Failure Node Detection and Recovery in Wireless Sensor Networks

S. John Justin Thangaraj, M. Rajesh Khanna, R. Balamanigandan

Abstract*: A Wireless Sensor Network may often consist of hundreds of distributed sensors. Our goal is to formulate wireless sensor networks (WSNs) fault identification problem in terms of pattern classification and to introduce a newly developed algorithm, neighbor node hidden conditional algorithm (NHCA) to determine the unknown path through which packets are transmitted from source to destination. We propose a concept of fault recovery in WSN using clustering. This includes the protocols of Dynamic Delegation based Efficient Broadcast and Neighborhood Hidden Conditional Random Field Algorithm. The history of transmission is classified according to the pattern, sorted and ranked along with the cluster information. The data privacy is maintained with in the cluster during the packet transmission apart from the destination which may present outside the cluster. The leader of the cluster is restricted only to view the transmission path in order to maintain the confidentiality of the data transmitted. Our simulation results strongly enforce fault recovery in quick time and also maintain the confidentiality of data.

***Keywords* : WSN, Fault diagnosis, Dynamic Delegation, Pattern classification, Cluster head.**

I. INTRODUCTION

Wireless Sensor Networks (WSNs) have become widely used to environment monitoring and control, because the system is able to collect data and transmit as information from several locations [1]. Classic applications include vehicle monitoring, environmental monitoring, weather monitoring and many other industrial applications [2]. Our goal is to formulate wireless sensor networks (WSNs) fault identification problem in terms of pattern classification and to introduce an advanced algorithm, neighbor node hidden conditional algorithm (NHCA) to determine the unknown path through which the packets are transmitted from source to destination. Initially the nodes in the wireless sensor network are partitioned in to sectors using the dynamic delegation based efficient broadcast algorithm [19] in which a group leader or head is assigned to each sector in the network.

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Each group leader is given an identification number based on which the members of the sector are also given an identification number. The group leaders of the sector in which the source is present accepts the packet through a hidden path and sends it to all other group leader in the network. The group leader which contains destination in its sector accepts the packets and the other leaders discard the packet. From the destination's group leader the packet is transmitted to the destination [5]. After each transmission the identification number randomly gets changed using the fast randomized algorithm. Hidden conditional random field algorithm is used to carry out the packet transmission from source to destination through hidden path and for determining the path neighborhood in which dynamic delegation based efficient broadcast protocol is used in which nodes are divided into sectors [15] and group leader is assigned which helps to transmit the packet from one group leader to rest others [19]. Fast randomized algorithm and ranking methodology is used to strengthen the security level, after each transfer of node from sectors to sector the identification number randomly changes this change in the id_num helps to detect the fault and misbehavior of nodes.

There are number of mobile nodes to be presented in the heterogeneous network and each mobile node acts as communicable sensor nodes in the network region. DDED protocol is used to split the network between horizontally and vertically based on limited coverage distance from the server location [6]. Then the four network region formed are found and each network has number of mobile nodes available and each node connect to the neighbor node packet transmission for identifying the highest node connection to elect the group leader and this same scenario will happen to other group leader selection to be presented. The source node sends the packets to their group leader and that leader send the multi-hop router transmission in hidden way mechanism. So, that particular group leader received their destination packet means then forward to destination as well as to its entire group mobile nodes for future reference. The group leader sends ACK to server within that time limitation reaches source packet response received via source group leader. Then the packet transmission between group leaders to that specific group leader communication can be involved easily. Even though there are sink hole or gray hole packet drop occurs while hidden way packet communication that time using packet forward algorithm to measure the packet size receiving and sending to each mobile nodes in hidden route.

Once sending packet is less to neighbor nodes then sending packet before node fetch the packet size that specific sender node. If packet sending is less to compare previous and next node then detect that node from the group leader to avoid the packet drop in hidden way communication [7].

