Graphical User Interface based SOFTAODV Simulator for WANET using MATLAB/True time

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ABSTRACT

Wireless Ad Hoc Network (WANET) consists of multiple, possibly mobile, nodes, which maintain network connectivity through wireless communications without any fixed centralized backbone infrastructure. The nodes in an ad hoc wireless network are thin clients, powered by batteries with a limited energy which can acts as a node also and can work as router to forward the packets or information between source and destinations in a multiple hope manners. So to exchange the information between nodes Routing and power control protocols required to decide the path and to convey the information which must consume few amounts of powers. Performance Optimization of Ad hoc On Demand Distance Vector (AODV) routing protocol using Adaptive Neuro Fuzzy Inference System (ANFIS) on MATLAB has been presented in the paper. A toolbox TRUETIME is used with MATLAB for wireless network simulation. Algorithm is proposed which uses adaptive value for signal reach based on the transmitted signal power and the threshold value of the received signal strength employing soft computing technique viz. ANFIS. The comparison of Performance of routing protocol done between the classical AODV, Fuzzy based AODV and ANFIS based AODV was carried out using AODV Simulator.

General Terms

Ad-Hoc on Demand Distance Vector Routing Protocol, Wireless Ad-Hoc Network, Adaptive Neuro-Fuzzy Inference System

Keywords

AODV, AODV Simulator, ANFIS, MATLAB/ TRUETIME, WANET

1. INTRODUCTION

Ad-Hoc networking is a temporary network concept in wireless communications environment, which means that users wanting to communicate with each other form a temporary network, without any form of centralized administrative infrastructure. Each node participating in the network acts both as host and a router and therefore is willing to forward packets for other nodes for the specific routing protocol, which makes use of a routing protocol. Each node has to maintain some form of information regarding the network around it, and some algorithm monitoring the sending and receiving of data packets. Routing protocol is gives the supporting information regarding network conditions [1].

Characteristics of dynamic topology of WANET due to the mobility of the mobile nodes which demands for the routing protocol with some efficient new features to handle the situations of the WANET nodes and topological changes. The routing protocol must adapt the adaptability in the position quite frequently changes by the nodes in WANET. Due to power limited nodes, the routing protocol should try to minimize control traffic, such as periodic update messages, conserving memory, power and bandwidth resources. The main function of the routing protocol is to detect and maintain the optimal route to send data packets between a source and destination via intermediate node(s).

Routing Protocols can be categorized in three parts as: table-driven (Proactive), on demand-routing (Reactive) and Hybrid routing protocols [2]. Table-driven routing protocols processed on routing information is periodically updates to all the nodes so all nodes have an up-to-date view of the network. On-demand routing protocols trying to find a new route when it is required to send some packets from source to the destination. Hybrid routing protocols have the combine characteristics of proactive and reactive routing protocols and they try to achieve an balance between both categories of protocols.

2. AODV ROUTING PROTOCOL

AODV stands for Ad-Hoc On-Demand Distance Vector of a reactive type protocol, even though it still uses characteristics of a proactive protocol [3]. AODV has the features of Dynamic Source Routing Protocol (DSR) and Direct Sequence Destination Vector (DSDV), in the sense that it uses the concept of route discovery and route maintenance of DSR and the concept of sequence numbers and sending of periodic hello messages from DSDV [4, 5]. Routes in AODV are discovered, established and maintained only when it requires handling any packet transmission. To ensure loop freedom sequence numbers, which are created and updated by each node itself, are used. These allow also the nodes to select the most recent route to a given destination node.

AODV takes advantage of routing tables. In these it stores routing information of destination and next hop addresses as well as the sequence number of a destination. Next to that a node also keeps a list of the precursor nodes, which route through it, to make route maintenance easier after link breakage. To prevent storing information and maintenance of routes that are not used anymore each route table entry has a lifetime. If during this time the route has not been used, the entry is discarded [6].Each routing table entry contains the information of Destination, Next hop, Number of hops,

Destination sequence number, Active neighbours for this route, Expiration time for this route table entry.

