TO PROPOSE A TECHNIQUE FOR FAULT TOLERANCE IN WIRELESS SENSOR NETWORKS

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Abstract: ***The wireless sensor network is the type of Ad hoc network. Wireless sensor network is the self-configuring networks; any sensor node can join or leave the network when they want. In Wireless sensor network no central controller is present, wireless sensor node are responsible for data routing in the network. Wireless sensor network is used to monitor the environmental conditions like temperature, pressure etc. Wireless sensor network is deployed in the far places like forests, deserts etc Wireless Sensor nodes are very small in size and have limited resources. In such far places it is very difficult to recharge or replace the battery of the sensor nodes. In such conditions, we focus to reduce the battery consumption of the sensor nodes. In this work, a new technique is proposed to reduce battery consumption. It will be based on the dynamic clustering using neural network. Before data transmission sensor nodes form the cluster dynamically using Boltzmann learning of the neural network and weights are adjust according to the situation and it also enhance the efficiency of the dynamic clustering. Experimental results show that new proposed technique is more efficient, reliable and provide more throughput as compare to the existing technique***

Key words: Scalability, Fault Tolerance, Neural Networks, Boltzmann Learning

1. INTRODUCTION

A wireless sensor network consist a large number of sensing nodes, these nodes are low-power multifunctioning sensor nodes, operating in an unattended environment with limited computational and sensing capabilities [2]. The sensor nodes are self-powered nodes and the sensor nodes are used to detect special events and process their data to a base station over wireless fashion. In wireless sensor network the sensor nodes monitor different conditions at different locations, like temperature, humidity, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on connected objects, the current characteristics like speed, direction and size of an object [4].

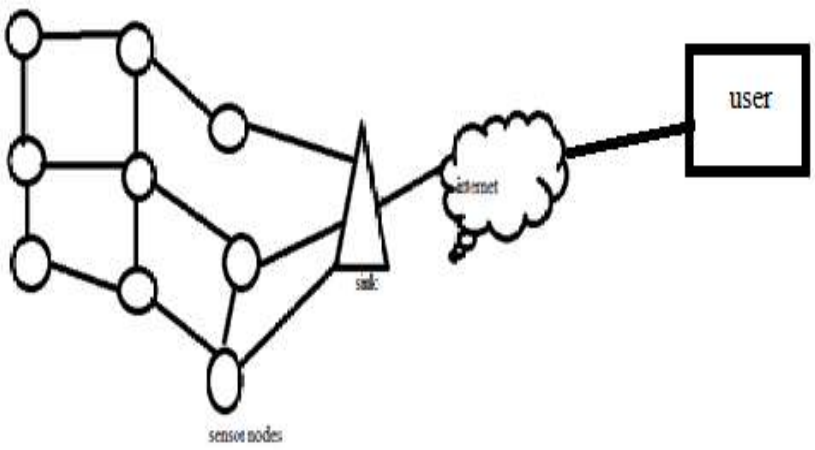

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Fig.1.1 Wireless Sensor Network

In wireless sensor networks, the sensor nodes are spatially distributed autonomous devices using sensors to cooperatively monitor conditions at different locations. These sensor nodes are normally consist sensing, processing and communicating. A sensor node consist a senor module, a battery, a processor and a radio module.

1.1 Issues in Wireless Sensor Networks: There are many issues in wireless sensor networks. These are as follows:

1. Battery Consumption: Sensor nodes which are near to the sink node use energy at very high rate because the traffic of other nodes is also forward by this node. Sensor node near to the sink, drain their energy resources at faster rate than other nodes which leads to the decreasing in network lifetime [6]. The mobile sink can lessen energy dissipation of those nodes which are closer to the sink by collecting information from the sensor network while moving within the monitored area [5].

2. Fault Tolerance: The major problem of WSN is mobility of nodes. When node moves from its position the performance of the system degrades. Hence it is related to the design of routing protocol. The routing protocol tells the various alternate paths to resend the packets. Hence different environment have the different kind of fault tolerance ability.

3. Scalability: In WSN network the scalability of the nodes vary from one to thousand. It depends upon the situation that what is the need of the environment at the particular time. For example: if we want to collect the data with high resolution then the node density should also be increase from hundreds to thousands. So that in the transmission range the complexity of the network is [7] increases. The protocols used in the WSN need to maintain a particular platform to resolve the issues arises in the network. So that it can maintain the performance of the particular network.