Intra and Inter Cluster Communication based on node mobility using fast randomized algorithm to keep the unique key generation for each mobile nodes. Once key is used then automatically the key can be modified and new key can be updated. This gives a way to avoid the fault node detection between Inter Communication regions where many mobile nodes are in communication under the secure transmission.

II. BACKGROUND STUDY

The collaborative nature of industrial wireless sensor networks (IWSNs) brings several advantages over traditional wired industrial monitoring and control systems, including self-organization, rapid deployment, flexibility, and inherent intelligent-processing capability [4]. Mobile nodes are connected to wireless sensor networks as a base station which senses the environment. Base station is limited in distance coverage between the sensor nodes and to the head nodes. The cluster group is formed and each group having numerous mobile nodes and it links to nearest mobile nodes. For identifying the highest connection of nodes from each group, then elected by cluster head is equivalent to highest connection of nodes to be presented. Then randomly elected by nearest nodes based on a few limited distance to be conditioned from the sink [3]. Each group having connected to related cluster head and it's are monitoring to all sensor nodes along with specified coverage area in the network.

Each cluster head should be connected to directly to sink which acts as in the network, then there are switch over from cluster head to cluster head under sink of direct connection along with mobile nodes. Each mobile node receives the multiple data packets from different Cluster heads at multiple recycle then it tries to forward the sink or base station. The mobile node has interconnected to nearest mobile node and it forwards the packets to base station under the range of packets, wave length distance, frequency signal, and cost and time that events are matches to base station or sink from the cluster range [9]. There are repetition of packet transmission occurred in the cluster environment network, so parallel and simultaneously transfer the data packets at multiple stages to be used. So, each cluster monitoring to different packet transmission, cost then schedule at unique packet maintenance into the cluster head from base station and specified allocation energy with less cost consumption and reduce the traffic off signal range, packet or wavelength collision rate till to reach the destination in the clustering network environment. Using random key generation mechanism [16], each mobile node having unique key and filter those key based on replication to be presented in the cluster network. The author of [3] proposes gradient routing with two-hop information for industrial wireless sensor networks to enhance real-time performance with energy efficiency. Accurate localization in cluttered and noisy environments is commonly provided by means of a mathematical algorithm referred to as a state estimator or filter. Author [5] proposes a novel hybrid particle/finite impulse response (FIR) filtering algorithm for improving reliability of Packet Filter based localization schemes under harsh conditions causing sample privation.

Anfeng Liu et.al [7] considers Per-Hop Acknowledgement (PHACK)-based scheme is proposed for each packet transmission to detect selective forwarding attacks. The sink and each node along the forwarding path generate an acknowledgement (ACK) message for each received packet to confirm the successful packet transmission. Zhang et.al [19], proposed a distributed algorithm to jointly optimize energy management, data sensing and routing for sensors to maximize overall network utility.

Network life- time becomes an important parameter for efficient design of data gathering for sensor networks [20]. The energy-efficient mechanism is the most appropriates hops for data forwarding will be selected and the lifetime of the whole network will be maximized. This data aggregation is used for a saving energy, because sensor nodes that arrive at an aggregating node may have to be held for some period of time before being reported so that additional data may reach the aggregator from slower nodes. If this number of nodes can be returned in less time than the maximum, then the maximum time will not be reached.

Multiple discriminant analysis (MDA) and artificial neural networks (ANNs) provide suitable environments to develop such fault-identification schemes [12] because of their multi input-processing capabilities. The first scheme is based on a single large-scale MDA representing the complete operating load-torque region of the motor, while the second scheme, consists of many small-scale MDA, each unit representing a particular load-torque operating region. The problems of fault identification, isolation, and estimation of new path are considered for discrete time-varying networked sensing systems. A least-squares filter [10] that minimizes the estimation variance is first designed for the addressed time-varying sensing systems, and then a residual matching (RM) approach is developed to isolate and estimate the fault, once it is detected [16]. The RM strategy is implemented to estimate the augmented signal composed of the system state and a specific fault signal. The design scheme for each filter was proposed in a recursive way. The main idea for the fault identification is regarded as corresponding to the right fault signal, and its estimation is utilized to represent the actual occurred fault.

