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Routing Optimization of WSN using Feed Forward Neural Network to Reduce Energy Consumption

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Abstract : *In this paper, demonstrates self healing capability to the fault recovery process for each cell. It is proposed to compensate cells in failure by neighboring cells optimizing their coverage with antenna reconfiguration and power compensation resulting in filling the coverage gap and improving the QOS for users. The right choice of these reconfigured parameters is determined through a process involving fuzzy logic control and reinforcement learning. Results show an improvement in the network performance for the area under outage as perceived by each user in the system. The proposed method uses a fuzzy logic approach for clustering using the two parameters of energy level and centrality supported by a controller in order to avoid unwanted concentration of cluster heads in a particular region. Maximum energy is saved in the process of assigning nodes to cluster heads. So there is a significant increase in network life time.*

Keywords: *Wireless sensor networks; Feed forward Neutral network; Signal-to-noise ratio; Fuzzy logic.*

1. INTRODUCTION

A common sensor network is composed of a large number of sensor nodes which are densely deployed either inside the phenomenon or very close to it. The position of sensor nodes need1 not be engineered or predetermined. This allows random deployment in inaccessible terrains or disaster relief operations. On the other hand this also means that sensor network protocols and algorithms must possess self organizing capabilities because deploying and maintaining the nodes must remain inexpensive manually configuring large networks of small devices is impractical.

Self Healing Dependency Constraints:

There are often intricate coupling and complex dependency relationships among different parts of a system in modern large scale Wireless sensor Networks. Such dependencies incur constraints that must be under-stood and accounted for when composing self-healing services. Creating a methodology and run time framework that addresses these issues provides more effective self healing both in terms of performance and correctness. A key element of this approach is the dependency assessment. Basically four key types of dependencies which are call invocation, parameter consistency, control and implicit assumption dependencies. The invocation dependencies are often considered easy to identify via the explicit dependency relationships implied by function calls. However even these dependencies are more complex than implied by the top down call tree. Beyond these dependencies there is a collection of more complex dependencies that exist in many systems. These complex dependencies share similar traits for example they are often more implicit and cannot be easily traced from explicit function calls.

Problem Formulation

Routing is an important part in any wireless communication system. If any node failure occurs the protocol due to any sort of miscommunication over which the routing is getting done has to be updated simultaneously. There are two approaches of routing, static and dynamic namely. It is not necessary that the dynamic routing may provide the best optimal path. The problem of this research is to find the optimal path in case of any node failure with the help of the optimization algorithm feed forward neural network. Self healing from bugs and failures can be accomplished using components for detection, diagnosis and repair. As we know the transport layer is responsible for end to end error recovery and flow control. With an adaptive self healing mechanism the transport layer is more reliable in providing transparent transfer of data and voice traffic between two individual mobile users thus relieving the application software from any concern with providing reliable and cost effective Data transfer.

There is a basic problem is to wait the signal from transmitter to send to receiver side. It occurs when any node of the wireless network be damaged by some sort of circumstances in that condition the error rate and accuracy of the system be varied by the time consumed in the waiting for signal.

To formulate those problems it has to do:

1.) Throughput: - Throughput is the amount of data or items passing through the system, by increasing throughput the waiting probability of the signal is reduced.
2.) Bit Error Rate :- Sometimes the state of being wrong i.e. bit error is not accessed by the system in that condition it have to control bit error rate to give best optimization.
3.) Accuracy: - As by the waiting of the signal the accuracy of the whole system is reduced. So by routing optimization the accuracy of the system increased.

Neural Networks:

Neural networks are mainly inspired by the biological nervous systems, such as the brain of living organisms. A well trained neural network can predict situations and answer what if questions. Neural network based solutions include a wide variety of problems due to the fact that neural networks comprise of several sub-categories with different capabilities.

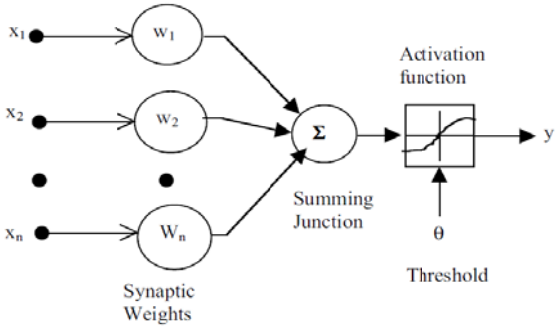

Fig. 1: Basic elements of artificial neuron

Network Management is a very complex problem with dynamic features and in the literature such problems are often addressed using Feed Forward solutions, which are static, requiring long training time and resulting in very big neural networks. To handle these issues, proposed the introduction of agents that integrate Recurrent Neural Networks, which have the ability to address problems with dynamic features, such as to adapt their function if the network topology changes. In a method for the prediction of resource availability is being proposed. More specifically for this solution two NN are being used, a Self Organizing Map for the real time visualization of the status of the communication network and a Multilayer Perception (MPL) or Evolving Fuzzy Neural Network (EFFUN), for the traffic prediction, trained from historic data. In failure detection algorithm is being proposed which is based on Feed Forward Neural Networks that collect data from a Management Information Database (MIB), using SNMP agents.