3. SFTWARE TOOLS

MATLAB is a high performance language for technical computing. It integrates computation, visualization and programming in and easy to use environment where problems and solutions are expressed in terms of mathematical notation which solves many technical computing problems, especially those with matrix a vector formulation, in a fraction of the time it would take to write a program in a scalar language such as C [7].Simulink is a software package for modeling, simulating and analyzing dynamic systems. It supports linear and non linear systems, modeled in continuous time, sampled time, or a hybrid of the two. Systems can also be multirate i.e. have different parts that are sampled or updated at different rates. For modeling, Simulink provides a graphical user interface (GUI) for building models as block diagrams. It includes a comprehensive block library of sinks, sources, linear and non linear components and connectors, customization and creation own blocks by writing separate S-Functions.

TrueTime [8, 9] is a Matlab/Simulink-based simulator for networked and embedded control systems that has been developed at Lund University since 1999.The use of the Matlab/Simulink-based [The Mathworks, 2001] simulator TRUETIME, which facilitates co-simulation of controller task execution in real-time kernels, network transmissions, and continuous plant dynamics is described.

Figure 1(a) shows the AODV WANET Simulink model present in MATLAB/Truetime [8] and the Figure 1(b) shows the topology generated using that simulation model.
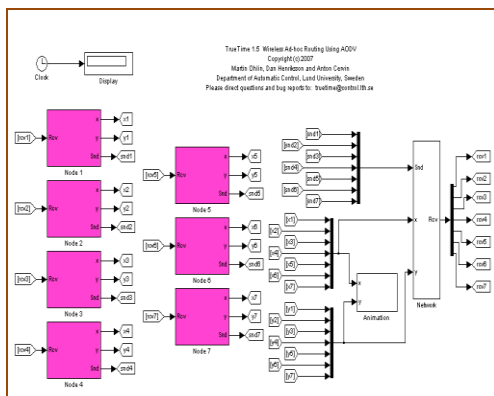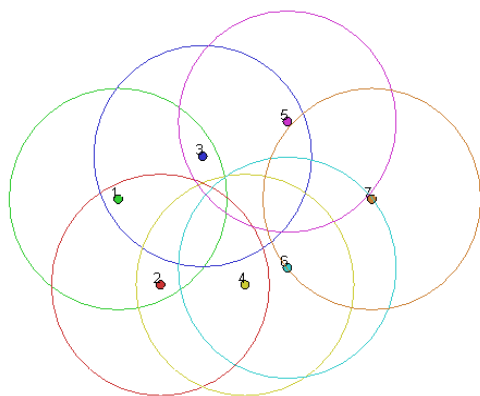

Fig 1(a): Simulink model in Truetime

Fig 1(b): Topology created by Simulink model in Truetime

3.1 ANFIS-AODV

The ANFIS derives its name from Adaptive Neuro-Fuzzy Inference System. Using a given input/output data set, the toolbox function ANFIS constructs a fuzzy inference system (FIS) whose membership function parameters are tuned (adjusted) using either a back propagation algorithm alone, or in combination with a least squares type of method. This allows your fuzzy systems to learn from the data they are modeling. The signal reach is also optimized using ANFIS with transmission power and threshold as input. Thus signal reach is output of the Neuro-Fuzzy system and inputs are transmission power and threshold shown in Figure 2(a) and ANFIS model structure in Figure 2(b).
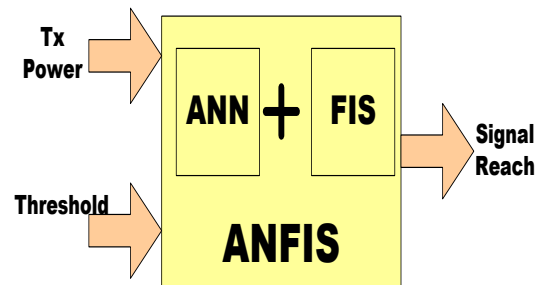

