RESEARCH ARTICLE OPEN ACCESS

Design and Implementation of ANFIS to enhance the performance of Secure LAR Routing Protocol in MANETs

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ABSTRACT
Due to the limited resources in MANETs, energy consumption has increased when security is incorporated in LAR. To enhance the performance of FB-S-LAR neural network is used. In this paper, the performance of Adaptive Neuro-Fuzzy Based Secure LAR (ANFIS-S-LAR) Routing Protocol for Mobile Adhoc Networks is analysed. The result shows that the ANFIS-S-LAR performs better than the existing LAR and Secure LAR.
Keywords :— MANET, LAR, ANFIS, S-LAR, Fuzzy.

I. INTRODUCTION

A mobile ad hoc network (MANET) is a collection of mobile devices that can communicate with each other without the use of a predefined infrastructure. Location aided routing is one of the routing protocol where a source node estimates the current location range of the destination node based on last reported location information [3][7]. During the route discovery process, the route request messages are flooded in limited region known as expected zone which is expected to have the current location of the destination node. In this paper, we have fine-tuned the transmission range in order to minimize the energy consumption in security enhanced LAR protocol using Adaptive neuro-fuzzy inference system.

A. Fuzzy based secure LAR

Secure Location aided routing protocol (S-LAR) has implemented ECC cryptography. It is observed that the energy consumption has been increased due to the increase in the control overhead. In order to reduce the energy consumption transmission range is optimized using fuzzy inference system. Hence energy consumption has been reduced in secure LAR with fuzzy inference system.

II. LITERATURE REVIEW OF RELATED WORK

V.R. Budyal, in their paper entitled “ANFIS and agent based bandwidth and delay aware any cast routing in mobile adhoc networks”, proposed an adaptive neuro-fuzzy interference systems based multiple Qos constrained anycast routing in MANETs by using a set of static and mobile agents. The authors used three types of agents in their scheme: i. Static any cast manager agent, ii. Static optimization agent and, iii. Mobile any cast route creation agent. The simulation results demonstrated reduction in end-to-end delay and control overhead, besides improvement in packet delivery ratio and path success ratio when compared to short cut tree based any cast routing(SATR) in MANETs.

Ahmed Al-Hmouz, in their paper entitled “Modelling and Simulation of an Adaptive Neuro-Fuzzy Inference System (ANFIS) for Mobile Learning” presented Adaptive neuro-fuzzy inference system for delivering adapted learning content to mobile learners. Results show that ANFIS has been successfully implemented for learning content adaptation within different learning context scenarios. The performance of the ANFIS model was evaluated using standard error measurements which revealed the optimal setting necessary for better predictability.

Jyh-Shing Roger Jang, in their paper “ANFIS: Adaptive-Network-Based Fuzzy Inference System” presented the architecture and learning procedure underlying ANFIS (Adaptive-Network-based Fuzzy Inference System), a fuzzy inference system implemented in the framework of adaptive networks. The proposed ANFIS constructed an input-output mapping based on both human knowledge (in the form of fuzzy if-then rules) and stipulated input-output data pairs. In their simulation, they employed the ANFIS architecture to model nonlinear functions, identify nonlinear components on-linely in a control system, and predict a chaotic time series, all yielding remarkable results.

III. ROUTING PROTOCOL

A. *LAR*

The entire Location aided routing is one of the reactive routing protocol where a source node estimates the current location range of the destination node based on last reported location information. During the route discovery process, the route request messages are flooded in limited region known as expected zone which is expected to have the current location of the destination node.

B. Secure LAR

Secure Location aided routing protocol (S-LAR) has implemented ECC cryptography [9]. It is observed that the energy consumption has been increased due to the increase in the control overhead.

C. Fuzzy based secure LAR

In order to reduce the energy consumption transmission range is optimized using fuzzy inference system as described in [1]. Good amount of energy saving is observed in FZ-S-LAR.

IV. PROPOSED WORK

In this paper, energy consumption is further reduced using Adaptive Neuro Fuzzy Inference System. ANFIS model of the Secure LAR parameters is generated. It is observed that optimized transmission energy from ANFIS model will give further energy saving compared to FZ-S-LAR [1]. This paper discusses the ANFIS-S-LAR protocol.

V. IMPLEMENTING ANFIS BASED SECURE LAR USING MATLAB

A. *Adaptive Neuro-Fuzzy Inference System*

An adaptive neuro-fuzzy inference system (ANFIS) is a kind of artificial neural network that is based on Takagi–Sugeno fuzzy inference system. It integrates both neural networks and fuzzy logic principles and captures the benefits of both in a single framework [2][5].Its inference system corresponds to a set of fuzzy IF–THEN rules that have learning capability to approximate nonlinear functions. Hence, ANFIS is considered to be a universal estimator.