4. Hardware Constraints: Each sensor node in the network has its own sensing unit, processing unit a transmission unit and the power supply. The sensor node in the network also has some additional devices, it may be inbuilt or not. Each additional device has the additional cost and also more power is consumed to maintain that devices. The size of the node is also affect by adding some extra features in that. Hence the additional functionalities need to be balanced.

1.2 Fault Tolerance in Wireless Sensor Network: Wireless sensor networks is an application based network which used for deployment in the faraway places like desserts, underwater etc. Moreover its sensors are small in size. Due to size it has fault problem also. An imperfect system due to some reasons can cause some damages. A task which is working on real time distributed system should be achievable, dependable and scalable [6]. The real time wireless sensor network like grid, robotics, nuclear air traffic control systems etc. are highly responsible on deadline. Any mistake in real time distributed system can cause a system into collapse if not properly detected and recovered at time [10]. Fault-tolerance is the important method which is often used to continue reliability in these systems. By applying extra hardware like processors, resource, communication links hardware fault tolerance can be achieved. In software fault tolerance tasks, to deal with faults messages are added into the system. Distributed computing is different from traditionally distributed system [7]. Fault Tolerance is important method in sensors because sensors are distributed geographically in this system under different geographically domains throughout the web wide. The most difficult task in sensor networks is design of fault tolerant is to verify that all its reliability requirements are meet [12]. Wireless Sensor Network must be fault tolerant. It should be able to continue in its functioning in the presence of faults. Most of the faults are related to dependability.

2. REVIEW OF LITERATURE

In paper [1] focused on the theoretical aspects of clustering in wireless sensor networks, as a mean to improve network lifetime. They investigate whether clustering itself (with no data aggregation) can improve network lifetime in particular application when compared to non-clustered networks. To analyze 1D and 2D networks, taking into account capabilities of real-life nodes, they use integer linear programming. Results show that clustering itself cannot improve network lifetime so additional techniques and means are required to be used in synergy with clustering.

In paper [2] proposed an improved routing algorithm based on LEACH protocol which involves choosing of cluster head, multi-hop routing and the building of its path. Let energy of every node is equal which leads to equal chance of becoming cluster head of every node. Once a cluster head is selected, then it will broadcast this message containing ID of cluster head. Interesting nodes will join this cluster head by sending message to cluster head containing current energy, cluster head's ID and their selves ID. Average energy of cluster is calculated. If for next round, node having larger current energy than average energy, then it will select as cluster head. If the nodes are nearer then less energy will consumed. In this cluster head near to base station are connected with base station and so on all the cluster head's are connected with each other by multi-hope route. Energy utilizing rate is higher in this improved routing algorithm, and network's lifetime is increased.

In paper [3] proposed a Tree-Based Clustering approach for increasing the lifetime of network. In this, load is distributed among all the sensors in the network. Firstly, cluster head is decided with the help of leach protocol. Random number of node is compared with the preset threshold, if it is smaller than node will become cluster head for current round. Otherwise, it will be not. Chance of every node to become cluster head exactly once is ensured by this algorithm within 1/p rounds where p is the probability of being a cluster head. After that tree is constructed with all member nodes. Every node has some level which is determined in first step and on the basis on these levels tree is constructed. After that, data is collected and phase of transmission will start. Collected data is sent to the parent node by each other nodes during preallocated time by cluster head.

In paper [4] proposed a highly resilient, energy efficient multipath routing. From the failure of the shortest path between source and sink, energy efficient recovery is to be done by constructing two kinds of multipath which is called disjoint multipaths and braided multipaths. In Disjoint multipaths, alternate paths are constructed which are node-disjoint with primary path. Alternate paths have larger latency as compared to the primary path. In Braided multipaths, alternate paths are not completely disjoint with primary paths. Node disjointedness is the main requirement in disjoint multipaths but this requirement of disjointedness in braided mulitpaths is not necessary. For energy efficient recovery from failure in wireless sensor networks, these multipaths are used. Braided multipath is a viable alternative for energy-efficient recovery from isolated and patterned failures.

In paper [5] discussed that the communication in the WSN. The data received by the nodes of wireless sensor Networks should be sent to the sink. It helps to performing calculations and making the right decisions. The density of data packets increases near the sink. This scenario is known as the Energy Hole. In the WSN the problem of energy hole should be reduced. It is the one of the key factors for designing large scale wireless sensor networks. The multiple sink model is used to reduce the problem of energy hole. It is done by increasing the number of nodes in the vicinity of the sink. This model consists of different levels of sink intensity. The sensor nodes are responsible for processing their surroundings. It sends the collected data to a specific node called sink. The energy maintenance plays a significant role in consistency of these networks.

