QoS Routing in Mobile Ad-hoc Networks using Agents

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Abstract: Quality of Service (QoS) provisioning in a Mobile Ad-hoc Network (MANETs) routing for multimedia traffic is a challenging task due to dynamic topology of such networks. Fuzzy Logic (FL) were used for QoS prediction from current uncertain QoS constraints in the network for particular applications, from these uncertain constraints there is an error at the QoS prediction. To overcome this error, we proposed an intelligent system called "Neuro-Fuzzy" (NF) system. Our proposed scheme optimizes the uncertain weights before QoS prediction using Error Back Propagation (EBP) algorithm, this optimization is done till to get acceptable error limit. From these optimized weights we can predict more accurately and hence, we can provide the well quality of service to the user. And also to provide real-time communication in MANETs, we used software agents.

Key words: MANETs, EBP, DSR, QoS, Neuro-Fuzzy, Software agents.

I. INTRODUCTION

During the last few decades, the world of personal computing has seen a paradigm shift. Technology that was until recently available only by the military or in research labs is now a common part of our everyday life. Mobile devices are gaining popularity both in business and for leisure and users can access a myriad of information on demand. A tourist visiting a foreign city can easily check the email, perform a video conference, download electronic maps and browse for the closest restaurant and more using handheld device. Lots of small devices in the environment communicate in pervasive computing, the communicating network provided by all mobile devices, referred as Mobile Ad-hoc Networks (MANETs)[1].

MANETs are autonomous systems of mobile hosts connected by wireless links, which provides communication anytime and anywhere. MANETs do not use any fixed infrastructure. The hosts are free to move around randomly, thus changing the network topology dynamically. If two mobile nodes are within each other's transmission range, they can communicate with each other directly; otherwise, the nodes in between have to forward the packets for them. Hence, in MANETs every mobile node acts as a router to forward the packets for others. Due to its dynamic nature it has many challenges. One of the important challenges is the routing, because of its need to guarantee a given level of Quality of Service to determine the path of a data flow based on knowledge of network resources availability.

For real-time multimedia communication, on-demand source routing algorithm is more suitable, because of its bandwidth and power constrained. Quality of service (QoS) provisioning is becoming a critical issue in designing wireless ad-hoc networks due to the necessity of providing multimedia applications in such networks. These applications are typically delay-sensitive and have high bandwidth requirements. Providing QoS in wireless ad hoc networks is challenging because the wireless channel is shared among adjacent hosts, and network topology can change as host's movement. Typical routing metrics for providing QoS include delay, jitter, bandwidth, and packet loss rate. QoS routing plays an important role in providing QoS aware services in wireless ad hoc networks. Fuzzy logic was used for QoS prediction, but accuracy of the prediction depends on the shape of membership function and hence there is an error at the prediction of QoS. Our proposed scheme provides optimized membership function for the approximation of QoS using Artificial Intelligent (AI) technique called "Neuro-Fuzzy". Agents are used in this scheme for providing real-time multimedia communication.

Organization of the paper: Section I provides the introduction on the QoS routing issue in MANETs. Section II discuses an overview of different schemes proposed in last decades for QoS routing. In section III, proposes a QoS routing scheme using neuro-fuzzy agents. Section IV provides a discussion on the simulation and results and finally section V provides the conclusion on the proposed scheme.

II. RELATED WORK

QoS routing has received attention recently for providing QoS for multimedia traffic in wireless ad hoc networks and some work has been carried out to address this critical issue. Here, we provide a brief review of existing work addressing the QoS routing issues in wireless ad hoc networks. Multiple paths routing has to achieving a good trade-off between success probability in route acquisition and protocol overhead [1]. It works by searching multiple paths in parallel for a QoS path.

Most of the routing protocols for mobile ad hoc networks, such as AODV [2], DSR [3], and TORA [4], are designed without explicitly considering quality-of-service of the routes they generate. QoS routing in ad hoc networks has been studied only recently [5, 6, 7]. QoS routing requires not only finding a route from a source to a destination, but a route that satisfies the end-to- ending QoS requirement, often given in terms of bandwidth or delay. Quality of service is more difficult to guarantee in ad-hoc networks than in most other type of networks, because the wireless bandwidth is shared among adjacent nodes and the network topology changes as the nodes move. This requires extensive collaboration between the nodes, both to establish the route and to secure the resources necessary to provide the QoS.