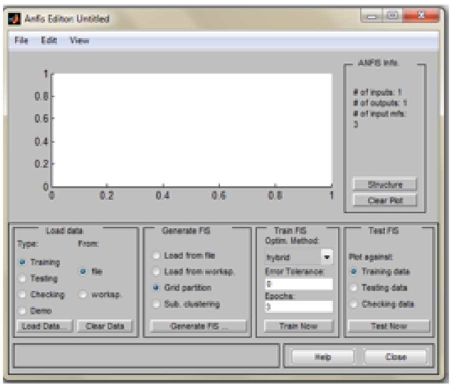

Fig. 1

Figure 1 depicts the training of parameters using ANFIS. Neuro-Fuzzy Sugeno model is used to model the FZ-S-LAR network. Selected parameters from previous stage are given to adaptive Neuro-Fuzzy system. The output of this system shows the optimized transmission range. Triangular Membership functions and Hybrid model is used as learning algorithm with two input and one output parameter for the model. Figure 2 shows the training data by ANFIS.

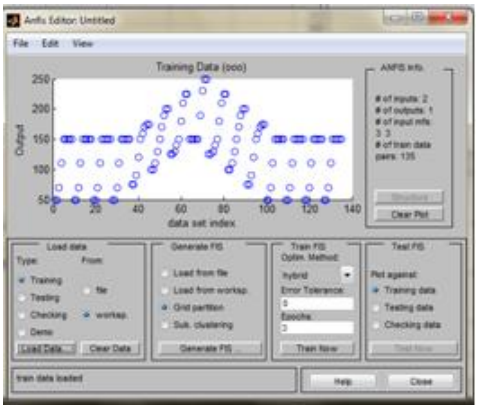

Fig. 2

Figure 3 shows the generated network model structure by ANFIS.

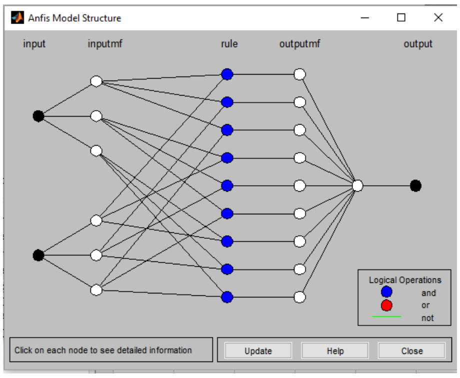

Fig. 3

Figure 4 shows the Rule editor of adaptive neuro-fuzzy inference system (ANFIS).

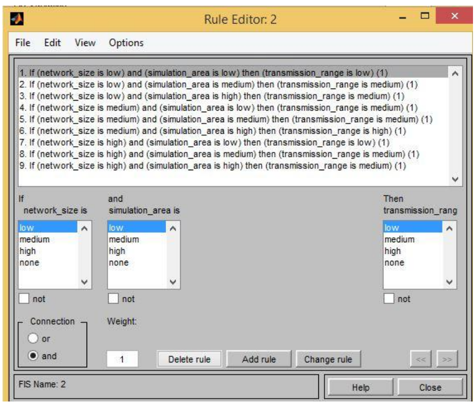

Fig. 4

VI. RESEARCH METHODOLOGY

To evaluate the designs proposed in this paper, an effort is made to choose the most suitable evaluation methodology. Three evaluation methodologies are identified as simulation, experimental and mathematical. Of these three methods, Simulation method is chosen for the present study, as experimental method is not practicable, while mathematical method is highly restrictive.

A. *Simulation Results and Analysis*

NS-2 is an open simulation environment for computer networking research that is preferred in the research community. It is aligned with the simulation needs of modern networking research. It encourages community contribution, peer review, and validation of the software.

Our simulation settings for NS2 are summarized in table below.

TABLE I
NS-2 SIMULATION PARAMETERS

Simulation Parameters	Values
Number of Nodes	27,65,87,100
Area Size	200x200,500x500,750x750
Routing Protocol	FZ-S-LAR, AN-FZ-S-LAR
Simulation Time	1000Sec
Propagation Model	Two Ray
Packet Size	256,512,1024
Mobility Model	Random Way Point
Speed	5m/s
Range	586,775,803,816,981,985,997,999

VII. PERFORMANCE METRICS

We evaluate mainly the performance according to the following metrics.

