Cluster Based Fault Identification And Detection Algorithm For WSN- A Survey

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Abstract: **The fault tolerant and reliable dissemination is an important issue in WSN, due to the deployment of sensor nodes in hostile environment. Most of the clustering algorithms are concentrated to increases the network lifetime and reduces the energy consumption among the sensor nodes and do not consider the reliability of the networks. Fault tolerance techniques detect and recover the sensor nodes from hardware and software failure to increase the reliability of the networks. In this paper, we study the different approaches for fault tolerant issues and we summarize and compare the current work that has been done in fault tolerant for clustering algorithm.**

Keywords: **Fault tolerance, Clustering, Network lifetime.**

I. INTODUCTION

Wireless Sensor Network is the rapid growing technique which consists of number of sensor nodes and a base station. Sensor nodes are capable of sensing, data processing and communication in a harsh environment. In general, the sensors are limited in their energy level and memory capability [1]. Therefore, the primary concern of sensor network is maintaining the network connectivity in spite of of the failure of one or more sensor nodes.

Recent research has developed several techniques for handling different types of faults at various layers of the network. Fault management technique includes fault detection, isolation, prediction, identification and recovery. The possible fault symptoms can be determined by using a different metric in Fault detection technique [2]. Faulty isolation is associates a different type's failure node indication such as alarm, ICMP messages received from the sensor networks and provides various suggestions for faulty hypotheses. Fault prediction is fault can be predicted before its occurrence or to avoid the failure node. Fault identification identify the failed nodes, the faulty nodes can be overcome by the fault recovery algorithm. The sensor nodes may be failed by the following reasons:

1. Energy Depletion: sensor nodes are easily broken and may fail due to depletion of batteries energy by an external event.
2. Link Availability: Link may fail either permanently or temporarily due to the network partitioning and dynamic changes in the network topology.
3. Packet Loss: Packets ma loss due to the dynamic topology changes and incorrect communication.
4. Network Congestion: Congestion may occur when a large number of nodes simultaneously transmit data to the base station.
5. Node Failure: a node may fail due to either software or hardware failure.

In multihop communication, the fault can be occurred more than single hop communication because of several hops is participated to deliver data from node to the base station. Therefore a single node failure may guide the mislaid from entire sensor networks. In this paper we study all these types of fault prediction and recovery for cluster based wireless sensor networks.

II. CLUSTER BASED FAULT IDENTIFICATIONS AND DETECTIONS ALGORITHMS

The cluster based architecture implemented fault detection mechanism in a distributed manner through intra cluster communication and reports the failed nodes to the upper layer of communication hierarchy. The existing algorithms which partition the network to perform fault detection and recovery locally with minimum energy consumption.

Fault detection in a sensor network largely depends on the type of application and type of failures. Faults can be recovered independent of applications. Most of the fault detection and recovery algorithms operate at the transport layer and few recovery algorithms perform at application layer.

Fault detection aims to find the possible faults depending on the different parameters are used, and fault recovery algorithm aims how to treat the fault efficiently with less energy consumption. The existing cluster based fault detection and recovery algorithms detecting the node failure according to the energy depletion, link failure and damaged node. In existing algorithms, the node failure can be predicted by two methods:

1. Monitoring Node Status
2. Monitoring Link Availability

The sensor nodes can be monitored periodically using i) predefined time schedule to detect link failure, ii) TDMA time slot allocation to detect the link and range failure, and iii) event-driven technique to detect the energy depletion. In this paper we study the existing algorithms based on these three techniques.

Monitoring link quality using predefined time schedule to detect the link failure. FTHC [3] detect the link failure by sending a ping messages to neighbour's node. It focuses on detection and recovery of Cluster Head (CH) failure over the protocol MECH. It presents two models for handling CH failure i) intra cluster recovery model and ii) inter cluster recovery model. In intra cluster recovery model, the failed CH can be replaced with another node within the same cluster. In inter cluster recovery model, the sensor networks works in the same manner when the new CH replaced and forced to move to a new CH.

Monitoring Link Quality Using TDMA time slot to detect link and range failure: The algorithms for TDMA time slot allocation to detect the link and range failure is discussed here. FT-DSC [4], the CH able to detect the cluster member failure and cluster head failure can be detected by base station. To reduce the energy consumption, the cluster member do not sent data to cluster head in every time slot of frame allocated to them. The cluster member sense either data or special packets to the cluster head in its allocation time does not receive any special packets or data from the specified node, and then the cluster head assumes that the node has failed. The same process is used for detects cluster head. The size of the special packet is smaller than the data packets. It consumes energy by sending special packets. In [5], propose a run time recovery mechanism based on consensus of healthy gateways to detect and handle faults. This mechanism detects different kinds of failure such as communication faults can be caused due to the network failure, energy depletion and out of coverage. It divided into two phases: detection and recovery. To detect the failure in gateways, it follows a consensus model of the gateway to agree a fault in a system. The second phase is used to identifies the type of fault and perform recovery of sensor. The fault tolerance can be performed by checking the status of the gateway periodically. It spends more energy for reconfiguring the clusters and recover from failures.