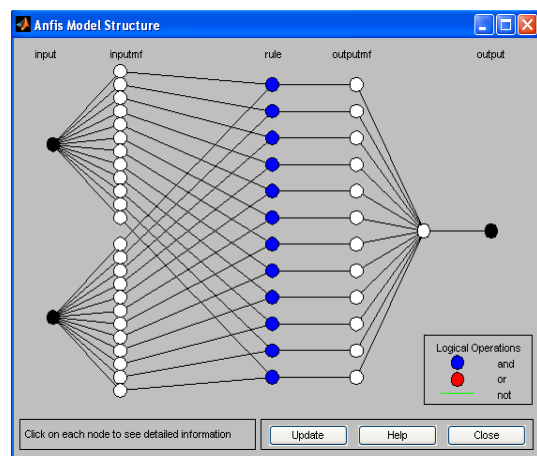**Fig 2(a): Block schematic of ANFIS**

Fig 2(b): ANFIS model structure

The simulation results were carried out using TrueTime toolbox of MATLAB. Wireless Ad-Hoc Network with random topology and 7 nodes was simulated. The model structure of AODV is considered as in [10]. The signal reach is optimized using fuzzy logic by using transmission power as input and threshold as other input of the system. With increase in transmission power and threshold, the signal reach is maximized. The fuzzy inference system with the inputs: as power, threshold and output as reach of signal from transmitter with mamdani type of inference system. The input1 and input 2 are transmission power and threshold respectively. The output of the system is signal reach [11].

The signal reach of AODV protocol is determined using ANFIS with inputs, transmission power and threshold. The implementation of ANFIS is accomplished using ANFIS editor available in MATLAB. The Sugeno type of inference system is used.

The MATLAB is used to load the training pairs decided by the Sugeno Fuzzy Inference System (FIS) to train the neural network using ANFIS Editor [12, 13]. The sub clustering option is used to generate FIS with 0.001 of error tolerance

and 10 epochs. The graph of error v/s epochs is as shown in Figure 3. The surface viewer for ANFIS editor is as shown in following Figure 4.
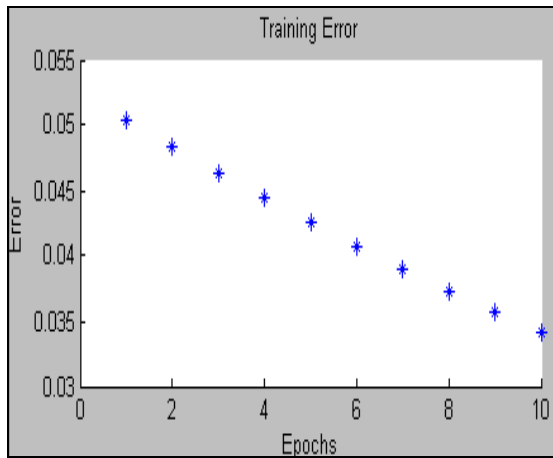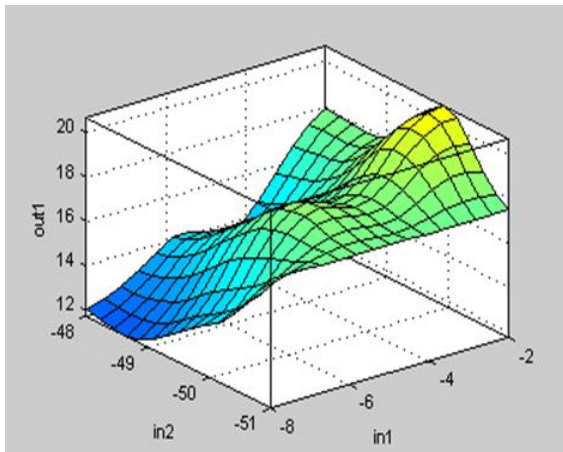

Fig 3: Error v/s Epochs

Fig 4: Surface viewer for ANFIS

3.2 Comparative Analysis: Classical & Soft AODV

The graph showing comparison between Simple AODV, Fuzzy AODV [11] and ANFIS AODV is as shown in Figure 5.
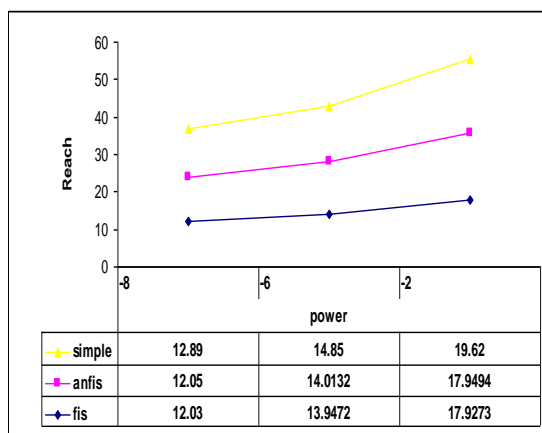

	power		
	-8	-6	-2
simple	12.89	14.85	19.62
anfis	12.05	14.0132	17.9494
fis	12.03	13.9472	17.9273

