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Performance Comparison of AODV and Soft AODV Routing Protocol

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***Abstract*—**A mobile ad hoc network (MANET) represents a system of wireless mobile nodes that can self-organize freely and dynamically into arbitrary and temporary network topology. Unlike a wired network, wireless network interface has limited transmission range. Routing is the task of forwarding data packets from source to a given destination. Ad-hoc On Demand Distance Vector (AODV) routing protocol creates a path for a destination only when it required. This paper describes the implementation of AODV routing protocol using MATLAB-based Truetime simulator. In MANET's node movements are not fixed while they are random in nature. Hence intelligent techniques i.e. fuzzy and ANFIS are used to optimize the transmission range. In this paper, we compared the transmission range of AODV, fuzzy AODV and ANFIS AODV. For soft computing AODV, we have taken transmitted power and received threshold as input and transmission range as output. ANFIS gives better results as compared to fuzzy AODV.

***Keywords*—**ANFIS, AODV, fuzzy, MANET, reactive routing protocol, routing protocol, Truetime.

I. Introduction

WIRELESS networks are classified into infrastructure networks and ald-hoc networks. Wireless network can be classified into three categories 1) Mobile ad-hoc network 2) Wireless mesh network 3) Wireless sensor network. In an infrastructure network, all nodes communicate through access point where the access point is a central coordinator for all nodes [1]. Mobile Ad-hoc network is a decentralized type of wireless network. The network is said to be ad-hoc because it does not depend on a pre-existing infrastructure like routers in wired network. An ad-hoc network typically refers to any set of the network where all devices have equal status on a network and free to associate with link range. The mobile ad-hoc network does not have a certain topology or a central co-ordination access point. A mobile ad-hoc network is a self-configuring infrastructure-less network of mobile devices connected by wireless ad-hoc means for this purpose. In MANET [2] each device is free to move independently in any direction and therefore changes its links to other devices frequently. MANETS possess certain characteristics like dynamic topology, limited bandwidth, frequent routing update, energy constrained operation.

Unlike wired network mobile ad-hoc networks having limited bandwidth. MANETs having more nodes require greater bandwidth, power, and memory to maintain accurate routing information; this introduces traffic overhead into the network as nodes communicate routing information, this, in turn, uses more battery power. There is no single protocol that fits for all type of networks perfectly. The protocols have been chosen accordingly to network characteristics such as density, size and mobility of nodes. There are three types of routing protocols i.e. i) Proactive routing protocols ii) Reactive routing protocols iii) Hybrid routing protocols. In proactive routing protocol, the routing table is updated every time. Due to this, there is more overhead in the proactive routing protocol. DSDV, OLSR, WRP, etc. are the examples of proactive routing protocols. In reactive routing protocol, the routing table is updated only when it required. In reactive routing protocol, there is less overhead as compared to the proactive routing protocol. A hybrid routing protocol is a combination of both proactive and reactive routing protocol. Examples of reactive routing protocols are AODV, DSR, ARA, etc. AODV is most widely used routing protocol because it is fast reactive routing protocol.

In this paper, Section II presents the overview of AODV. Section III presents Truetime toolbox. Section IV presents AODV simulation model, fuzzy and ANFIS AODV. Section V presents simulation results and analysis, and Section VI presents the conclusion.

II. Overview of AODV

Ad Hoc On-Demand Distance Vector Routing Protocol is a reactive type of routing protocol which is designed for networks having more number of mobile nodes. In AODV for each routing table entry, destination sequence number is used [3]. To establish and maintain an ad-hoc network, AODV enables multi-hop routing among participating mobile nodes.

For routing in the ad-hoc network, two types of routing algorithm are used i.e. distance vector and link state vector routing algorithm. AODV is based on the distance vector algorithm. In AODV every node has its routing table. When a node knows its path from source to the destination then it sends route reply to the source node. The basic message set consists of Route Request (RREQ), Route Reply (RREP), Route Error (RERR) and HELLO for link status monitoring. There are two types of mechanisms in AODV routing protocol i.e. route discovery process and route maintenance. The following steps of route discovery process are as follows:

1. When there is a need for a route from source to the destination then source node broadcasts an RREQ. Any nodes with a current route to the destination can unicast an RREP back to the source node.

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2. Route information is maintained by each node in its route table.
3. Information obtained through RREQ and RREP messages is kept with other routing information in the route table.

