Energy Optimization of Wireless Sensor Network Using Neuro-Fuzzy Algorithms

ABSTRACT

Wireless sensor network (WSN) is one of the recent technologies in communication and engineering world to assist various civilian and military applications. They are deployed remotely in sever environment which doesn't have an infrastructure. Energy is a limited resource that needs efficient management to work without any failure. Energy efficient clustering of WSN is the ultimate mechanism to conserve energy for longtime. The major objective of this research is to efficiently consume energy based on the Neuro-Fuzzy approach particularly adaptive Neuro fuzzy inference system (ANFIS). The significance of this study is to examine the challenges of energy efficient algorithms and the network lifetime on WSN so that they can assist several applications. Clustering is one of the hierarchical based routing protocols, which manage the communication between sensor nodes and sink via Cluster Head (CH), CH is responsible to send and receive information from multiple sensor nodes and multiple base stations (BS). There are various algorithms that can efficiently select appropriate CH and localize the membership of cluster with fuzzy logic classification parameters to minimize periodic clustering which consumes more energy and we have applied neural network learning algorithm to learn various patterns based on the fuzzy rules and measured how much energy has saved from random clustering. Finally, we have compared to our Neuro-Fuzzy logic and consequently demonstrated that our Neuro-Fuzzy model outperforms than random model.

Key Words: ANFIS*, BS, *CH, WSN

INTRODUCTION

Nowadays technological advancements enable to produce and utilize large amount of sensor node with cheap cost (sajid Hussain & Islam, 2007). They have the ability to sense the environment, process the information and communicate to the nearest base station (BS). In Wireless Sensor Network (WSN), sensor node is a small tiny sensor device which has the ability to sense important information from the surroundings and use their communication component in order to transmit sensed data over a wireless channel to other nodes and to a designated sink node referred to as the BS. Due to the collaborative use of sensors multiple sensor nodes perform data processing in an interleaved fashion and communicate to the sink node to existing conditions. WSN has various benefits to control and support different application such as agriculture, traffic monitoring, environment and habitat monitoring, object tracking, fire detection and surveillance and reconnaissance (A. & Yaghmaee, 2012).

NEURO-FUZZY DESIGN

Despite the advantages, WSN have severely limited by energy constraint posed by sensor nodes. Energy consumption on wireless sensor node depends on the application we use and the place where sensor nodes located remotely. Energy depletion occurs while the sensor node gathers vital information from the environment, data processing and transfers of information to the neighbor node or sink. Therefore the major challenge is to select the appropriate CH by taking into consideration various parameters such as residual energy, number of neighbors, location (position) of node among others, proximity to BS, mobility factor and density of sensor nodes. Our research focus on optimization of energy consumption based on the hybrid of two algorithms Neuro and Fuzzy to select appropriate CH. The hybrid of the two known algorithms has been modeled on matlab toolbox known as ANFIS. It encompasses the framework of adaptive neural network to work on ANFIS. The fuzzy rules and membership functions have done based on the type of fuzzy sugeno inference system.

EXPERIMENTAL RESULT

We have demonstrated our experiment with network simulator based on the above parameters with 50 and 100 sensor nodes deployment respectively. We have done the experiment on two separate major scenarios. The first scenario considered that cluster election has been done randomly without the concern of energy and proximity to the base station issues and the second scenario has been considered that cluster election has been done on the residual energy, proximity to the base station and speed of the node in which their values determined with the Fuzzy Inference System (FIS).

We have measured the performance of the randomly deployed model with 100 sensor nodes and one BS. According to simulation result packet delivery ratio, number of packet sent and received has inconsistently changed with different mobility factors and their packet dropping rate and normalized routing overhead is high. As we compared with our Neuro-Fuzzy model with 100 sensor nodes their average and total energy consumption is high.

As shown in **Table 1**, the Fuzzy Clustering model has improved the performance of the random clustering mechanism. Because we have used fuzzy parameters namely proximity to sink, mobility factor with random motion and residual energy for CH elections as well as we used equal number of clusters. Consequently one can observe that the average residual energy of our Fuzzy clustering technique has outperforms very well as compared with random Model. The energy consumption of our model also has lower value, which has saved more energy in comparison with random clustering technique.

Table 1: 100 sensor node deployments on Random vs. Fuzzy model

	Random Model				Fuzzy Model			
Mobility Factor	Total Energy Cons.	Avg. Energy Cons.	Overall Residual Energy	Avg. Residual Energy	Total Energy Consumed	Avg. Energy Consumed	Overall Residual Energy	Avg. Residual Energy
1	15.7367	0.157367	9984.19	99.8419	13.6485	0.136485	9986.19	99.8619
2	30.6332	0.306332	9969.2	99.692	13.266	0.13266	9986.57	99.8657
3	38.8523	0.388523	9960.98	99.6098	18.8072	0.188072	9981.03	99.8103
4	42.1487	0.421487	9957.69	99.5769	13.6831	0.136831	9986.15	99.8615
5	33.6391	0.336391	9966.2	99.662	12.9782	0.129782	9986.86	99.8686
6	31.7673	0.317673	9968.07	99.6807	21.5049	0.215049	9978.33	99.7833
7	30.9875	0.309875	9968.85	99.6885	17.0155	0.170155	9982.82	99.8282
8	51.068	0.51068	9948.77	99.4877	18.5043	0.185043	9981.33	99.8133
9	103.901	1.03901	9896.02	98.9602	14.1877	0.141877	9985.65	99.8565
10	112.178	1.12178	9887.75	98.8775	13.8697	0.138697	9985.97	99.8597

CONCLUSION

Energy efficient clustering algorithms have been developing to optimize energy utilization of WSN. We proposed energy efficient equal cluster of Neuro-Fuzzy to elect CH in based on available energy, proximity to sink and mobility factor with different node speed to increase the network lifetime. According to the result we have confirmed that our model has performed very well. Because we have added more features during election of CH in related with mobility sensor nodes, communication range, sensing range, and node speed. Consequently we have increased the performance of our Neuro-fuzzy model.

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