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SG-AODV: Smart and Goal Based AODV for Routing in Mobile Ad hoc Networks

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Abstract*— A mobile ad hoc network is a continuously self-configuring, infrastructure-less network of mobile devices connected without wires. As nodes are mobile in this network, routing is an important challenge. In this paper, we proposed new intelligent algorithm (SG-AODV) for routing to improve AODV routing protocol. In proposed algorithm, scores are considered for nodes according to energy of nodes, congestion in the routing queue of nodes and link states. Algorithm uses scores for selecting best rout and chooses rout with highest score as main route and rest of discovered routs are stored in temporal memory or cache of nodes to use them if main route is damaged or interrupted. SG-AODV is implemented in NS2 simulator and results show proposed algorithm improves the delay of sent packets, routing overhead and delivered packets of AODV protocol.

Keywords— Network, Mobile Ad Hoc Network, Routing, AODV Protocol, SG-AODV.

I. INTRODUCTION

Wireless networks are an emerging new technology that will allow users to access information and services electronically, regardless of their geographic position. Wireless networks can be classified in two types: infrastructure network and infrastructureless networks (ad hoc). Infrastructure network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed.

In contrast to infrastructure based networks, in ad hoc networks all nodes are mobile and can be connected dynamically in an arbitrary manner. Ad hoc networks don't use any infrastructure such as base station, router, switch and anything else that other networks are used to help the network structure. Nodes are connected to non-neighbours with the help of communicating with neighbour nodes [1,2]. A sample of infrastructure of ad hoc network is demonstrated in Fig. 1. Small computers are indicated wireless nodes and circle represents the effective range of each node. It means each node is located in effective range of another node; it can receive data and detect noisy data. For convenience, these networks are connected with lines and lines as edges show the relationship between two nodes.

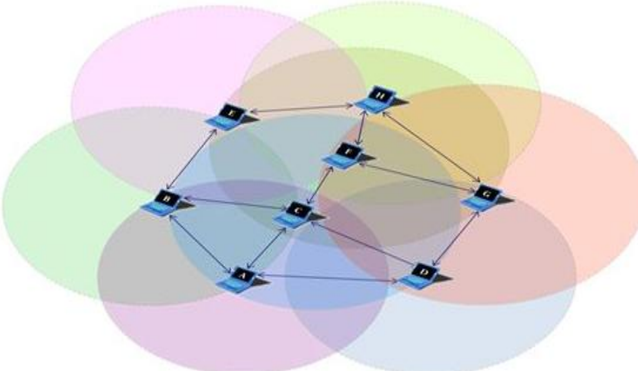

Fig. 1 A Sample of Ad Hoc Networks Topology

In ad hoc networks, mobile nodes may alter the path between two nodes. This challenge is to differentiate the ad hoc networks of other wireless networks [3]. Despite all these problems and challenges, ad hoc network are used in many cases and applications, Because of the speed and ease of implementation and independency on the structure of the building. Nodes in ad hoc networks are responsible for routing. In routing, there are no auxiliary devices such as network switches, routers and routing hubs, but the nodes constituting the network will perform routing functions. Routing protocols in ad hoc network are difficult, because each node can move randomly and can be removed in network. Therefore, the optimal path at a time, from the source to the destination, may be removed a few seconds later [4].

In the rest of paper, related works about routing in networks are in section 2, section 3 introduces popular routing protocols in network, proposed algorithm is presented in section 4 and experimental results and simulations of proposed algorithm are discussed in section 5. Finally, conclusions and suggestions for future work are presented in section 6.

II. RELATED WORKS

Nadylma et al. [5] proposed a new routing algorithm for ad hoc networks that use concept of connection to repair links had been cut between nodes. Particles swarm algorithm and search the full state space are used to find the best and optimal path in this algorithm.

Rajabzadeh et al. [6] proposed intelligent algorithm based on agent by improving DSR algorithm. This algorithm find best path by considering energy of nodes, congestion in network and distribute traffic in network among all nodes.

Kvrvndkar et al. [7] paper presented new routing algorithm using a stability factor for saving energy of nodes. The proposed method is based on the concept that routing algorithm does not use all nodes as one size. So, some nodes are shut down earlier. They define a stability factor for nodes and try to use the balance of the nodes in the routing.