Average Packet Delivery Ratio: It is the ratio of the number of packets received successfully to the total number of Secure packets transmitted at each node.

Average Energy Consumed: Total energy consumed by all the nodes to the number of nodes.

Throughput: Total bytes received to the total bytes transmitted.

Overhead: Total protocol control bytes to the total data bytes transmitted.

Average End to end Delay: Average time take for the secure packets from send time to received time at the target node.

Figure 5 compares the average energy consumed for FZ-S-LAR and AN-FZ-LAR. Average 20% of energy saving is observed with AN-FZ-LAR when compared to FZ-S-LAR.

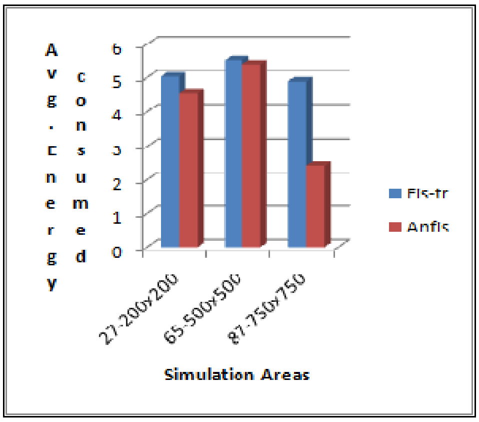

Fig.5

Figure 6 compares the throughput for FZ-S-LAR and AN-FZ-LAR. Average 0.7% throughput improvement is observed with AN-FZ-LAR when compared to FZ-S-LAR.

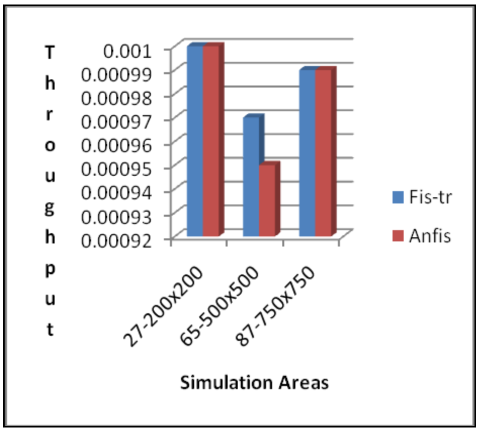

Fig.6

Figure 7 compares Average end to end delay for FZ-S-LAR and AN-FZ-LAR. Average 3% improvement of end to end delay is observed in AN-FZ-LAR compared to FZ-S-LAR.

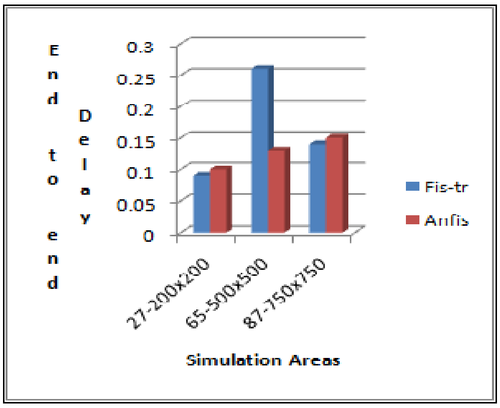

Fig.7

Figure 8 shows the comparison of Packet Delivery Ratio for FZ-S-LAR and AN-FZ-LAR. Average 0.3% of PDR improvement is observed in AN-FZ-LAR.

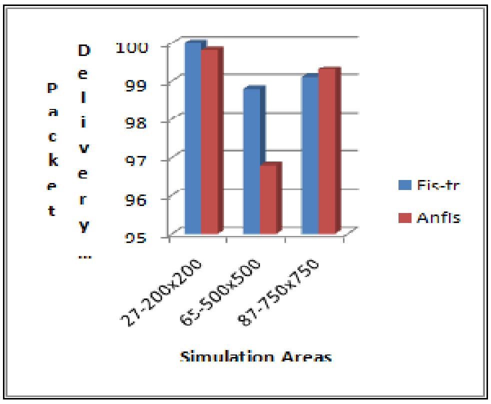

Fig.8

VIII. CONCLUSIONS

From the Simulation results it is concluded that AN-FZ-LAR total energy consumption decreases by 20% compared to FZ-S-LAR. Average 0.3% of PDR improvements is observed in AN-FZ-LAR compared to FZ-S-LAR. Further work can be done on optimizing the PDR and End to End delay of AN-FZ-LAR.

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