Sequence numbers are used to eliminate stale routes.

A. Path Discovery

When a node wants to send a packet to the destination node, it checks its route table to determine whether it has a current route to that node. If there is a route present, then it forwards the packet to the appropriate next hop toward the destination [4]. However, if the node does not have a valid route to the destination, it must initiate route discovery process shown in Fig. 1. To start such a process, the node creates an RREQ packet. This packet contains source node's IP address and current sequence number as well as the destination's IP address and last known sequence number [4]. A broadcast ID contained by RREQ, which is incremented each time the source node initiate RREQ.

For processing of the RREQ, the node sets up a reverse path entry for the source node in its route table. This reverse path entry contains the source node's IP address and sequence number as well as the number of hops to the source node and the IP address of the neighbor from which the RREQ was received. This is the way by which node knows how to forward an RREP to the source if one is received later.

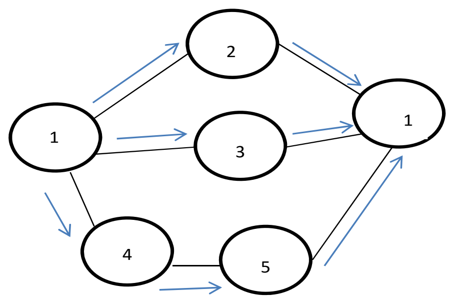


Fig. 1 Propagation of RREQ throughout the network

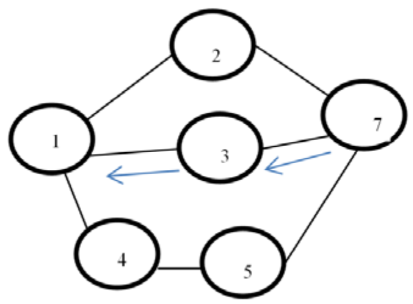


Fig. 2 Path determination from source to destination

B. Forward Path Setup

When a node found that it has a current route enough to respond to RREQ, it creates an RREP. The RREP sent in response to the route request contains the IP address of both the source and destination. When an intermediate node receives the RREP, it sets up a forward path entry to the destination in its route table [5]. For finding the distance from the source to the destination, the Hop count field is incremented by the source node. Forward path setup is shown in Fig. 3, when a node receives a route reply (RREP) for a given destination more than one neighbor. In this case, it forwards the first RREP it receives and forwards a later RREP only if that RREP contains a greater destination sequence number or a smaller hop count.

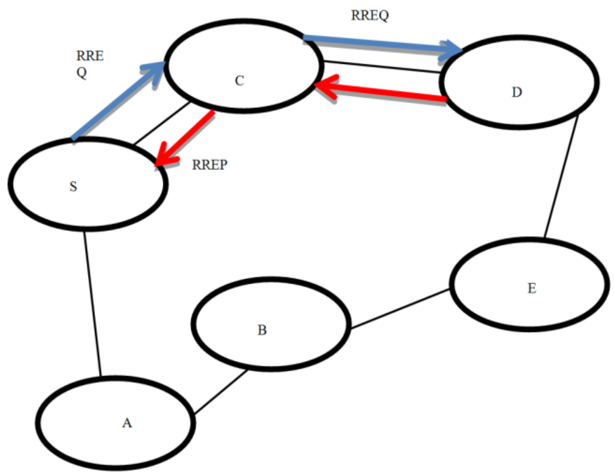


Fig. 3 Forward path setup

C. Path Maintenance

If a path has been discovered for a given source/ destination pair, it is maintained by the source node. Movement of nodes within the ad-hoc network affects only the route containing those nodes; such a path is called an active path. When any of the nodes moves either the destination or some intermediate node, however, a Route Error (RERR) message is sent to the affected source node. The RERR is initiated by the node which closer to the source node. When the neighbor's node receives the RERR, they mark their route to the destination as invalid by setting the distance to the destination equal to infinity and in turn propagate the RERR to their precursor nodes. When a source node receives the route error, it can reinitiate route discovery if the route is still needed.

Various parameters of AODV are given certain time which is listed in Table I.

TABLE I
AODV PARAMETERS

Parameters	Values
Allowed hello loss	2
Active route time out	3000 ms
Received Threshold	-49 dB
Transmission power	-8 to -2 dB
Hello interval	1 S

D. Performance Measuring Parameters

1.Packet Delivery Ratio

The ratio of a number of data packets is received verses the number of data packets to be sent.