Biradar et al. [8] in their paper routing algorithm in ad hoc networks **analysed** and they have found that multi routing algorithms have better performance. They proposed a multi routing algorithm using genetic algorithm. Results of implementations show their algorithm decreases delay and overhead of routing in ad hoc networks.

Anjum et al. [9] presented a routing method based on genetic algorithms in ad hoc networks to find the shortest path in a given time and measure the quality of service had improved in the network by their method.

III. ROUTING PROTOCOLS IN AD HOC NETWORKS

In this section, some routing protocols are introduced.

A. DSDV Algorithm

The Destination-Sequenced Distance-Vector (DSDV) Routing Algorithm is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements. In this method, each node provides a list of all destinations and the number of jumps to any destination. Each entry in the list is numbered with a number. This algorithm uses Incremental Packets to reduce the volume of traffic resulting from updating the path on the network [10]. The only advantage of this protocol is avoiding of creation of routing loops in networks of mobile routers. Thus route information are always present regardless of whether the nodes need to provide the path or not. DSDV protocol needs some parameters such as the time required to update the information that is required and the number of updates of its. DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle. Whenever the topology of the network changes, a new sequence number is necessary before the network re-converges; thus, DSDV is not suitable for highly dynamic or large scale networks [11].

B. DSR Algorithm

Dynamic Source Routing (DSR) is routing protocol for wireless ad hoc networks. It forms a route on-demand when a transmitting node requests one. Dynamic source routing protocol (DSR) is an on-demand protocol designed to restrict the bandwidth consumed by control packets in ad hoc wireless networks by eliminating the periodic table-update messages required in the table-driven approach. The major difference between this and the other on-demand routing protocols is that it is beacon-less and hence does not require periodic hello packet (beacon) transmissions, which are used by a node to inform its neighbours of its presence. In DSR algorithm, mobile nodes should provide temporal memory for routes that are aware of their existence. DSR algorithm has two main phases [12,13].

1. Rout detection
2. Rout update

In rout detection phase, algorithm uses route request/reply packet to find best rout. Also, in rout update phase this algorithm uses link acknowledgment to update links and routes [14].

This protocol uses a reactive approach which eliminates the need to periodically flood the network with table update messages which are required in a table-driven approach. In a reactive (on-demand) approach such as this, a route is established only when it is required and hence the need to find routes to all other nodes in the network as required by the table-driven approach is eliminated. The intermediate nodes also utilize the route cache information efficiently to reduce the control overhead. The disadvantage of this protocol is that the route maintenance mechanism does not locally repair a broken link. Stale route cache information could also result in inconsistencies during the route reconstruction phase. The connection setup delay is higher than in table-driven protocols. Even though the protocol performs well in static and low-mobility environments, the performance degrades rapidly with increasing mobility. Also, considerable routing overhead is involved due to the source-routing mechanism employed in DSR. This routing overhead is directly proportional to the path length [12,15].

C. TORA Algorithm

Temporally Ordered Routing Algorithm (TORA) is a highly adaptive, efficient and scalable distributed routing algorithm based on the concept of link reversal. The TORA attempts to achieve a high degree of scalability using a non-hierarchical routing algorithm. TORA algorithm is based on distributed routing algorithm and is designed for highly dynamic mobile networks. The algorithm for each pair of nodes determines the multiple paths and clock synchronization is required. The main feature of TORA is that the control messages are localized to a very small set of nodes near the occurrence of a topological change. To achieve this, the nodes maintain routing information about adjacent nodes. This algorithm has three main phases [14,15]:

1. Rout creation
2. Rout update and maintenance
3. Rout erasure

D. AODV Algorithm

Ad hoc On-demand Distance Vector Routing (AODV) is an improvement on the DSDV algorithm discussed in section III.A. AODV minimizes the number of broadcasts by creating routes on-demand as opposed to DSDV that maintains the list of all the routes. In AODV algorithm unlike previous algorithms, the path is not in packet headers. Rather, each node controls it while receiving the route request (RREQ) which is already on the table. If nodes have rout of final node in their table, then they export route reply (RREP). Otherwise, they broadcast the RREQ message. Certainly, RREP can be sent back to the transmitter node of RREQ. An intermediate node should be aware of nodes and request, so it uses sequence number in RREQ messages. Thus, since sequence number of RREQ is less than sequence number of rout in table of intermediate node, it will send RREP message [16,17,18].