Fig 5: Comparisons between Simple AODV, Fuzzy AODV and ANFIS AODV

The Neuro-Fuzzy is also applied to the network for optimizing signal reach for AODV routing protocol. The inputs are same as that of fuzzy logic system [11]. The analysis of the results obtained with fuzzy system and Neuro-fuzzy system says that the signal reach was optimized more efficiently by Neuro-Fuzzy system than fuzzy logic system but not than the traditional AODV.

4. AODV Simulator: MATLAB/Truetime

A graphical user interface (GUI) [14] is a user interface built with graphical objects; the components of the GUI; such as buttons, text fields, sliders, and menus. The action that results from a particular user action can be made clear by design of the interface.
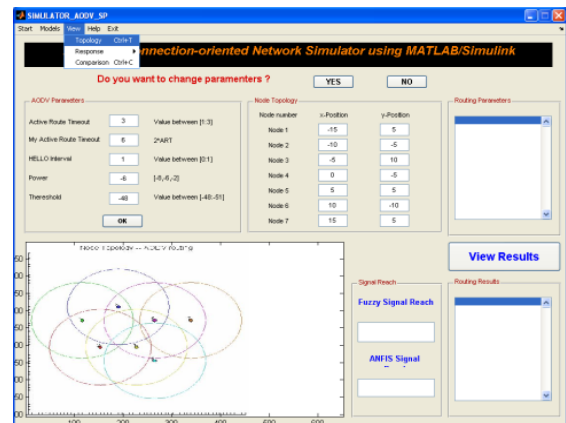

Fig 6: AODV Simulator: User Interface for Application

AODV Simulator shown in Fig 6 has facilities to change the parameters of the AODV protocol, to initialize the model with default parameters of AODV routing protocol, to set the various parameters of AODV and generate random topology, to view node topology and responses of various performance metrics like PDR, EED and RANGE, To run various models like simple AODV, Fuzzy AODV and ANFIS AODV through menu bar, to view results of workspace in list box like tout, x-position, y-position, route, threshold, power, received data, etc, Help menu to operate the designed simulator, Close menu to close all opened window related to simulator.
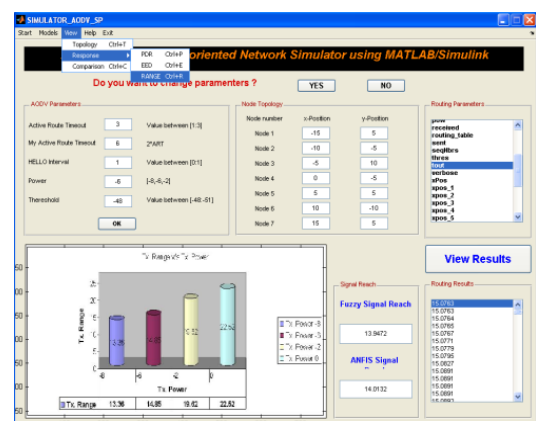

Fig 7: Snapshot of results in AODV Simulator

The node topology and comparison between various models performance viz. Traditional AODV, FUZZY AODV, ANFIS AODV can be seen through view menu. The node topology is displayed on axes of user interface; Selection of various models can be done through models menu, The response of

various performance metrics can be displayed from view menu, The results from workspace can be displayed by clicking on View Results, The graph of PDR, results of Fuzzy and ANFIS signal reach, workspace results are shown in Figure 7.

5. CONCLUSION

The Fuzzy and Neuro-Fuzzy is applied to the WANET for optimizing signal reach of the network which uses AODV routing protocol. The analysis of the comparison of results obtained with fuzzy system and Neuro-fuzzy system described that the signal reach was optimized more efficiently by Neuro-Fuzzy system than fuzzy logic system but not better than the classical AODV. Soft computing based Signal reach of AODV can be improved by applying genetic algorithm for training of ANFIS or we can apply ANN to decide signal reach. AODV simulator (Graphical User Interface) provides the better facility to compare the results, changing of the network topology and visualization of that result.

6. ACKNOWLEDGMENTS

7. REFERENCES

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