III. LIMITATIONS OF THE SYSTEM

In present scenario, there is lot of nodes connected or disconnected from the network without proper handling from the base station. So, it may be chances to occur are misbehavior nodes or spoofing attacks in the wireless sensor network. Neighborhood hidden conditional random field algorithm is used for transmitting the packet through hidden path.

The following are some of the limitations may found in the present systems:

- Misbehavior of nodes
- More time consumption
- Energy Loss
- Miscommunication between nodes
- Low data rate in transmission
- No secure transmission.

IV. EXPERIMENTAL STUDY

There are many sensor nodes involving in packet transmission. In the Proposed System, by clustering conception we are grouping the nodes in sectors. By assigning head to each sector, the packets are transmitted from source to their cluster head through a hidden path, which can be determined by neighborhood hidden conditional random field algorithm. From source head the packets are transmitted to each cluster head in network and packets reaches the destination by considering node id, group id and location. In the Modification Process, using ranking methodology faulty node is detected and the best network path is found which the predefined path becomes.

Fast randomized algorithm is used to periodically change the node id randomly after each transmission and change of node position from one sector to another. Some of the scopes to be experimentally verified are:

Data transmission is secured
Time consumption is less
After a transmission of data, the path becomes predefined

A. System Implementation

There are number of mobile nodes to be presented in the heterogeneous network and each mobile node acts as communicable sensor nodes in the network region. There is DDED protocol using to split the network between horizontally and vertically based on limited coverage distance from the server location. Then found the four network region formed and each network has number of mobile nodes available and each node connect to the neighbor node packet transmission for identifying the highest node connection to elect the group leader and this same scenario will happen to other group leader selection to be presented. Then source node sends the packets to their group leader and that leader send the multi-hop router transmission in hidden way mechanism using NHCRF algorithm. So, that particular group leader received their destination packet means then forward to destination as well as to its entire group mobile nodes for future reference. Then group leader sends Ack to server within that time limitation reaches source packet response received via source group leader. Then easily packet transmission between group leaders to that specific group leader communication to be involved. So, time can be saved and packet transmission to be sending to avoid the hidden way rules.

Even though there are sink hole or gray hole packet drop occurs while hidden way packet communication that time using packet forward algorithm to measure the packet size receiving and sending to each mobile nodes in hidden route. Once sending packet is less to neighbor nodes then sending packet before node fetch the packet size that specific sender node. If packet sending is less to compare previous and next node then detect that node from the group leader.

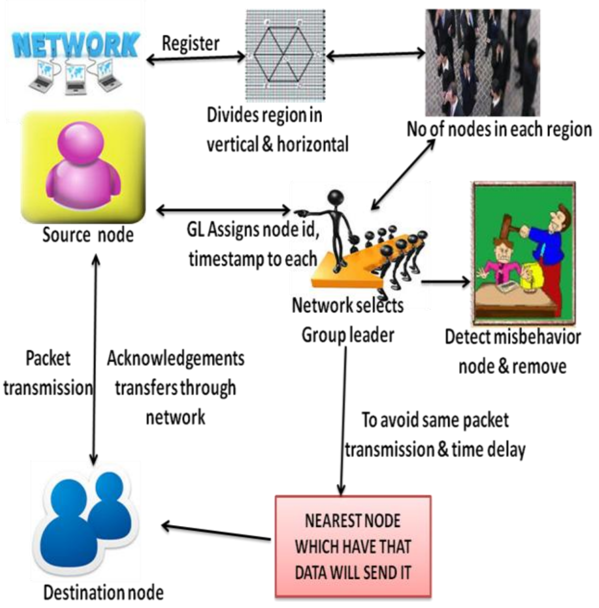

Figure 1 System Architecture

So, this used to avoid the packet drop in hidden way communication. Intra and Inter Cluster Communication based on node mobility using fast randomized algorithm to keep the unique key generation for each mobile nodes. Once key is used then automatically can be modified and new key to be updated. Because, to avoid the fault node detection between Inter Communication region. So, many mobile nodes are to be in communication under the secure transmission.