To find a path to the destination, the source broadcasts a route request packet. The neighbours in turn broadcast the packet to their neighbours till it reaches an intermediate node that has recent route information about the destination or till it reaches the destination [19,20]. This process is shown in Fig. 2.

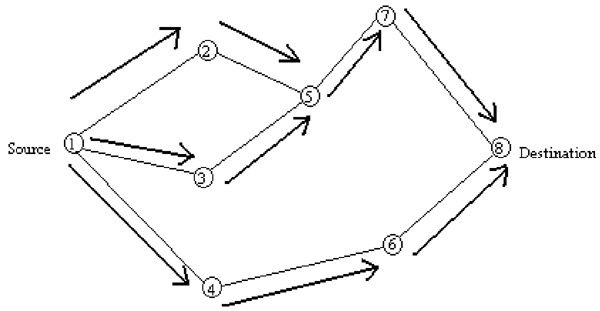

Fig. 2 Propagation Route Request (RREQ) Packet

When a node forwards a route request packet to its neighbours, it also records in its tables the node from which the first copy of the request came. This information is used to construct the reverse path for the route reply packet. AODV uses only symmetric links because the route reply packet follows the reverse path of route request packet. As the route reply packet traverses back to the source, the nodes along the path enter the forward route into their tables [19,20]. This process is shown in Fig. 3.

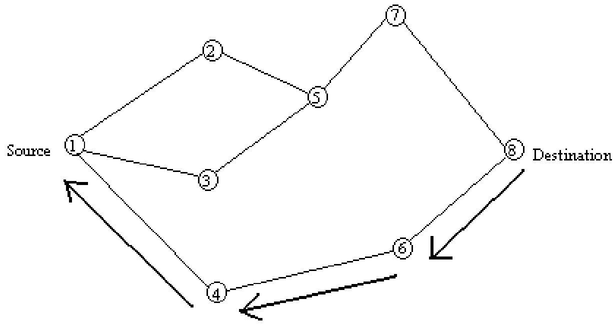

Fig. 3 Path Taken by Route Reply (RREP) Packet

So, AODV just find rout and does not find optimal rout, we will improve detection routes of this algorithm using purpose oriented agents and use of all detected routes in this paper.

IV. SG-AODV: IMPROVED AODV ALGORITHM

In this section, proposed algorithm is presented. To improve each algorithm, algorithm should be altered in performance. In this section, changes in rout detection phase and rout maintenance phase are explained. Although the techniques are widely used to improve the protocol, but the results of researches indicate that agent-oriented algorithms collect information and work together. These algorithms can achieve appropriate convergence in acceptable time and improve efficiency and performance.

The proposed method try to collect information from different nodes and their situation awareness to decide the best and the information obtained from the components of the system lead the system toward the steady state.

SG-AODV proposed algorithm relies on five fundamental principles:

1. Maintain positive feature of the standard AODV algorithm
2. Determine the congestion in each node

3. Predict link status with respect to received signal power at the intermediate and destination nodes in order to prevent or reduce the effects of a link failure
4. Select the route by considering the energy of the battery nodes
5. Use of temporary memory for storage alternative routes of nodes

In the following, mechanisms are used in the algorithm will be described and effectiveness on performance of algorithm will be assessed.

A. Congestion in each Node

Node congestion level will be reached by measuring certain parameters at each node. One of the most important parameters is queue (buffer) of each node. So, Send Buffer is important and should be noticed. Send Buffer at each node is a queue include packets that have no rout to destination in their headers. Then after determining the rout, it will be deleted from queue and selected rout will be added to header and will be sent to destination. Each node can wait at Send Buffer for specified time and it will be removed after deadline. So if the queue is busier likely more packets will be removed. A threshold value is defined for maximum size of a queue for determining congestion in each node and is indicated it by TMQ. The Number of packets in the queue of a node is displayed by C. Node Congestion (NC) is calculated by equation (1):

$$NC = \frac{C}{TMQ} \quad (1)$$

According to the above calculations value of NC is placed between zero and one that its higher value is indicated the higher congestion. For example, if NC≈1, node is in maximum congestion status. Such nodes have less chance for cooperation in routing.

B. Link Status

Nodes send Hello Packet to each other to recognize the link between Neighbors, periodically. If destination node received the packet, it will send reply to source node.