3. FAULT DETECTION TECHNIQUES IN WSN

There are many fault detection techniques are available. The main function of fault detection is to verify the services being provided are carrying out appropriately and in some cases to calculate if they will continue to function properly in the near future [8]. The simplest way to carry out such a task is through visual observation and manual removal of incorrect values. The main techniques are:

1. Self Diagnosis: There are some cases in which node failure can be detected by performing self diagnosis. A comparable approach, nodes could identify when they are being moved to a different location. Moreover there is another approach to emulate the identities of the nodes in the neighborhood. A cosmetic change in the neighborhood could point to that either the node itself or some of its previous neighbors have been moved.

2. Group Detection: The detection of services failing due to incorrectly generated values is only possible if a reference value is available. In detection mechanisms are proposed to identify faulty sensor nodes. Both algorithms are based on the idea that sensors from the same region should have similar values unless a node is at the boundary of the event-region. The algorithms start by taking measurements of all neighbors of a node and uses the results to calculate the probability of the node being faulty.

3. Hierarchal Detection: The definition of a detection tree enables a scalable fault detection algorithm in WSN. It is proposed that the usage of the network topology to forward the fault detection results of child nodes to the parent nodes and up to the sink. Each node forwards the status of the child nodes that it is monitoring to its parent node. The parent performs an aggregation (bitwise OR) operation on the results of the child nodes together with its on results and forwards it to the next level [9].

3.2 Neural Network: Artificial neural network is composed of interconnecting of artificial neurons. Artificial neural networks may either be used to gain understanding of biological neuron or to solve artificially intelligence problems without creating any model [1].

3.2.1 **3.2 Boltzmann Learning** :A restricted Boltzmann machine is a two-layer undirected graphical model where the first layer visible units are held to values given by the teacher and second layer are unlearning component (where the output units are free to vary) The visible layer is fully connected to the hidden layer via pair-wise potentials, while both the visible and hidden layers are restricted to have no within-layer connections [2].BM is a stochastic recurrent neural network consisting of binary neurons arranged in two layers. Each neuron v_i in the visible layer is connected to all the hidden neurons, and each neuron hj in the hidden layer is connected to all the visible neurons. It can be denoted by v a binary column vector containing the states v_i of the visible neurons and similarly by h a vector of hidden states hj.

4. PROPOSED METHODOLOGY

In this work our main concern is reclustering the grids using neural networks. In the present work clustering of grids is static but in our work clustering of grids is dynamic. It can be adjustable and changeable according to the situation. In this node data which is send can be easily adjustable according to the situation and calculation made on the basis of battery consumption. Here main concern is to avoid battery wastage. The cluster head is also choosing according to the minimum battery consumption by applying election algorithm.

Suppose we have a network in which number of batteries are placed. Each battery has the data send capacity in milliampere. We considered that we have number of batteries available and each battery further forward data from source to destination. AODV algorithm is used in it. We have three clusters in which we have three cluster heads present. Cluster heads choose according to the maximum sending capacity and minimum battery consumption. The battery which satisfies both the above mentioned technique that will be head of that cluster.

Algorithm: START ()

1. Deploy sensor network with fixed number of sensor nodes
2. Apply location based clustering to cluster sensor nodes
3. Select cluster head in each cluster using LEACH protocol
4. If (link failure occurred in the network)
   {
   1. Apply Boltzman learning to rate sensor nodes
   2. Recover path through sensor nodes which has higher rating
   }
   Else
   {
   1. Start communication from source to destination
   }

STOP

5. EXPERIMENTAL RESULTS

The whole scenario has implemented in NS2 simulator.

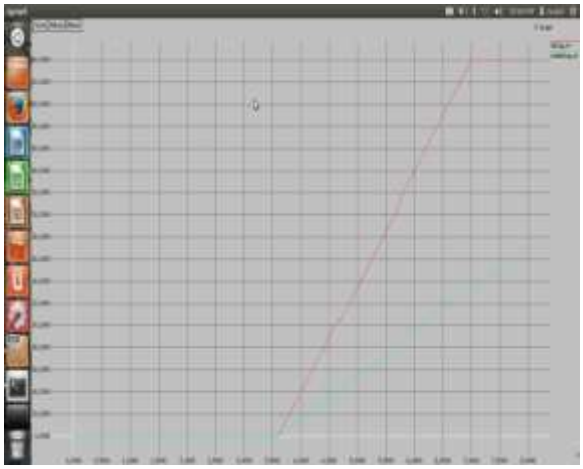

Fig.1 Delay graph

As illustrated in figure 1, the delay graph has been plotted in which the delay of the previous scenario and new scenario is shown and compared. The graphs represents the delay in the new simulation will be reduced by 30 % due to fault removal in the network.