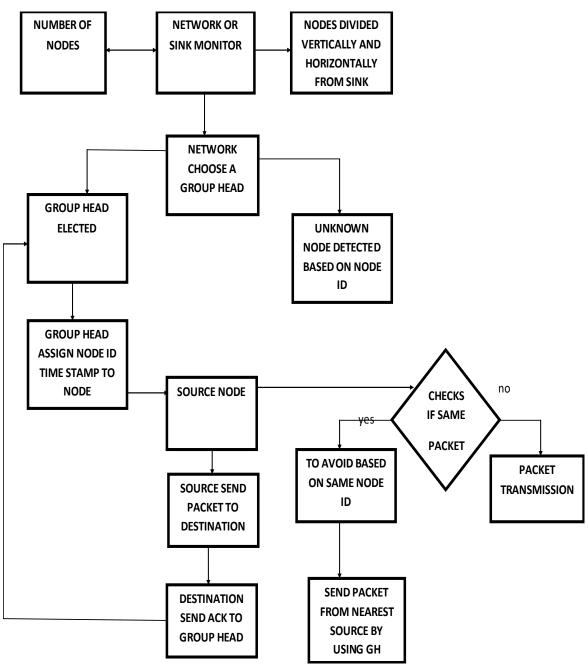

Figure 2 Data Flow Diagram

V. RESEARCH METHODOLOGY

Neighbor node Hidden Conditional Algorithm (NHCA) can assign labels during the initial phase of agreement with the production rules of a packet hidden way before transmitting data. The main novelty is including prior knowledge of the problem by means of separated network to be defined. Our current implementation allows regular path and irregular path of rules can be achieved in hidden format processed. The prediction of the network topology performs better way than the routine applied.

The random fields are a class of statistical modeling of method applied to recognize and structured division of the prediction, while an ordinary network predicts a label for a single sample without concern to "Neighboring" node communication establishment as can chaining reaction to be processing predicts sequences of input samples. The undirected probabilistic graphical network divided horizontally or vertically of node relationship between packets transmissions in hidden way from network to network traversal are occurred. The destination of received at specific network then that group leader to notify at all their specific network group. Then network group communicates to another network group network. Network conditions of all heads are monitoring and fault diagnosis with removed or put into idle state of the location.

Packet distribution is used to forwarding traffic among network nodes. Forwarding is performed for many kinds of network nodes. Routing directs packet forwarding through intermediate nodes. The data content of the packet are used to provide some content-specific transformation which allows the requested node to transfer the packet continuously based on packet forwarding process. Fast Randomized algorithm gives excellent results when detect and verify on both locations from source to the base station via cluster head selection under the key from distance coverage area. This is much faster, typically thousands of times faster using keys Gives a new cluster head elected by recycling for achieving new keys based on inter and intra cluster in the agreement among asynchronous processes which communicate by monitoring every mobile nodes in the cluster. It maintains the optimization cost and interference path minimum hop to be selected.

VI. PERFORMANCE ANALYSIS

A. Packet Delivery Ratio

PDR is the ratio of packets successfully transmitted from a node to all multicast receivers to the total number of data packets generated by the sender. In X-axis is the number of nodes and Y-axis is the Packet delivery ratio for Sensor Lifetime increasing as well as increasing the Network Lifetime. So network performance to be analyzed.