The status of communication links will be predictable by comparing the power of received signal in a receiver with transmitted power of sender. Thus, whatever ratio of received power from signal is less than transmitted power, it is indicates that signal attenuation is increasing and by considering to equation(2), the nodes are get away from each other.

$$L = 10 * \text{Log}\left(4\pi d / \lambda\right)^2 \quad (2)$$

$$SP = \frac{P_r}{P_t} \quad (3)$$

The initial value of SP is considered 0.5

C. Energy Status of each Node

The limited battery power characteristic limits the utilization time of wireless devices and the networks. Thus, the algorithms and mechanisms that implement the networking functions should be optimized for lean power consumption [14]. This work, we consider the residual battery power capacity of nodes to reach better performance. From the energy efficiency point of view, we use Node Energy (NE) as the parameter to illustrate energy level in each node.

Each node has initial value energy that is decreased with time due to the following factors:

- The amount of energy that are decreased by sending packets
- The amount of energy that are decreased by receiving packets
- The amount of energy that are decreased in idle mode
- The amount of energy that are decreased in sleep mode

A technique of using information is related to the amount of energy in each node in the path selection. In this way, nodes with very low energy are superseded and paths that include nodes with acceptable level of energy get higher priority [21,22]. In SG-AODV, this method is used. Passing through each node, the packets carry information related to the node's energy; and finally, the origin has a clear vision of intermediate nodes energy, so it will choose a path that is in an acceptable level of energy. Thus, the algorithm tries not to use nodes that have less energy as router, as much as possible.

D. Memory for each Node

In the SG-AODV algorithm, each node has a temporary memory that stores routes discovered in the course of routing for each node. This memory is limited due to the physical constraints of nodes and acts as a queue. When the queue is filled, the oldest discovered routes will be removed. By adding the feature to the AODV algorithm, it becomes similar to the DSR algorithm [23].

E. Calculation of the Score of each Node

A score is determined for the energy and congestion at node level based on the signal power, which is shown by Score in Relation (4).

$$Score = \frac{(a*Ne)+\left(b*\frac{1}{NC}\right)+(C*SP)}{a+b+c} \tag{4}$$

Coefficients a ,b and c add dynamicity to the formula and their values change based on conditions and priorities. In general, a=b=c=1.

a, b and c are three weight factors to calculate the cost. We can change these three weight factors to change the importance of the three cost metrics during route discovery.

For example, we can set (a, b, c) = (1, 0, 0),

It means we only consider Node energy. We can scale these factors to change our route selection scheme. At end, we want that various values of Scores have nonlinear affect on the total results, thus we use particular function such as;

$$Score = (1-(1-Score)^3) \tag{5}$$

F. Rout Discovery

In the course of route discovery, if node ‘a’ wants to send a packet to node 'b’, it first examines its own memory and uses an available route. Otherwise the process of route discovery begins. For each route one score (route value) is assumed which is shown by RV in equation (6).

This score (RV) is obtained by multiplying the scores of the nodes in the route and following the routing operation and determined by equation (7):

$$Rv = \prod_{i} Score\ of\ node(i)_{\ i\ \varepsilon Nodes\ between\ Source\ and\ Distination} \tag{6}$$

Each node selects the route with the highest score by comparing the scores of different routes. It afterwards stores the other routes in its temporary memory based on their score values.

Fig. 4. shows a network which there are two routes for sending a packet from ‘a’ to ‘b’. The optimum route is determined after calculating the RV of each route.

RV(a-c-d-b) = 0.29*0.67=0.19

RV(a-e-f-b) = 0.47*0.55=0.26 (7)

After calculating the score of each route, the lower route (i.e. the route containing nodes a, e, f, b) is selected as the optimum route.