For selection of the QoS, based on the parameter constrained in the network is very difficult. In many research papers, they proposed fuzzy logic technique for QoS prediction. It has the better performance comparatively other technique, but the inputs to the fuzzy system are uncertain [8, 9]. So, we won't get required QoS. We were seen in many applications, the uncertain data sets are tuned to require one by using neural back propagation algorithm and hence in this paper, we used error back propagation algorithm [10].

III. PROPOSED WORK

This paper focuses on QoS routing in MANETs using neuro-fuzzy technique. Dynamic source routing (DSR) algorithm is extended to QoS based source routing for multimedia ad-hoc communication. For provisioning of QoS in ad-hoc networks, we proposed an intelligent scheme. To provide a QoS to the user by selecting a best path based on user requirement. we proposed an Artificial intelligent technique called "Neuro-Fuzzy". The main role of the NF is to get more Quality of Service (QoS) paths. The proposed NF scheme is shown in figure 1.

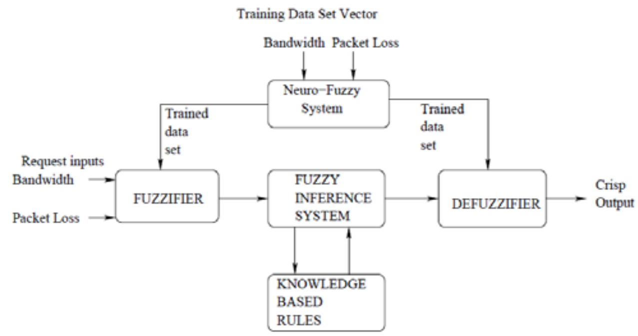

Fig. 1 Proposed Neuro-Fuzzy scheme (QoS agency)

Fuzzy logic is used while tracing in forward direction and backward propagation neural network learning technique which is used to tune the fuzzy membership functions. The parameters considered for Quality of Service (QoS) are Bandwidth (BW) and Packet Loss (PL). The Linguistic terms for bandwidth LOW, MEDIUM and LARGE and for packet loss LESS, NORMAL and MORE are used as shown figure 2 and 3.

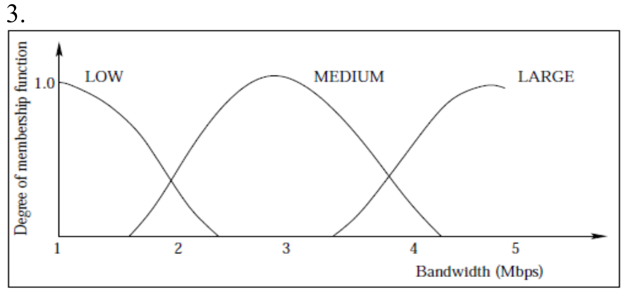

Fig. 2. Membership Functions for Bandwidth

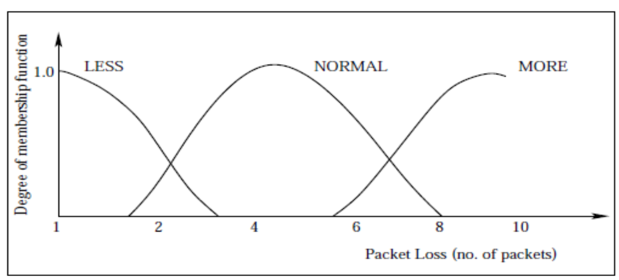

Fig. 3. Membership functions for packet loss rate

A. Error Back Propagation Algorithm:

The proposed multilayer structure of neural network is shown in figure 4. The mathematical mappings of forward and backward steps are as fallows.