Artificial neural networks represent a well-established computational model, which can be used for solving complex tasks requiring large data sets. It is widely used in areas like data mining, web mining, bioinformatics or multimedia data processing. When solving these kinds of problems, we will concentrate especially on the speed of the learning and recall process and on the ability to generalize well the extracted knowledge. To satisfy these demands, adequate initial parameters of the model (learning rates, number of neurons and number of layers) are essential. For a given problem, especially the architecture of the model affects its generalization capabilities. Finding the optimal model consistent with the considered data thus constitutes one of the principle tasks of machine learning. Nevertheless, searching for an optimal architecture has more objectives than just an improved generalization and computational efficiency. It can also help create a transparent structure of the network. The main criticism of standard feed forward neural networks concerns the inability to explain easily the knowledge they have extracted. Therefore, some of the techniques used to optimize the architecture of BP-networks are not focused on finding the minimum number of neurons and weights but rather on forming a clear and transparent network structure. This simplifies the following knowledge extraction.

2. FEED FORWARD NEURAL NETWORK

Neural Network provides tools for designing, implementing, visualizing, and simulating neural networks. Neural networks are used for applications where formal analysis would be difficult or impossible, such as pattern recognition and nonlinear system identification and control. The Neural Network supports feed forward networks, radial basis networks, dynamic networks, self-organizing maps, and other proven network paradigms. Though a number of different kinds of neural networks exist I will be focusing on feed forward neural networks with one hidden layer. A feed forward neural network is a network where the signal is passed from an input layer of neurons through a hidden layer to an output layer of neurons. The function of the hidden layer is to process the information from the input layer. The hidden layer is denoted as hidden because it contains neither input nor output data and the output of the hidden layer generally remains unknown to the user.

The feed forward network with one hidden layer is one of the most popular kinds of neural networks. The one discussed in this article is known as a Multilayer Perceptron (MLP) which uses supervised learning. Some feed forward neural networks have more than one hidden layer but such networks are not common. Neural networks incorporate either supervised or unsupervised learning into the training. A network that is trained using supervised learning is presented with a target variable and fits a function that can be used to predict the target variable. Alternatively, it may classify records into levels of the target variable when the target variable is categorical. This is analogous to the use of such statistical procedures as regression and logistic Regression for prediction and classification. A network trained using unsupervised learning does not have a target variable. The network finds characteristics in the data that can be used to group similar

records together. This is analogous to cluster analysis in classical statistics. This article focuses only on supervised learning feed forward Multilayer Perceotron neural networks with one hidden layer. In the learning algorithm for the proposed network and the rules for updating the network weights and bias are congestion control parameters such as BER (Bit error Rate), RTT (Round Trip Time) are used. There are mainly two methods for training neural networks: a back-propagation-trough-time algorithm, feed forward learning algorithm. A feed forward neural network is a network where the signal is passed from an input layer of neurons through a hidden layer to an output layer of neurons. The function of the hidden layer is to process the information from the input layer.

Structure of a Feed Forward Neural Network:

The structure of a feed forward neural network with one hidden layer. The first layer contains the input nodes. Input nodes represent the actual data used to fit a model to the Dependent variable and each node is a separate independent Variable. These are connected to another layer of neurons called the hidden layer or hidden nodes, which modify the data. The nodes in the hidden layer connect to the output layer. The output layer represents the target or dependent variable. It is common for networks to have only one target variable or output node but there can be more. An example would be a classification problem where the target variable can fall into one of a number of categories.

Sometimes each of the categories is represented as a separate output node. Generally, each node in the input layer connects to each node in the hidden layer and each node in the hidden layer connects to each node in the output layer.

