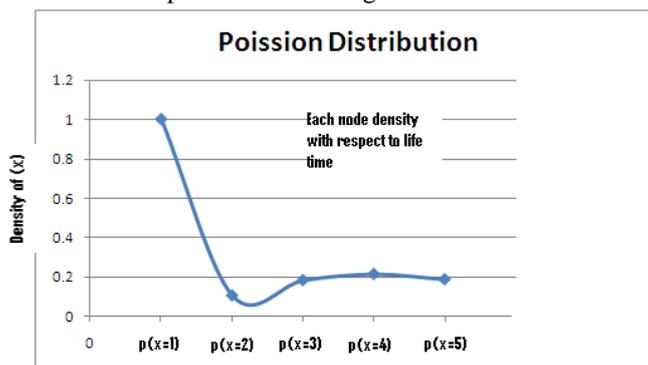

Fig 4.1 Density of each node

 Represents node failure with at most possibilities and denotes the general node energy level representation which can be referred as the strength of individual node density from which Maximum energy level node can be chosen to act as next cluster head.

Number of node(x)	Density of each node
P(x=1)	0.105
P(x=2)	0.183
P(x=3)	0.214
P(x=4)	0.187

Table III: Energy level(Density) of nodes

VIII.   CONCLUSION

We have proposed this scheme to conclude the results of evaluation with respect to set of parameters satisfied as shown in fig. the list of nodes whose probability 1 is respect to parameter satisfied are true and the probability 0 represent the result where it not satisfied. Our evaluation is general representation of maintaining fault tolerance to support network life time, effective usage of energy and performance of relay node. This scheme stretches reasonable results in fault tolerance and controlling of annoying radio signal propagation. This scheme becomes reliable for decision making over the wireless sensor network communication.

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