Forward Output Calculation: In this, we compute the output at each neuron from inputs and link weights. The input training data set vector can be represented as,

$((x_1, x_2, x_3, ...xn), y)$ (1)

((x1(BW1, PL1), x2(BW2, PL2), ...xn(BWn, PLn)), y) (2)

The degree of membership values of both bandwidth and packet loss are considered as weights at the first layer of neural network. Those can be represented as,

BW1(L1,M1,H1),BW2(L2,M2,H2), ...BWn(Ln,Mn,Hn) (3)

PL1(L1,N1,M1), PL2(L2,N2,M2), ...PLn(Ln,Nn,Mn) (4)

At each layer the output can be computed using,

$y = \sum(W_iX_i - t)$ (5)

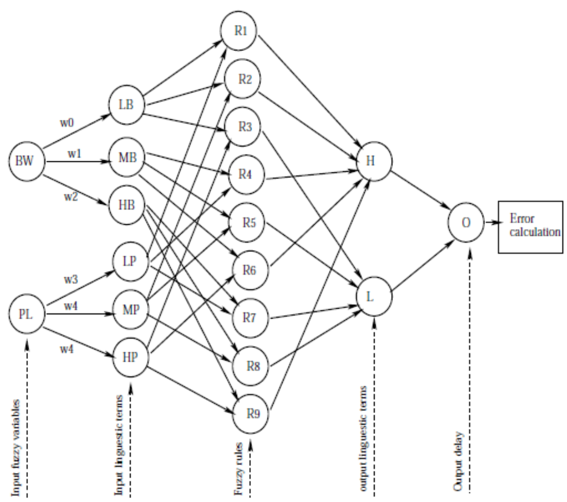

Fig. 4. Proposed multilayer structure of NN

Where, **t** is the, threshold level prescribed by user similarly, at all stage the output can be computed and at the 5th stage the error (E) can be computed using the bellow equation,

E = O(x)desired − O(x)output (6)

Where, O(x)desired is the desired output to get desired error. In this the desired error considered is 0.1. If the error at the output is not less than desired error then the calculated error can be propagated back through the neural network.

Backward Error Calculation: In this step, the error at each layer can be computed by using the Error equation,

$En = On(1 - On) \sum W_{nj}E_j$ (7)

where En is error associated with nth node, On is output of nth node, Ej is error associated with jth, wnj is a weight associated between nth and jth node.

After calculating the errors associated with each node the weights are updated using equation.

Where, $x_1, x_2, ...$ xn are training data set vectors and y is the desired delay. Every data set vector can be represented by,

Wjk(new) = Wjk(old) +aEk Xjk (8)

where Wjk = weight associated with the path connecting the jth element of the ith layer to the kth element of the (i + 1)th layer, a=learning constant, Ei+1 is error associated with the kth element of the (i + 1)th layer, xjk = input from the jth element of the ith layer to the kth element of the (i + 1)th layer. This forward and backward Procedure is repeated till the error is within the acceptable limits. After the training, the tuned membership functions for particular application are shown in figure 5.

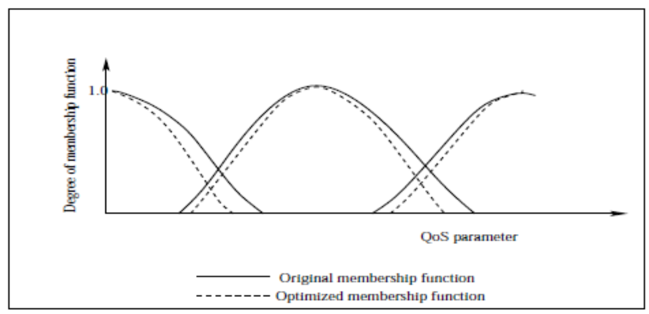

Fig. 5. Optimized membership function

Fuzzy Logic for QoS Prediction: After the training, this optimized data set is used to approximate the QoS level accurately using fuzzy logic. Rules generated by experience knowledge for this system are listed in table 1.

Packet loss / Bandwidth	LOW	MEDIUM	LARGE
LESS	HIGH	HIGH	HIGH
NORMAL	HIGH	HIGH	LOW
MORE	LOW	LOW	LOW

TABLE I: KNOWLEDGE BASED FUZZY RULES

From the above rules, the crisp output of the fuzzy system can be compared with crisp value of request that is to be generated in the network, if both are equal then that communication node has ability to handle QoS and this process is applied to all nodes, if all nodes in the routing path are satisfied then that path is the QoS path. After getting all QoS path, one of the best QoS is selected by the MANET. If any route failure then the route maintenance module will maintain the network according to dynamic source routing algorithm. In this paper, the extended DSR using NF is shown in algorithm.