2.Packet Drop Ratio

The ratio of a number of data packet dropped means the data packet which is not received by the receiver to the total number of data packets which are sent by the receiver. For better performance of routing protocol, packet drop ratio should be less.

3.Transmission Range

Transmission range defines up to how much long distance data can be transmitted.

III. True Time

Truetime is a MATLAB® Simulink based simulator for networked and embedded control systems. The simulator software consists of a Simulink block library and a collection of MEX files. Truetime library consists of 7 blocks shown in Fig. 4. The TrueTime kernel block simulates a real-time kernel executing user-defined tasks and interrupt handlers. The latest release, Truetime 2.0 beta, also features a couple of standalone network interface blocks that makes it simpler to develop networked control simulations [5], [6].

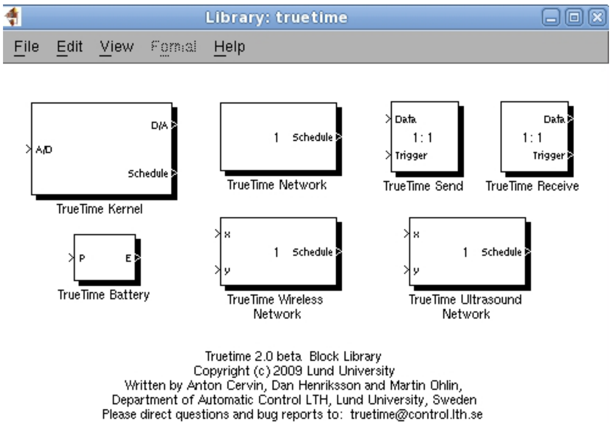


Fig. 4 Forward path setup

Programming of Truetime simulation is similar to the real embedded system. Programming is written in MATLAB® code or in C++.

A. Software Requirements for True Time

1. It currently supports MATLAB 7.x (R14 and later) with SIMULINK 6.x and MATLAB 6.5.1 with SIMULINK
2. A C++ compiler is required to run TRUETIME in the C++ version.
3. For the MATLAB version, pre-compiled files are provided in the archive that is downloaded from the TRUETIME web site.
4. The following compilers are currently supported:

a) Microsoft visual C++ 2010 express for Windows
b) gcc, g++ - GNU project C and C++ Compiler for LINUX and UNIX

The simulation results are carried out using Truetime toolbox of MATLAB. Wireless Ad-Hoc network with random topology and 7 nodes is simulated. The model structure of AODV is as shown in Figs. 6 and 7 show the random topology for the ad-hoc wireless network used for simulation.

IV. Simulation Model of AODV

The simulation results were carried out using Truetime toolbox of MATLAB. Mobile ad-hoc network with random topology and seven nodes was simulated.

A. Fuzzy AODV

Two inputs of fuzzy AODV are 'transmitted power' and 'received threshold', and output is 'transmission range'. The approximate fuzzy rule base is as given in Table II The domain of the membership functions i.e. transmitted power is in the range of -10 to 0 and threshold power is in the range of -51 to -47 and the output are in the range of 10 to 25. For fuzzy AODV, Mamdani fuzzy inference system is used. Here in Mamdani fuzzy inference system, we used triangular membership function both for input and output. [7], [8]

TABLE II
AODV Parameters

Pow / Thres	Low	Medium	High
Low	Low	Medium	Low
Medium	Medium	High	Medium
High	Medium	High	Medium

B. ANFIS AODV

ANFIS is an acronym stands for adaptive neural fuzzy inference system. ANFIS is multi-layer adaptive based fuzzy inference system [8]. Only Sugeno fuzzy inference system is used for ANFIS.

In Sugeno FIS there is always one output but in Mamdani, FIS output can be more than one [10]. In ANFIS, inputs and output are same as of Mamdani fuzzy inference system. ANFIS model structure is shown in Fig. 9 (b) and plot of training error v/s epoch is shown in Fig. 10. Training of ANFIS is done using a database of Mamdani fuzzy inference system.

For ANFIS model, the number of training epochs is 10 and training error tolerance sets to .001.

V. Simulation Result and Analysis

The simulation result shows the performance of AODV routing protocol. The performance metric transmission range is calculated by varying power for analysing the performance of AODV routing protocol [9], [10].

