DYNAMIC CLUSTERING BASED FAULTY NODE DETECTION IN SECURITY CRITICAL WSN

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Abstract- A number of security critical systems like sensors deployed in a chemical plant to monitor the gas leakage, monitoring nuclear radiation level in particular area for example near any nuclear power plant to prevent nuclear radiation spill etc. are the applications where dynamic clustering are applied . Energy of each node is fixed in wireless sensor network so energy conservation is major task in our dynamic nodes clustering based methodology because of the fact that batteries can't be replaced or recharged. We proposed a new concept of dynamic topology in safety critical application of wireless sensor network adding concept of clustering based on distance from neighbouring nodes to the system model of trust voting algorithm to detect faulty nodes.

Keywords: *Sensor nodes, Topology, Dynamic, Security, Cluster-based, Critical systems.*

I. INTRODUCTION

WSN is a network that consists of microelectronics system nodes having limited power and processing capability which record and report various physical variables related to the environment in which they are deployed. A WSN consists of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants. When taking a number of security critical systems like sensors deployed in a chemical plant to monitor the gas leakage, monitoring nuclear radiation level in particular area for example near any nuclear power plant to prevent nuclear radiation spill etc. are the applications where dynamic clustering are applied instead of static just like for application like highway bridge etc. Faulty reading nodes detection can trigger the alarm and locate the source when abnormal data are generated. Generally, protocol complexity, node deployment, heterogeneity, requirement of GPS device, etc. are major issues for a given system model. A SN also called mote is a node in WSN that is capable of performing some processing, gathering sensory information and communicating with other connected nodes. Due to recent technological advances, the manufacturing of small and low cost sensors became technically and economically feasible. The sensing electronics measure ambient condition related to the environment surrounding the sensor and transforms them into an electric signal [1]. Processing such a signal reveals some properties about objects located and/or events happening in the vicinity of the sensor. A large number of these disposable sensors can be networked in many applications that require unattended operations.

II. LITERATURE REVIEW

Faulty reading node detection refers to the problem of finding patterns in data that do not conform to expected normal behaviour. These anomalous patterns are often referred to as outliers, anomalies, discordant observations, exceptions, faults, defects, aberrations, noise, errors, damage, surprise, novelty, peculiarities or contaminants in different application domains.

Types of Faulty reading node: When the complete data is analyzed as per the central data approach by any central authority faulty reading nodes can be identified properly and can be tackled appropriately at the corresponding station. When type of data is considered the faulty reading nodes can be classified as local and global faulty reading nodes:

Local Faulty reading nodes: Taking the point that local faulty reading nodes are recognized in wireless sensor network at individual sensor nodes, techniques for reducing communication overhead and maintaining scalability of network with proper determination of faulty reading nodes is important. Many event detection applications, for example, vehicle following, surveillance and monitoring can be done using local faulty reading node detection. Local faulty reading node identification has two variations in wireless sensor network. One variation is that historical values are used for determining the wrong or faulty value in the given sensor network. Another option is adding historical reading of their own; where the value of neighbour is taken to determine the value is proper or not i.e. the anomaly is based on the feedback from the neighbour node. When compared with the second approach the first one lags as it doesn't provide that much accuracy and robustness in the detection of faulty reading nodes.

Global Faulty reading nodes: Global faulty reading nodes are popular as they have global perspective and also they draw more attention as they focus on the complete characteristics of WSN instead of working locally like local faulty reading node. On basis of different network architecture, different type of identification can be done on many nodes. All the data collected id transmitted to sink node in the centralized architecture. It delay the response time very much and cause a lot of communication overhead. Cluster head collect the data and identifies faulty reading node in cluster based approach. It has better response time and energy consumption as compared to the former one.[4,5]

Faulty reading node Sources and Handling There are three likely faulty reading node sources in WSNs:

(a) Noise and errors which result in fault detection [2]

(b) Events which result in event detection [3].

(c) Malicious attacks which finally lead to intrusion detection.

Faulty reading node handling is carried out by performing these three important steps:

Faulty reading nodelabelling: Faulty reading nodelabelling stands for detection of faulty reading node from the given dataset it is performed with the help of various faulty reading node detection algorithms.

Faulty reading node Identification: Faulty reading node identification deals with faulty reading node detection as event or error or any kind of noice.