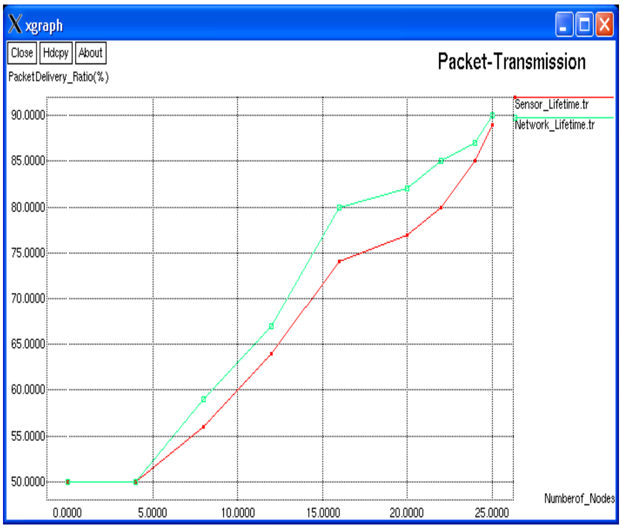

Figure 3 Packet Delivery Ratio

B. End-To-End Delay (Latency)

End-to-end delay or one-way delay (OWD) refers to the time taken for a packet to be transmitted across a network from source to destination.

$$D_{end\text{-}end} = N[\, D_{trans} + D_{prop} + D_{proc} + D_{queue}]$$

where $D_{end\text{-}end}$ specifies end-to-end delay, D_{trans} denotes transmission delay, D_{prop} denotes propagation delay, D_{proc} as processing delay and D_{queue} as Queuing delay.

The time elapsed between the request sent and the data transmitted back to the sender averaged for all the successful transmission.

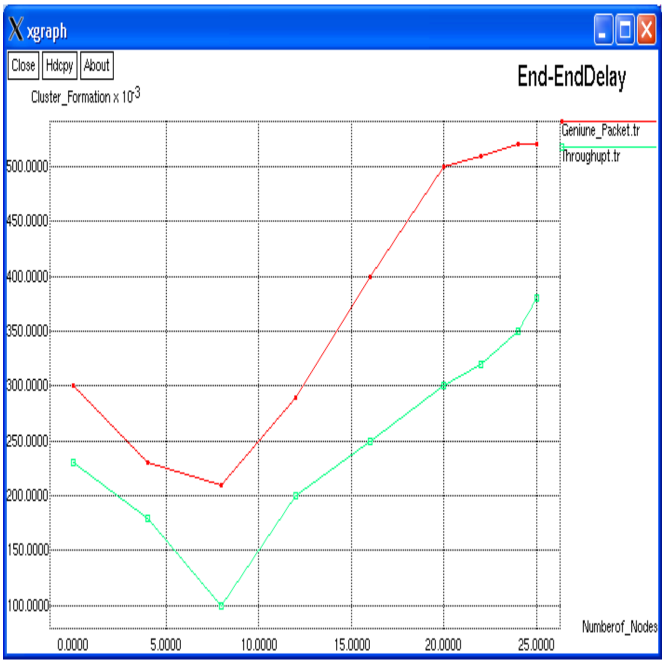

Figure 4 End-to-End Delay

VII. CONCLUSION

In this paper, we use packet distribution algorithm for transmission of data packets from source to destination. We proposed a concept of fault recovery in WSN using clustering.

This includes the protocols of Dynamic Delegation based Efficient Broadcast and Neighborhood Hidden Conditional Random Field Algorithm. The history of transmission is classified according to the pattern, sorted and ranked along with the cluster information. The data privacy is maintained with in the cluster during the packet transmission apart from the destination which may present outside the cluster. The leader of the cluster is restricted only to view the transmission path in order to maintain the confidentiality of the data transmitted. Our simulation results strongly enforce fault recovery in quick time and also maintain the confidentiality of data. We use ranking methodology to find the best path for transmitting the data packets which later becomes a predefined path. In this we also made fault diagnosis for example, if any node misbehaves, by fault diagnosis mechanism we identify and disable the node.

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