Fig. 11 represents AODV simulation results, which show the path of communication, the sending time and receiving time means the time at which the data is sent and received, node expiry time and status of messages. The performance metrics are calculated by varying the power. Graph of transmission range with the variation of the power of classical AODV is shown in Fig. 12. Comparison of the transmission range of AODV, fuzzy and ANFIS AODV is shown in Fig. 13.

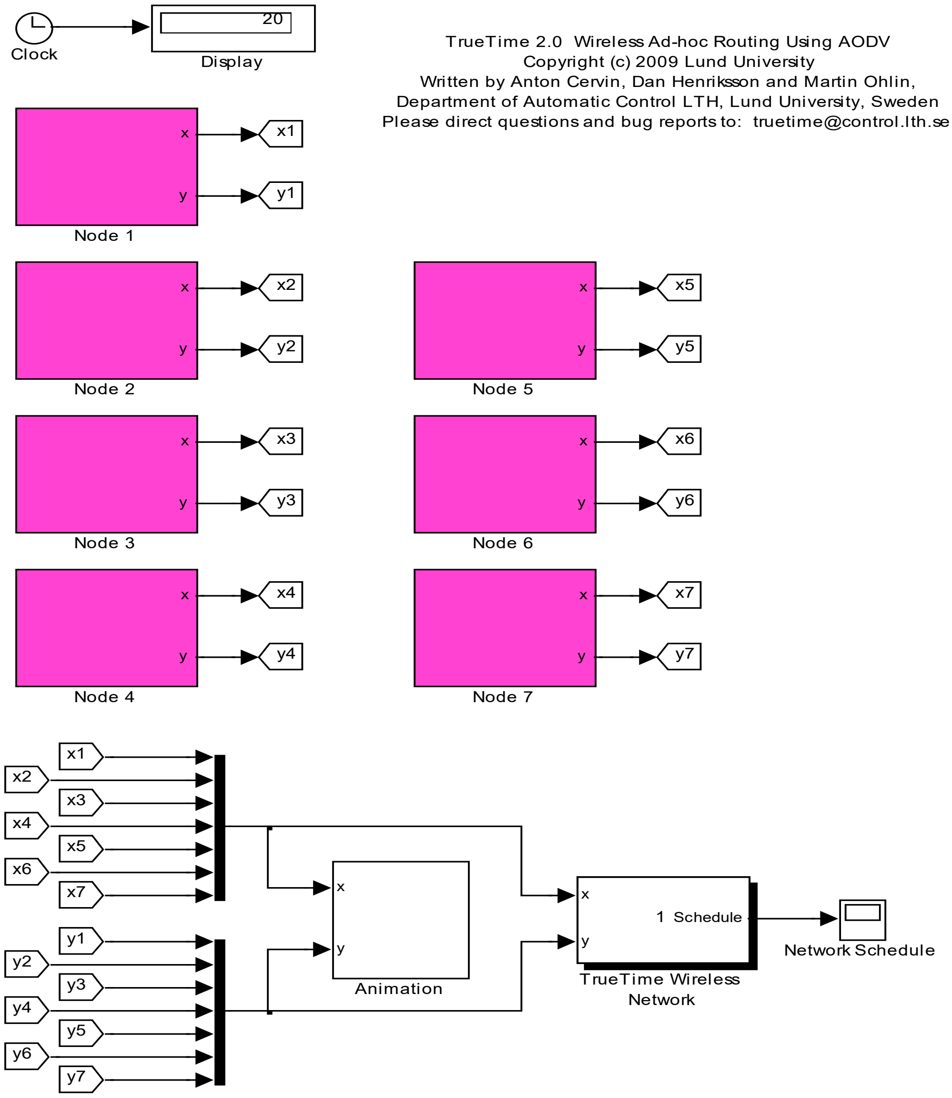


Fig. 5 Simulation Model of AODV

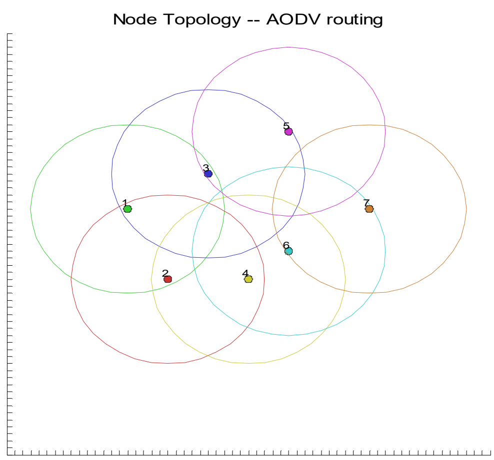