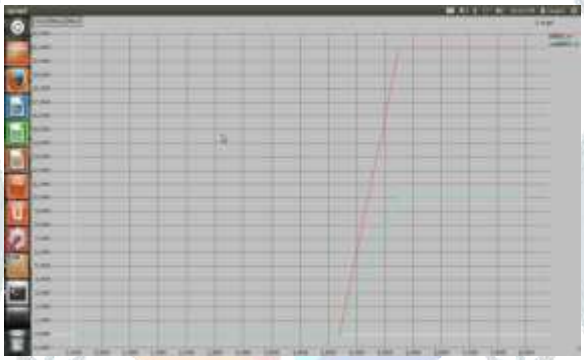

Fig.2 : Energy

As shown in figure 2, the energy consumption of the previous and new scenario is compared. The graph clearly represents that energy consumption of old scenario is more due to fault in the network. When fault is removed from the network energy consumption is reduced from the network.

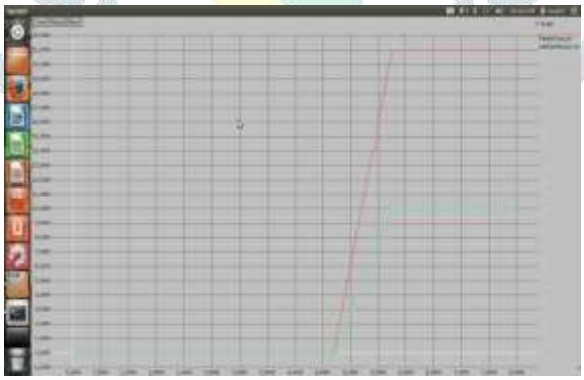

Fig.3 Packet Loss

As shown in figure 3, packet loss of the previous and new scenario is compared. The graph clearly represents that packet loss in the old scenario is more due to fault in the network. When fault is removed from the network packet loss is reduced from the network.

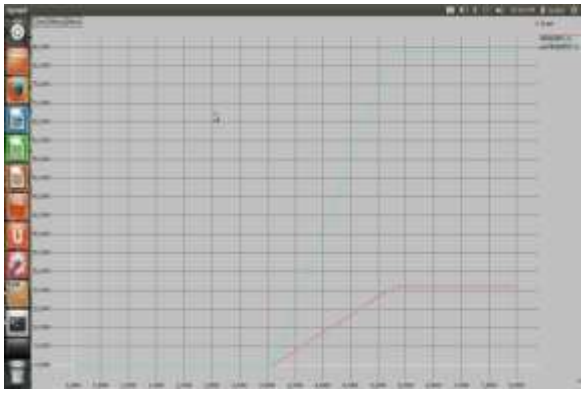

Fig 4: Throughput Graph

As shown in the figure 4, the throughput comparison of the old and new scenario is shown. Due to fault in the network, the throughput of the old scenario gets reduced. When fault will be recovered from the network throughput of the network gets increased.

6. CONCLUSION

In this work, a novel technique has been proposed which is based on neural network and other techniques. To reduce the overhead in dynamic clustering and to increase lifetime of the sensor network, cluster heads are changed using the approach of neural network technique has applied like Knowledge Based Learning to decrease battery consumption of the network. In the previous work, static clustering of grid had been used. But in this research work, clustering of grid is dynamic. It can be adjustable and changeable according to the situation. In this node data which is send can be easily adjustable according to the situation and calculation made on the basis of battery consumption. Here main concern is to avoid battery depletion. The cluster head is also choosing according to the minimum battery consumption by applying election algorithm. Suppose there is a network in which number of batteries a replaced. Each battery has the data send capacity in mill ampere. It is considered that there are number of batteries available and each battery further forward data from source to destination. The routing algorithm which we have used in this work is AODV. There are three clusters having three cluster head. Cluster heads are chosen according to the maximum sending capacity and minimum battery consumption of the node. The implementation of this research work has done in Ns2 and simulation results show that novel technique has increased the network throughput and network lifetime.

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