Faulty reading node Accommodation: Once an observation is identified as a potential faulty reading node, analysis should begin to determine whether an assignable cause can be found for the spurious result. If none of the reason can be found, a repetition can be suggested, the potential error node data should be backed up for future consequences. Robust statistical methods such as weighted least-squares regression minimize the effect of afaulty reading node observation. Robust faulty reading node detection techniques should be employed when the number of faulty reading nodes is large, so that the resulting data distribution is not skewed, however non-robust techniques can be employed when the number of faulty reading nodes is small.

III. SECURITY CRITICAL APPLICATIONS

In WSNs, faulty reading nodes can be defined as, "those measurements that significantly deviate from the normal pattern of sensed data" [6]. This definition is based on the fact that in WSN SNs are assigned to monitor the physical world and thus a pattern representing the normal behaviour of sensed data may exist. Recently, the topic of faulty reading node detection in WSNs has attracted much attention. According to potential sources of faulty reading nodes as mentioned earlier, the identification of faulty reading nodes provides data reliability, event reporting, and secure functioning of the network. Here, we exemplify the essence of faulty reading node detection in several real-life applications.

- Environmental monitoring
- Habitat monitoring
- Health and medical monitoring
- Industrial monitoring
- Target tracking
- Surveillance monitoring

Security critical application include various areas like chemical plant in which sensor nodes are deployed to monitor the gas leakage and keep the system alert in case of any emergency condition. Also, in nuclear plant to monitor radiation level a security critical wireless sensor network is used. To monitor the temperature in thermal plant is also such kind of application.

IV. PROPOSED WORK

Faulty reading node detection in WSNs is needed in many applications that monitor abnormal behaviours, measurements, and events. For example, a sensor network, embedded in a highway bridge around beams or columns for detailed building structural monitoring, can give early warning of any structural weakness or deterioration, reducing the chance of unexpected failures. Faulty reading node detection helps pinpoint the accurate locations of the weakening parts, especially in the early stage of the problem development. Faulty reading node detection can trigger the alarm and locate the source when abnormal data are generated. Habitat monitoring for endangered species is another application in which animals will be attached with small non-intrusive sensors. Faulty reading node detection indicating abnormal behaviours suggests closer observation of an individual animal and maybe more human interactions. The proposedalgorithm is as follow

START

1. Deploy a wireless sensor network in an area 100*100 using rand() i.e. random number generator in MATLAB.
2. Dynamic clustering is used in determining cluster head on the basis of distance with no of cluster head changes every time and CH will allot time schedule to each of the member nodes of that cluster. A node will transmit only during its TDMA schedule an remain sleeping at other time to save energy. [8]Sensor Rank [7] is then used to calculate rank of each node for the purpose of voting in error reading node detection. We can formulate SensorRank of S_i , denoted as $rank_i$, as follows:

$$p_{j,i} = \frac{asso_{i,j}}{\sum_{k \in nei(i)} asso_{i,k}}$$

$$ranki = \sum_{S_j \in nei(i)} p_{j,i} \cdot rank_j$$

where$p_{j,i}$ is the transition probability from state i to state j.

3. Trust Voting algorithm [7] is used which consists of two phases Self-diagnosis and Neighbour diagnosis phase. Vote with high Sensor Rank are more reliable, whereas the votes from the neighbours with low Sensor Rank should pitch less weights.If a neighbour with a high Sensor Rank has a small association node, they will not provide good decision for each other.

$$vote_j(i) = \begin{cases} rank_j, & asso_{i,j} \geq \sigma \text{ positive vote} \\ -rank_j, & \text{otherwise negative vote} \end{cases}$$

4. Collection of faulty reading node data within the cluster using CH, it will send data to the BS. Aggregated data from the BS can be forwarded to every cluster for proper recognition.