Fig. 6 Node Topology

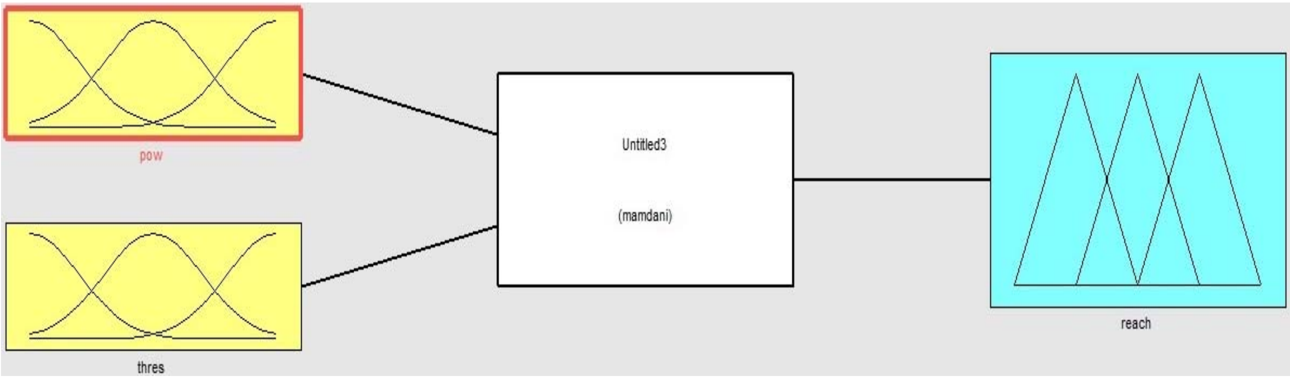


Fig. 7 Mamdani Inference Type of System

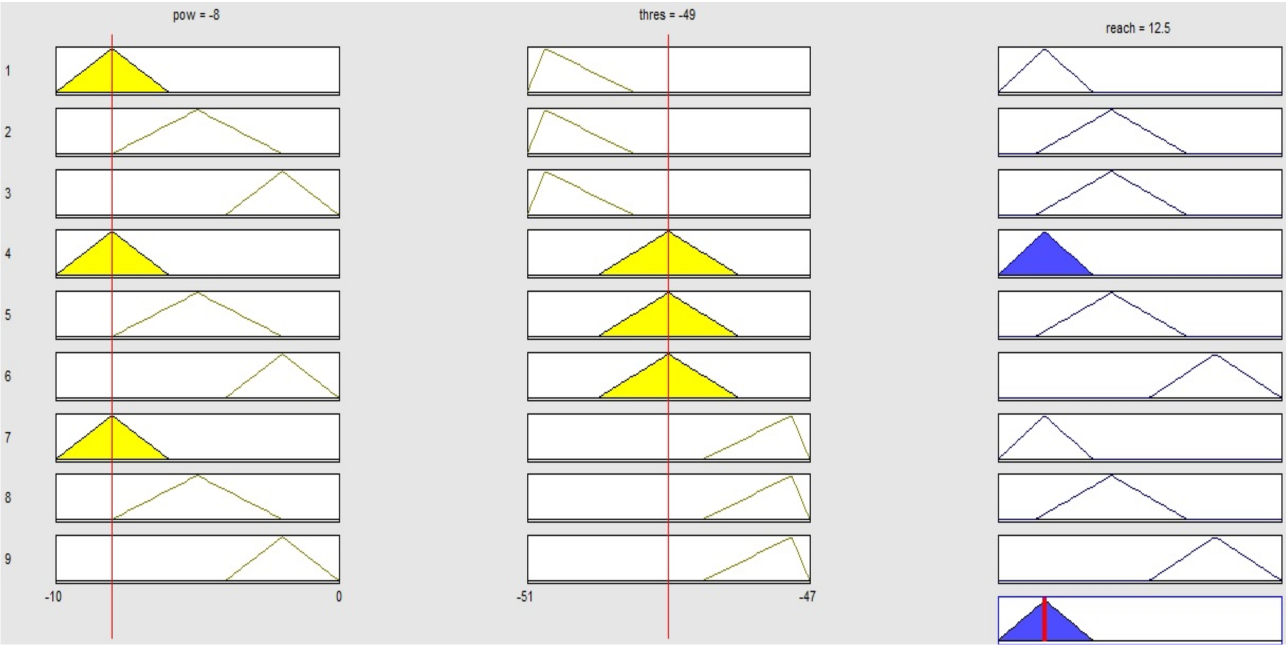


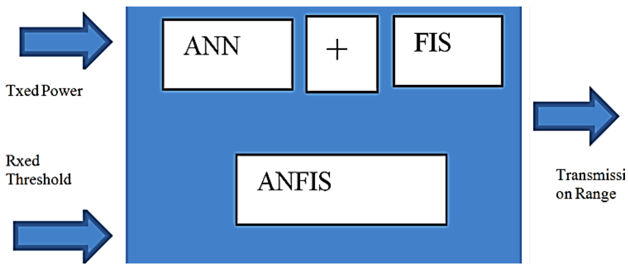
Fig. 8 Rule view of Mamdani fuzzy inference system

TABLE III
AODV PARAMETERS

Parameters	-8dB	-6dB	-4dB
AODV	13.84	15.93	18.31
Fuzzy	12.5	15	16
ANFIS	13.6	15.5	17.6

VI. CONCLUSIONS

Mobile ad-hoc network is a wireless network having decentralized administration. AODV routing protocol is most widely used in MANET because it is a fast reactive routing protocol and it