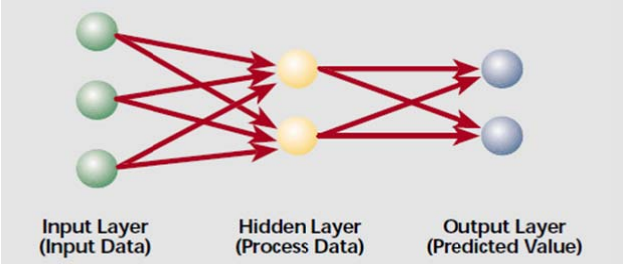

Fig. 2: Three layer feed forward neural network

The artificial intelligence literature views this structure as analogous to biological neurons. The arrows leading to a node are like the axons leading to a neuron. Like the axons they carry a signal to the neuron or node. The arrows leading away from a node are like the dendrites of a neuron and they carry a signal away from a neuron or node. The neurons of a brain have far more complex interactions than those displayed in the diagram but the developers of neural networks view them as abstracting the most relevant features of neurons in the human brain. Neural networks learn by adjusting the strength of the signal coming from nodes in the previous layer connecting to it. As the neural network better learns how to predict the target value from the input pattern each of the connections between the input neurons and the hidden or intermediate neurons and between the intermediate neurons and the output neurons increases or decreases in strength. A function called a threshold or activation function modifies the signal coming into the hidden layer nodes. In the early days of neural networks this function produced a value of 1 or 0, depending on whether the signal from the prior layer exceeded a threshold value. Thus the node or neuron would only fire if the signal exceeded the threshold a process thought to be similar to that of a neuron. It is now known that biological neurons are more complicated than previously believed.

A simple all or none rule doesn't describe the behavior of biological neurons. Currently activation functions are typically sigmoid in shape and can take on any value between 0 and 1 or between –1 and 1, depending on the particular function chosen. The modified signal is then output to the output layer nodes, which also apply activation functions. Thus, the information about the pattern being learned is encoded in the signals carried to and from the nodes. These signals map a relationship between the input nodes and the output nodes.

Methodology:

The methodology of optimizing the WSN routing is quite simple. In this contrast we would be defining the training set of feed forward in case of any failure occurrence while the transmission of the data through a wireless sensor network .First of all a training will have to be performed to let the system know what exact are the best possibilities of transmission . This trained system would be attained through Feed Forward method of Neural Network.

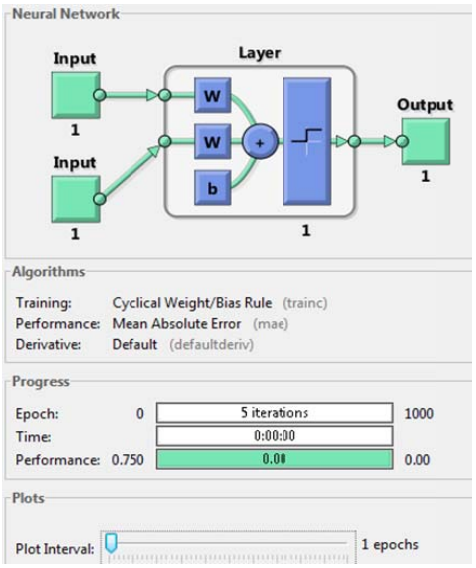

Fig. 3: Neural Network Tool

This method would consists of two parameters, first is the training dataset and another is the target set. The target set identifies the routes selected. At the time of the failure the trained model would be called along with the features of the failed node to search for an alternative to it. The Feed Forward method would return one or more than one probable path and out of them the minimum energy consuming path would be selected as the transmission path. A smart routing protocol, which enables self optimization, is used and in the Mac layer, radio resources are managed in a self-configurable and self-optimizing manner using learning Based strategies. Once the physical path is decided from the sender mobile station to a receiver mobile station, the self-protecting mechanism should protect channels from any unauthorized access and maintain overall stability. The methodology used in this is neural network designed which must be trained to optimize a TCP network performance measure and other wireless parameters. During network training, the weights and the bias are iteratively updated until they reach their optimal values.

From the literature survey it recognized that the bit error rate and signal to noise ratio are the major parameter that reduce the performance of the system. For that reason, this research is focused on the analysis of the signals in the noise environment. To use MATLAB simulation processes, finally compare our results with other researchers results those obtained by using different approaches and methods.

3. RESULT AND DISCUSSION

A cumulative distribution functions of downlink SINR measurements of all characterization of the system performance. The main theme of these results is to reveal the effectiveness of using our fuzzy reinforcement learning algorithm, controlling the antenna down tilt and transmit power autonomously to guarantee minimum Quality of Service for all users irrespective of unexpected events. Here the benchmark performance is 3dB which is a set threshold for this study