Algorithm: QoS based DSR protocol using Neuro-Fuzzy agent

Begin

step 1: Optimize the Membership functions
by training of input data set vector using
error back propagation algorithm.

step 4: If QoS paths are present,
If only one QoS path,
than, start transmission of
packets through it.
else
Select One best QoS path and start the
transmission of packets through it.
else
update the network and go to step 2.

step 5: If any route failure,
then, start route discovery from
disconnected
node and go to step 3.
else
Update the network and go to step 2.

step 6: If any more requests,
then, go to step 2.
else
Update the network and go to step 2.

End.

B. Agent based QoS routing

The scheme uses a mobile agent to perform this operation. Every node in a network comprises of an agent platform. We assume that every node in a network maintains an agency for QoS routing. Agents which are used in the routing scheme are shown in figure 6.

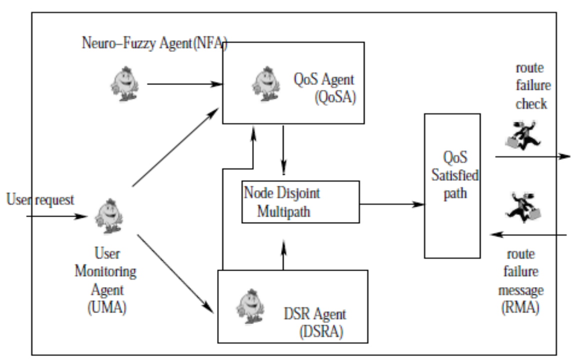

Fig. 6. Agent based QoS routing

- **User Monitoring Agent (UMA):** It is a static agent which is present in all nodes that monitors the request generated at the node. If demand generated, this agent triggers the DSR

step 2: If any demands from the user in the network,
then, Start multipath route discovery
else
Update the network and go to step 2.

step 3: Get the QoS satisfied paths among
stable paths using trained data set vector
and fuzzy logic.

Agent (DSRA) and Qos Agent (QoSA) and also this agent computes the residual bandwidth, delays, jitters and packet losses for each link and updates the QoS status profile at regular intervals. All the parameters are computed within a given continuous time window this database sends to the QoSA for future computation.

- **Neuro-Fuzzy Agent (NFA):** It is a static agent, when there is demand at the node, automatically this agent triggers and starts training of data sets defined for multimedia communication till acceptable error limit.
- **DSR Agent (DSRA):** It is a Static agent. When the request from the UMA, it starts discovery of multipath from source to destination and selects NDMR With stable paths. After finding it requests to QoS agent for QoS selection of each path.
- **QoS Agent (QoSA):** It is also a static agent. This receives two requests, first from UMA that demands to compute requested QoS for particular application using optimized membership values and second request from DSRA to check QoS at each node according to requested QoS. After this, this provides QoS paths for communication.
- **Route Mentainance Agent (RMA):** It is a mobile agent, which migrates along the path which is communicating. If any link failure due to node mobility or failure of node, this agent finds alternate path to destination from disconnected link.

IV. SIMULATION AND RESULTS

Simulation is carried out to evaluate the performance of the proposed model. The proposed model has been simulated in various network scenarios on a Pentium-4 machine by using ’c’ tool. In this section we discussed the network model, simulation procedure and result analysis.

A. Network Model

We considered simulation area of A × B sq meters. N numbers of nodes are placed randomly in A × B sq meters. Among N number of nodes some of nodes are in mobile with different mobility in meter/sec. Random way point model is used for node mobility. Simple network model for the simulation is shown in figure 7.

To illustrate some results of the simulation, we have to set some parameters for simulation. Some of the parameters considered for simulation are listed in Table 2.