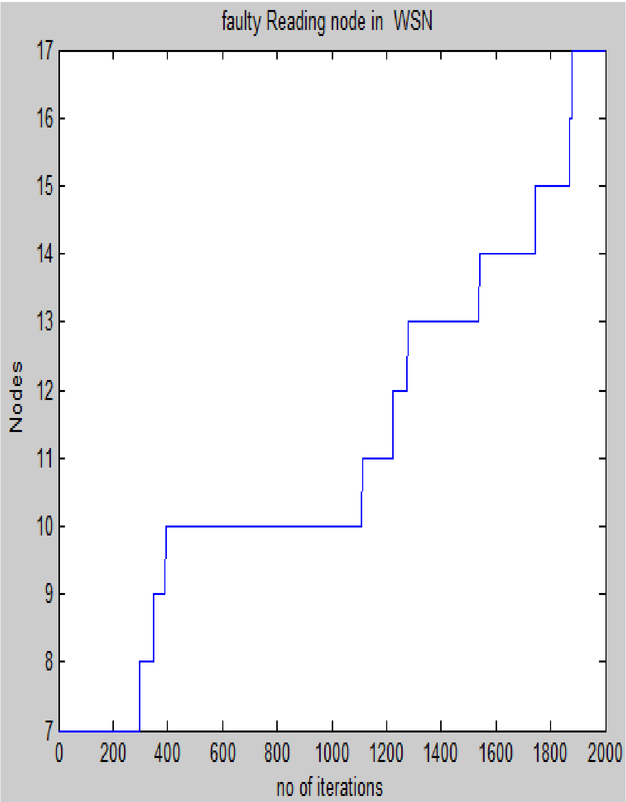
STOP

V. SIMULATION AND RESULT

The proposed model is simulated in MATLAB 7.9. It introduces performance evaluation matrices used to analyze performance of the presented model. The basic parameters used for simulations are listed in table 1.

Table 1: Parameters employed in Simulation

Parameter	Value
Field Size	100m X 100m
No. of Nodes	100
Probability of cluster	0.2
Initial Energy of sensor node	100 J
Min Reading	1
Max Reading	10
E_{fs}	10 J/bit/m^2
E_{mp}	0.0013 J/bit/m^4



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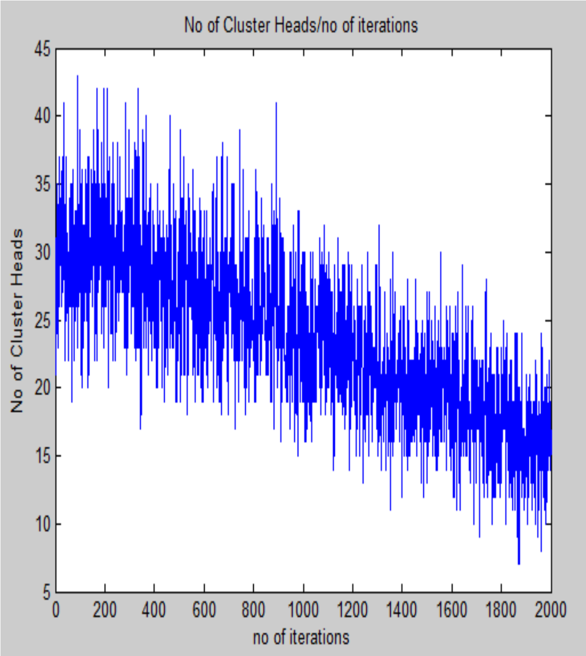


Fig 1 A) No of faulty reading nodes in WSN B) No of cluster heads/no of iterations