FEED [6], which selects the cluster head based on energy, density, centrality and the distance between the nodes for making clusters. Every cluster has a supervisor nodes and pivot cluster head to increase the network lifetime. A supervisor node has the responsibility for detecting and replacing the failed cluster head and pivot cluster head by its new cluster head or pivot cluster head. The energy consumption of FEED is increased by selecting three types of cluster heads for handling a faulty cluster head. Clustering and fault tolerant for target tracking [7] it provides three major contribution for detecting and recovering a cluster head from failures: i) static cluster formation which facilitates cluster head recovery procedure, ii) to reduce the cost of fault tolerance, energy consumption, RN are identified and to maintain a sleep state, iii) how the cluster member can be recovered when cluster head activate RNs. It is capable of tracking the moving object as well as recovering supervisor nodes and cluster heads, but it is applicable for a specific number of cluster head failures and supervisor node.

Fault Tolerant Network Management Architecture [8] which carries out localized fault detects and recovery mechanism through a hierarchy of sensor nodes such as central manager, zone manager and cluster head. ZFTMA divide the whole networks into four symmetric zones assign a node as a zone manager to each node. zone manager is a 1 hop direct communication with the central manager. The central manager is located at the centre of the sensor area that will be in equal distance to all zone managers. Each zone is divided into number of clusters and each cluster has a cluster head. Each cluster head performs local management information such as allocate TDMA schedule to nodes, detection of faulty nodes. Fault management is performed by a local decision making. This local decision making avoids the excessive data communication with the base station. It does not focus on the zone manager and cluster member faults.

EFB [9], is power adaptive protocol for wireless sensor networks to decrease the energy consumption of the network resources in each rounds of data communication and aggregation and it is a fault tolerant techniques that guarantees trustworthy of the communication between sensor nodes and the base station by selecting cluster head in terms of power and dimension.

Monitoring the node statues by driven technique to detect the energy depletion are discussed here. DFMC [10] which is the energy efficient decentralized fault tolerant algorithms for WSN. There are three types of nodes: i) observer cluster head, ii) cluster head and iii) cluster member. The observer cluster head is responsible for detecting the fault at cluster head in each cluster. For this reason, the cluster manager sends the query message periodically to cluster head. If it does not receive any message from cluster head, it assumes that cluster head is failure of its cluster. The observer cluster head selects the new cluster head for this cluster. This recovery mechanism is performed locally by each cluster. It improves the throughput of network.

Incorporating fault tolerance in LEACH protection for WSN [11], the fault recovery is detected by sending a ping message periodically to all the nodes. If no response is comes from the cluster head to base station then it assumes that the cluster head is faulty and it can be recovered by two ways: i) replace the faulty cluster head by the next higher energy node in the cluster, ii) maintain two cluster head in each cluster by using token. The energy consumption is increases when maintaining tow cluster head in each cluster.

A new algorithm fault management by clustering in WSN [12], which is energy efficient and responsive to network topology changes due to sensor node failure. If cluster head residual energy is less than the threshold value, it sends a message to the cluster member including secondary cluster head. The failed cluster head can be replaced by a secondary cluster head. It does not require passing the information to the cluster members about new cluster head. The time for recovering the failed node is less than the existing algorithms.

A novel energy aware fault tolerant mechanism for WSN [13], each cluster has two cluster heads: Primary Cluster Head (PCH), Backup Cluster Head (BCH). The cluster nodes sending data to PCH at regular interval and at each round, the BCH check the availability of PCH by sending a beacon message. After three rounds, the BCH does not receive any message from PCH, then it will announced that the PCH is failed and informed to non cluster head nodes. This mechanism improves the network throughput while the cost of energy is decreased.

The overall classification and comparisons of existing cluster based fault management algorithm for WSN is shown in table 1.

Clustering approach	Inter cluster	Intra cluster	Detection recovery	Re-clustering	CH	CM	Methods for detection	Fault Types	Network model
FTHC [3]	√	√	√	√	√	×	Time schedule	link	Hetero
FT-DSC			√	√	√	√	TDMA	Link	Homogeneous
Fault tolerant clustering model for WSN [4]	√	√	√	√	√	×	TDMA	Link, Range	Homogeneous
Fault tolerant clustering for WSN [5]	√	×	√	×	√	×	TDMA	Link Range	Homogeneous
FEED [6]	√	√	√	√	√	×	TDMA	Link	Heterogeneous
Clustering and fault tolerance for target tracking [7]	√	√	√	×	√	√	TDMA	1.Energy depletion 2.Link 3.damage	Homogeneous
Fault tolerant n/w mgmt architecture for WSN [8]	√	×		√	√	×	Energy driven	link	Heterogeneous
EFB [9]	√	×	√	×	√	×	TDMA	link	Homogeneous
DFMC [10]	√	√	√	×	√	√	Energy Driven	Energy depletion	Homogeneous
Incorporating fault tolerance in LEACH protection for WSN [11]	√	√	√	×	√	×	Energy driven	Link	Homogeneous
A new algorithm fault mgmt by clustering in WSN [12]	√	×	√	×	√	×	Energy Driven	Energy depletion	Homogeneous
A novel energy aware fault tolerant mechanism for WSN [13]	√	×	√	√	√	×	Energy driven	1.Energy depletion 2. transmitter failure 3. Malicious human behaviour	Homogeneous

III. CONCLUSION

In this paper we presented the detailed summary of proposed fault detection and recovery algorithm for cluster based WSN. The fault tolerant plays an important role for making the reliable communication between the sensor networks. The sensor nodes may be failed due to energy depletion, link failure, range failure and damaged nodes. All the proposed algorithms use the special packets, ping messages and beacon messgaes to check the availability of link and event driven techniques for detecting the energy depletion. We suggest that it is not sufficient for detect the node failure and it spends some more energy for handling the special packets.

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