Parameters	**Values**
Mobility Model	Random waypoint
Simulation Area	100 Sq. meter
Speed of mobile nodes	5-10m/s
Number of nodes	10-60 nodes
Distribution of nodes	Random
Learning constant	0.1
Channel bandwidth	2-5mbps
Communication range	10meter

TABLE II: SIMULATION PARAMETERS

After considering the above parameters, the simulation is carried out according to the bellowed steps.

1) Set the network as mentioned above.
2) Tune the membership functions till to get desired error by using proposed neuro-fuzzy system.
3) If any demands from the user then start the multipath route discovery to the destination.
4) Find the Node Disjoint path among all possible paths.
5) Find stable paths among all Node Disjoint paths.
6) Find the QoS paths for requested application and select one best QoS path for data transmission.
7) Compute the performance of the system by simulating the performance parameters.

C. Results Discussion

In this section, we discuss the various results obtained through the simulations. Some of the important results are listed below.

1) **QoS Acceptance Ratio:** It is the ratio of number of paths accepted the QoS to number of multipath. This is analyzed with number of nodes. Figure 8 shows how the percentage of requests acceptance ratio varied with

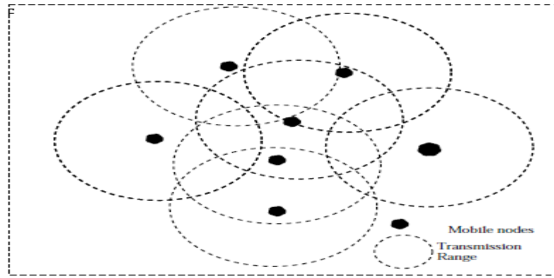

Fig. 7. Network Model

B. Simulation Procedure

change in number of nodes with varied mobility of 4m/s, 8m/s, 12m/s and number of requests are 12. In general acceptance ratio is increases with increase of number of nodes by getting more multipath between source and destination. Acceptance ratio is high in Neuro-Fuzzy DSR than Fuzzy DSR with increase in the number of nodes since; more number of intermediate nodes are existing for a connectivity between a pair of hosts. And also as the node mobility in the network is less the acceptance is more.

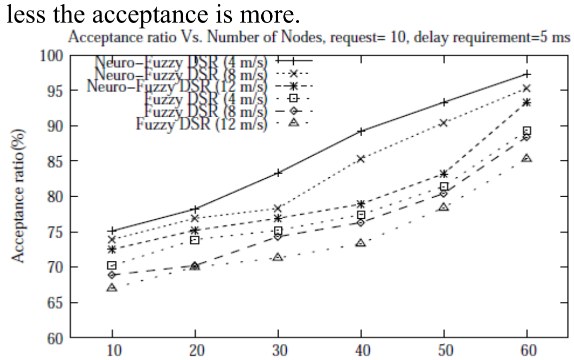

Fig. 8. Percentage of requests acceptance ratio Vs. Number of nodes

2) **Route Discovery Time:** It is the time required to discover multipath between source and destination. This parameter is analyzed with number of nodes. Figure 9 shows how the route discovery time varied with number of nodes and fixed requests of 12 and varied mobility of 4m/s, 8m/s, 12m/s. In general the Route Discovery Time is increases with increase of number of nodes because for more number of node. The dropped packets are the data packets that are dropped during the link or node breaks. The effect of packet delivery ratio over number of nodes s there are more number of paths then it requires more time to discover all paths. Here the acceptance ratio is more by the use of neuro-fuzzy than the use of only fuzzy system. And also for higher mobility in the network, the route discovery time will be more.