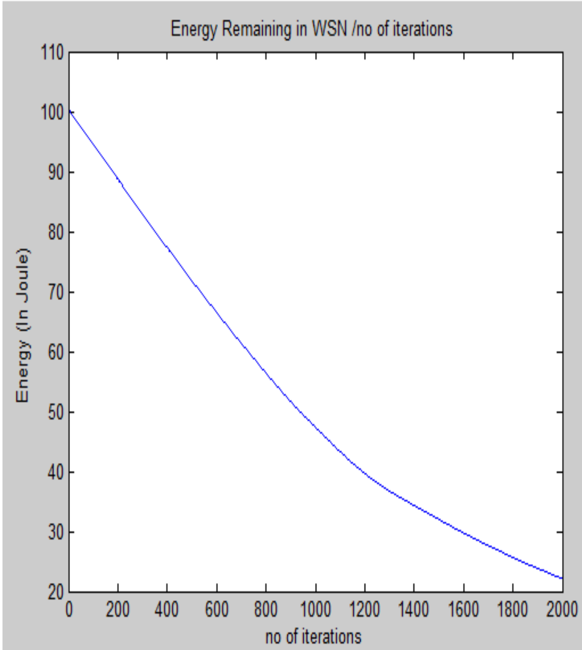
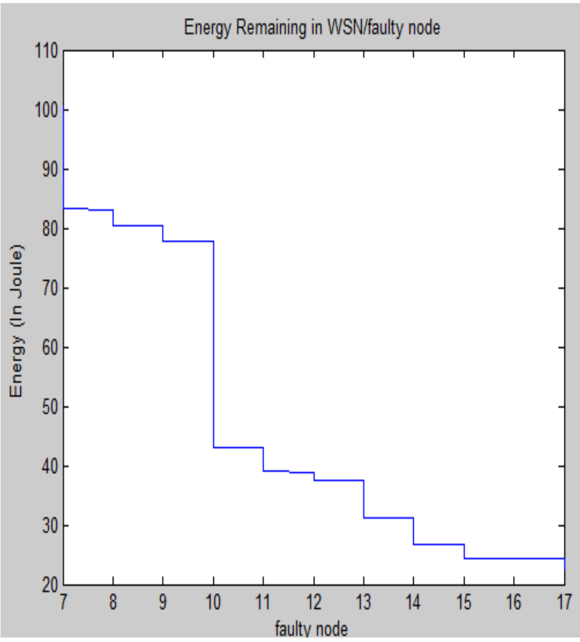
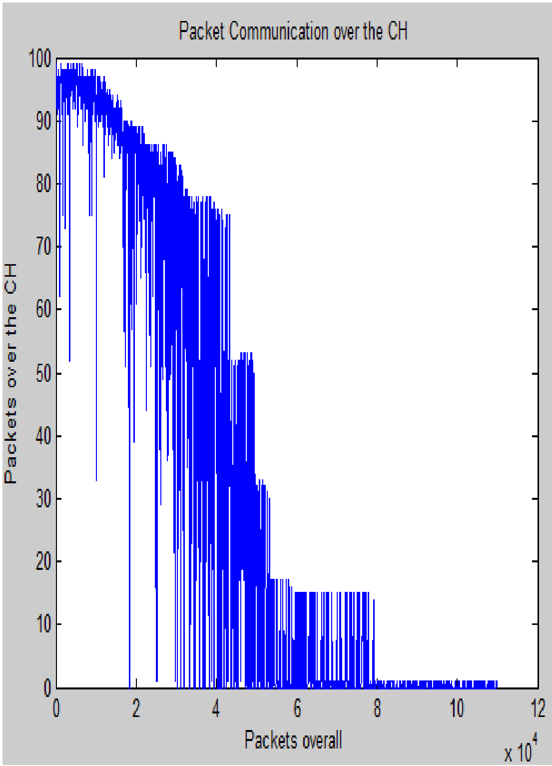


Figure 2 A) Energy remaining in WSN/Faulty Nodes B) Energy remaining in WSN/No of Iteration





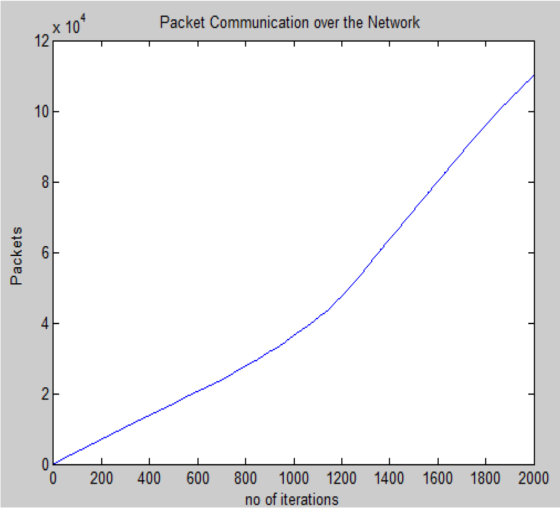


Figure 3 A) Packet comm. over the cluster head B) Packet comm. over the network

VII. CONCLUSION

We proposed a new concept of dynamic topology in safety critical application of wireless sensor network adding concept of clustering based on distance from neighbouring nodes to the system model of trust voting algorithm to detect faulty nodes. So that no problem arise in safety critical systems but also saving energy by the use of clustering with Sensor Rank concept. The cluster head of each cluster detect Faulty nodes from cluster and send this information to the Base Station. We also implemented the proposed dynamic clustering algorithm in MATLAB with around huge number of iteration to completely analyse various factors.

VII FUTURE SCOPE

The proposed work can be simulated using fixed number of cluster heads and static topology for the same environment.A dedicated node can be there to which a default high energy can be given. The CH of each cluster hand over the data to this node and this node will perform all the calculation in place of CH. Further recovery mechanism for the CHs can also be provided in future. It can also be compared to other algorithms like major voting and weight voting algorithm under same simulation criteria.

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