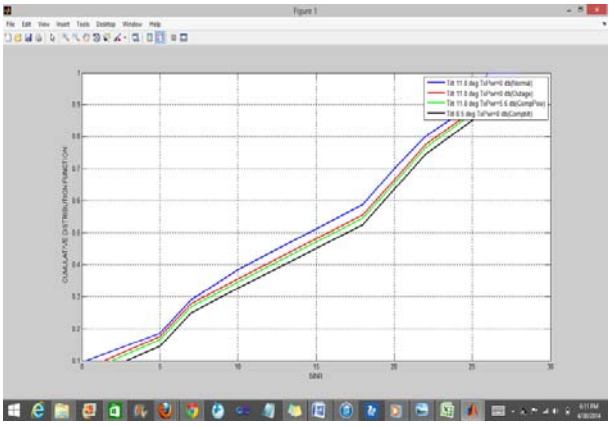

Fig. 4: Analytical result of the system for different angles of transmission

The above Fig. represents the analytical result of the system for different angles of transmission. The cumulative distribution function defines the vertical side of the graph and signal to noise ratio define the horizontal side.

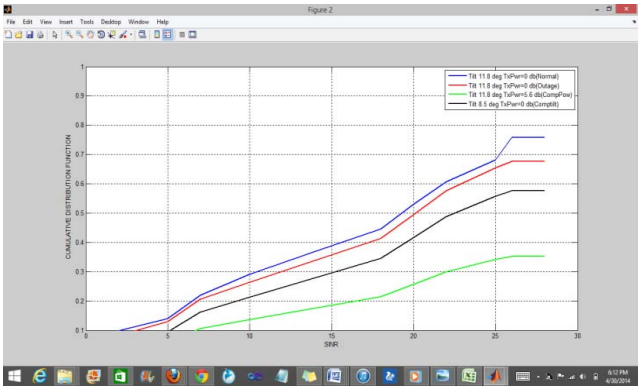

Fig. 5: Communicative Distribution function against Signal to Noise Ratio

The above Fig. represents communicative distribution function against Signal to Noise Ratio. There are basically 0 to 30 values for signal to noise ratio and 0 to 1 for cumulative distribution function. Total four types of tilts of different colors as normal, outage and comtilt.

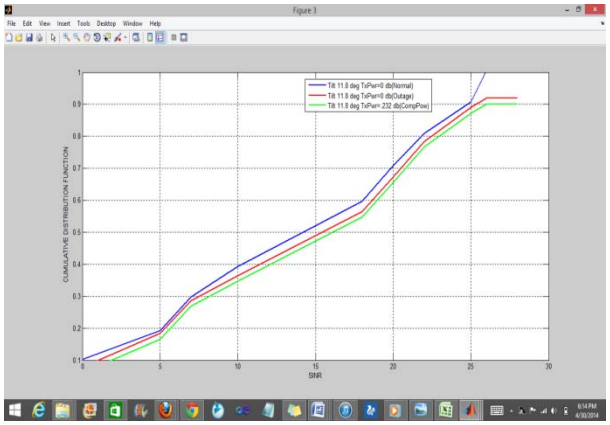

Fig. 6: Communicative distribution function against signal to noise ratio for different distribution angles

The above Fig. represents communicative distribution function against signal to noise ratio for different distribution angles. It is visible from Fig. 4, that the normal case 20th Percentile performance was 2.99dB. When there was an outage in the central site sectors 1, 2 and 3 the 20th percentile performance drops to 1.85dB and with compensation from neighbors using tilt optimization only, the system performance improves back to about 2.81 dB.

In this work we set out to show that a neural network is a viable method of implementing a learning mechanism for data communication networks. We have illustrated through the use

of a network simulator that a neural network can achieve great accuracy in predicting one particular network problem, namely congestion. We realize many more problems exist that for which this approach is applicable, but predicting congestion is just the first step towards our research goals. We also have shown one situation in which a carefully constructed neural network can achieve above average results when structural information about the actual data network is used to form.

4. CONCLUTION AND FUTURE SCOPE

Energy consumption level is a major challenge in Wireless Sensor Networks. The focus of many researches has been to lower the energy consumption level and consequently increase the network life time. The proposed method uses a fuzzy logic approach for clustering using the two parameters of energy level and centrality supported by a controller in order to avoid unwanted concentration of cluster heads in a particular region. Maximum energy is saved in the process of assigning nodes to cluster heads. So there is a significant increase in network life time.

During routing in the wireless sensor network if any node failure occurs the protocol due to any sort of miss communication over which the routing is getting done has to be updated simultaneously and enhance the performance of routing using feed forward neural network and some other software tools also like neural network etc. After all we can protect the data accuracy using the desired protocols at the time of failure. To automatically manage hybrid wireless networks, self optimization is given special attention for routing protocols. Because the topology of hybrid networks can change dramatically with routers potentially appearing and disappearing from the network, congestion or link failure increases with the number of node. A good self-managed protocol for routing packets with mobility support is desirable which is given by feed forward neural network in this work.

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