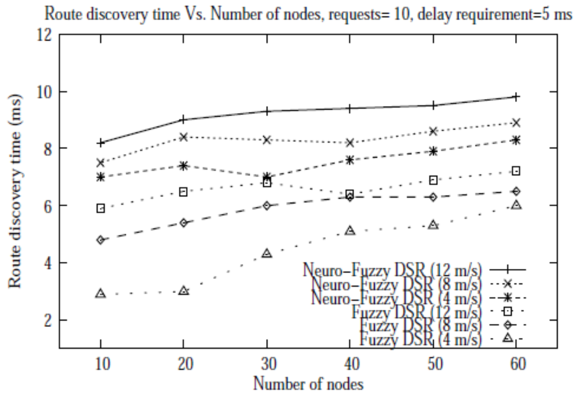

Fig. 9. Route discovery time Vs. Number of nodes

3) **Control Overheads:** For establishment and maintaining of routing path requires control packets and in this, we used agents and hence, there is more control overheads in the network. This parameter is analyzed with number of nodes. Figure 10 shows how the control overheads varied with change in number of nodes with fixed requests of 12 and varied mobility of 4m/s, 8m/s, 12m/s. In general the control overheads is increases with increase of number of nodes because, to update neighbor table at each node requires more control packets. For higher mobility of nodes in the network, control overheads are more.

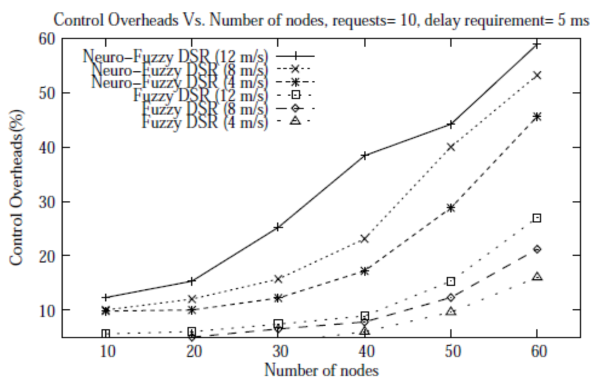

Fig.10. Control Overheads Vs. Number of nodes

4) **Packet Delivery Ratio:** The dropped packets are the data packets that are dropped due to link failure. Figure 11 shows how the packet delivery ratio varied with change in number of nodes with fixed requests of 12 and varied mobility of 4m/s, 8m/s, 12m/s. In general the packet delivery ratio is increases with increase of number of nodes because rare case of path failure in the network. Here the packet delivery ratio is more by the use of neuro-fuzzy than the use of only fuzzy system. And also as the mobility in the network is increases the packet delivery ratio is decreases.

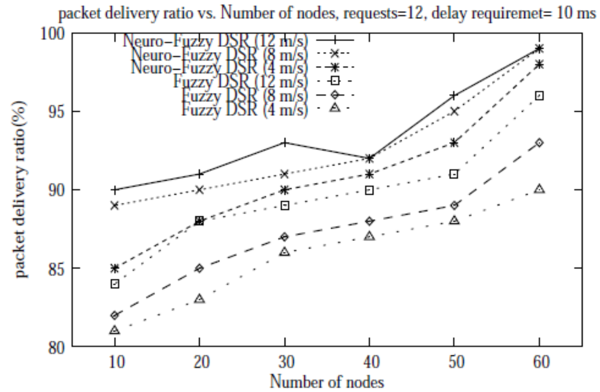

Fig. 11. Packet delivery ratio Vs. Number of nodes

V. CONCLUSIONS AND FUTURE WORK

In this paper, we proposed a QoS based dynamic source routing in mobile multimedia ad-hoc network based on Neuro-Fuzzy agents. In this, we used artificial intelligence for selection of best QoS path for multimedia communication. The fuzzy system approximates more efficiently. Because our proposed system (neuro-fuzzy) converts uncertain data set to certain data set at the input of the fuzzy logic system and hence, the efficiency of the DSR algorithm is improved by this we can provide Quality of service to the user. In this agent technology is used for solving complex computational tasks in the routing algorithm. Hence we reduced the complexity and improved the flexibility in the network. MANETs are likely to expand their applications in the future communication environments. Other challenges and open issues include robustness and security, and support for multiple levels of services in QoS routing schemes.

REFERENCES

[1] Padmini Misra, Routing Protocols for ad hoc mobile wireless Networks, *http://www.cse.ohio-state.edu/ jain/cis788 99/ftp/adhocrouting/TDRP*, Nov-1999.

[2] Susan Rea, Dirk Pesch, Multi-Metric Routing Decisions for Ad-Hoc Networks using Fuzzy Logic, *1st international symposium on wirless communications systems*, pp no. 234-237, Sept. 2004.