has less communication overhead. Performance metric i.e. transmission range increases with increase in power. From simulation results, it is concluded that as the power increases the number of hops decreases to forward the packet from source to destination which results to decrease in the end to end delay. From the comparison, it is found that output i.e. transmission range is optimized efficiently in case of ANFIS than fuzzy but not better than classical AODV.



(a)

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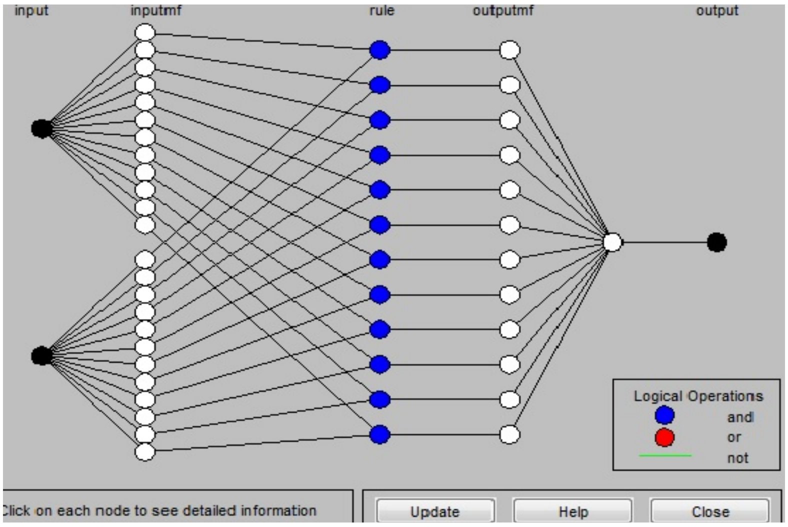

(b)