[3] D. B. Johnson and D. A. Maltz, Dynamic source routing in ad-hoc wireless networks, *proc. International Conference on Mobile Computing*, vol. 353, pp. 153181, 1996.

[4] Zhi Ren, Wei Guo, Unicast Routing in Mobile Ad hoc Networks: present and future directions, *Proc. 4th International Conference on Parallel and Distributed Computing, Applications and Technologies*, PDCAT2003, pp no. 340-344, Aug 2003.

[5] Ronald Beaubrun, Badji Molo, Using DSR for Routing Multimedia Traffic in MANETs, *proc. International journal of computer networks and communication*, vol.2, no.1, pp no. 120-138, January 2010.

[6] Chunxue Wu, Fengna Zhang, Hongming Yang, A Novel QoS Multipath Path Routing in MANET, *proc. International Journal of Digital Content Technology and its Applications*, Vol.4, no.3, pp no. 132-136, June 2010.

[7] E. M. Royer, C. K. Toh, A review of current Routing Protocols for Ad-hoc Mobile Wireless Networks, *IEEE Personal Communications Magazine*, vol. 6, pp no. 46-55, 1999.
[8] R.Asokan, A.M.Natarajan, C.Venkatesh, "Ant Based Dynamic Source Routing Protocol to Support Multiple Quality of Service
(QoS) Metrics in Mobile Ad Hoc Networks", *International Journal of Computer Science and Security*, volume (2) issue (3), pp no. 48- 56, 2003.
[9] Sushmita, Mitra, Yoichi Hayashi, "NeuroFuzzy Rule Generation: Survey in Soft Computing Framework", *IEEE Transactions on neural networks*, VOL. 11, NO. 3, MAY 2000.
[10] M. Yaghmaei, M. Baradaran, H. Talebiana Fuzzy QoS Routing Algorithm for Communication Network, *proc. 10th IEEE International Conference on Communication systems*, ICCS 2006, pp.1-5, Singapore, October 2006.
[11] Jian Liu, Dongfeng Yuan, Song Ci, Yingji Zhong, A New QoS Routing Optimal Algorithm in Mobile Ad Hoc Networks Based on Hop field Neural Network, *springer link*. ISSN-3, 343-348, 2000.
[12] Xu Zhang, Sheng, Cheng,Mei-yu Feng, Wei Ding, Fuzzy Logic QoS Dynamic Source Routing for Mobile Ad Hoc Networks, *IEEE fourth International conference on Computer and Information Technology*, pp.652-657, sept 2004.
and
Applications", *Cambridge University Press*, New York, Melbourne, Madrid, Cape Town, Singapore, Sao Paulo, 2008.
[13] J. Martin Leo Manickam, S. Shanmugavel, Fuzzy Based Trusted Ad-Hoc On-demand Distance Vector Routing Protocol for MANET, *proc. IEEE International Con-ference on Wireless Mobile Computing, Networking and Communication*, pp.39, Oct. 2007.
[14] Raju G.V.S, Hernandez G, Q. Zou, Quality of Sservice Routing in Ad-hoc Networks, *proc. IEEE international conference on Wireless*
Communications and Networking, vol.12, PP. 263 - 265, Chicago, 2000.
[15] Baoxian Zhang, Hussein T. Mouftah, "QoS Routing for Wireless Ad Hoc Networks: Problems, Algorithms, and Protocols", *IEEE Communications Magazine* , University of Ottawa, pp no. 110-117, October 2005
[16] Subir Kumar Sarkar, T. G. Basavaraju, C. Puttamadappa, "Ad-hoc Mobile Wireless Networks: Principles, Protocols and Applications", *Auerbach pablications*, Taylor and Francis group, 2008.
[17] Michael Luck, Peter McBurney, Chris Preist, "Agent Technology: Enabling Next Generation Computing", *Agent Link II*, version 1, January 2003,
[18] Xiangyang Li, "Wireless Ad Hoc and Sensor Networks: Theory
[19] Georgios Kioumourtzis, "Simulation and Evaluation of Routing Protocols For Mobile Ad-hoc Networks (MANETs)", *NAVAL Postgraduste Sschool Monterey*, California, Thesis, Sept. 2005

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