Fig. 9 (a) Block schematic of ANFIS (b) ANFIS model structure

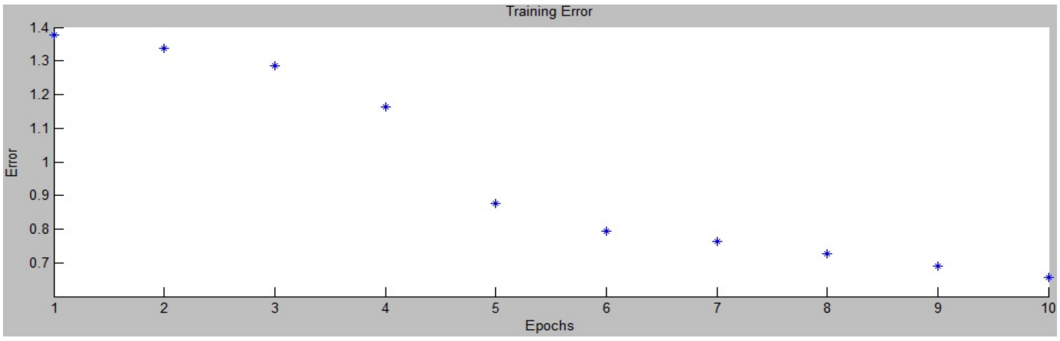

Fig. 10 Training error v/s epochs

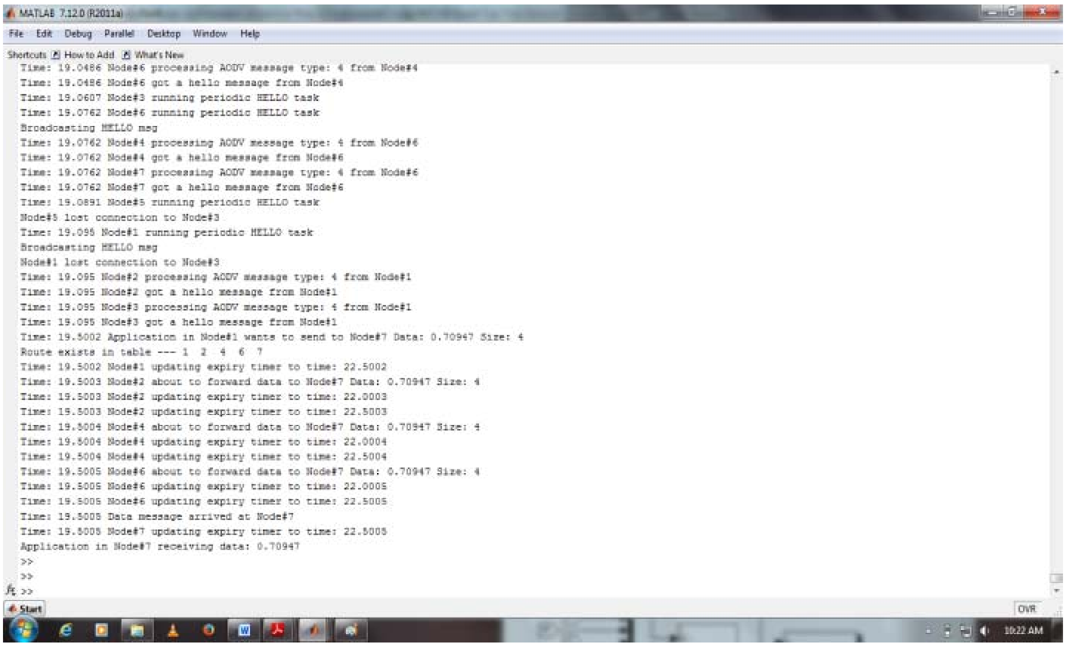

Fig. 11 AODV Simulation Results

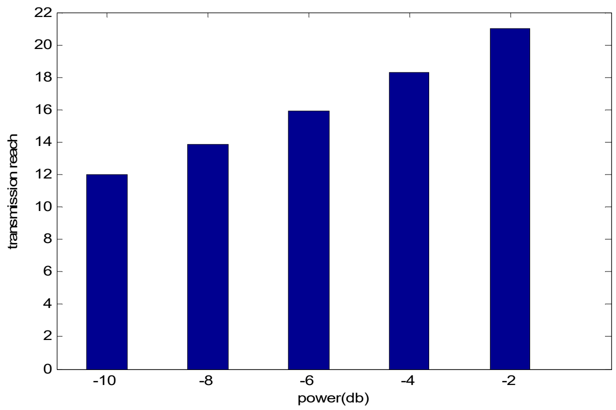

Fig. 12 Transmission Range

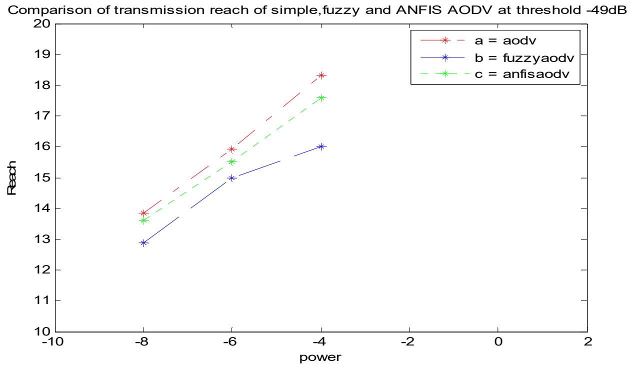

Fig. 13 Transmission range of fuzzy, ANFIS, and AODV

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