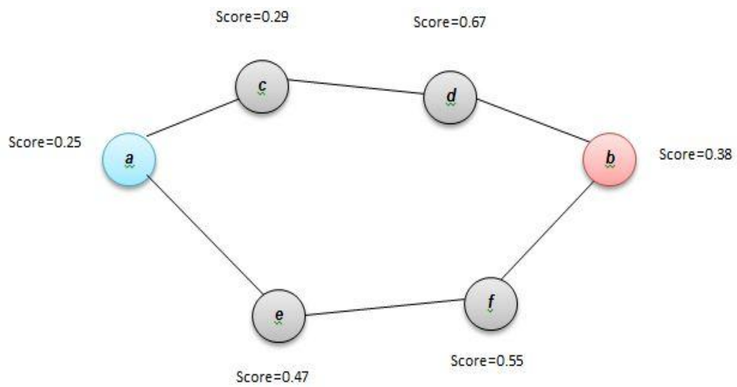

Fig. 4 Rout Discovery in Mobile Ad hoc Network

V. SIMULATION AND RESULTS

In proposed algorithm, to develop AODV protocol, the software NS2 has been used that is introduced in the following. One way to study network behaviour under different conditions is using the simulator. Simulators are able to simulate network conditions and changes with high precision, and also to provide the results in order to be analyzed and evaluated. NS2 is the most widely used simulator in scientific circles and also it is suitable for usage in specific networks [24,25]. In this paper, version NS-2.34 of this simulator has been used. To work with NS2, after preparing the desired scenario in a tcl file, we put it as an argument to NS2. Using Network Animator, the changes can be observed as shown in Fig. 5.

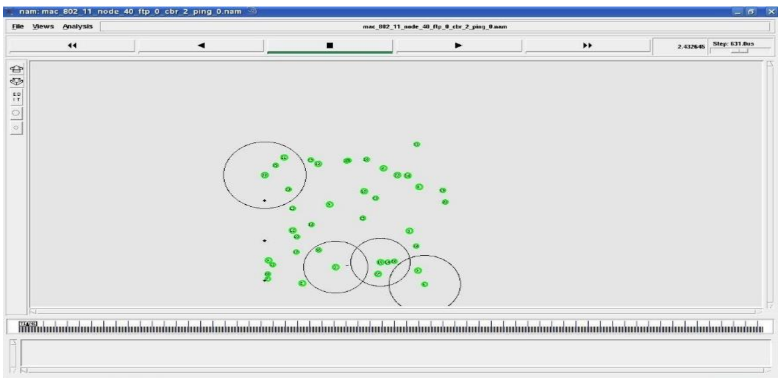

Fig. 5 Simulation Environment in Network Animator

To compare AODV and SG-AODV protocols, two different scenarios are considered in this case, one with 10 nodes in a 450 x 450 m^2 network and the other with 100 nodes in a 1000 x 1000 m^2 network and there are three traffic flows between the nodes. Some nodes are fixed and some of them move at different speeds across the network. The time of simulation is considered as 300 seconds. The parameters considered for the comparison of protocols are average delay of end to end, packet delivery rate, and the amount of packet exchanged for routing.

The delay in SG-AODV protocol was lower than AODV protocol, which can be seen in Fig. 6, and Fig. 7; and according to intelligently selection of the path, this conclusion is expected. Percentage of packets delivered in both protocols were acceptable and close together, and in SG-AODV protocol this parameter was slightly improved, which given the temporary memory intended for nodes and using alternative paths in case of interruption of a path, this amount of improvement is not unexpected. The obtained results are shown in Fig. 8 and Fig. 9.

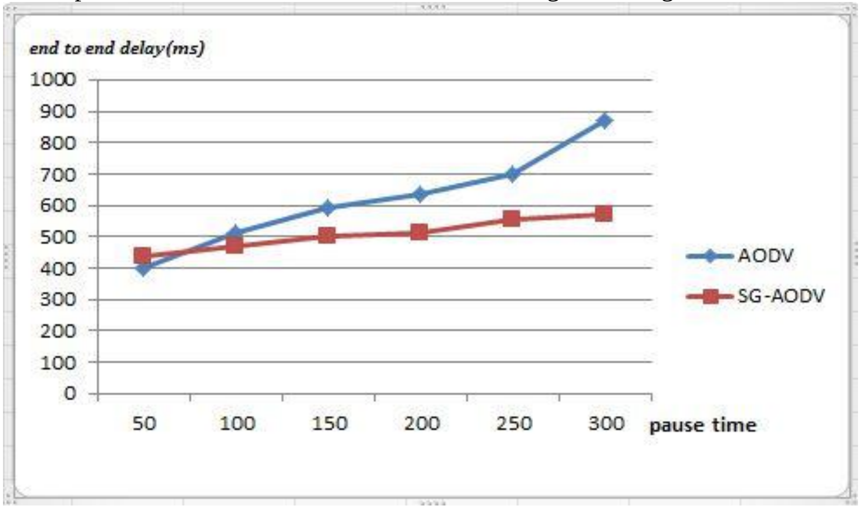

Fig. 6 End to End Delay of Protocols for 10 Nodes

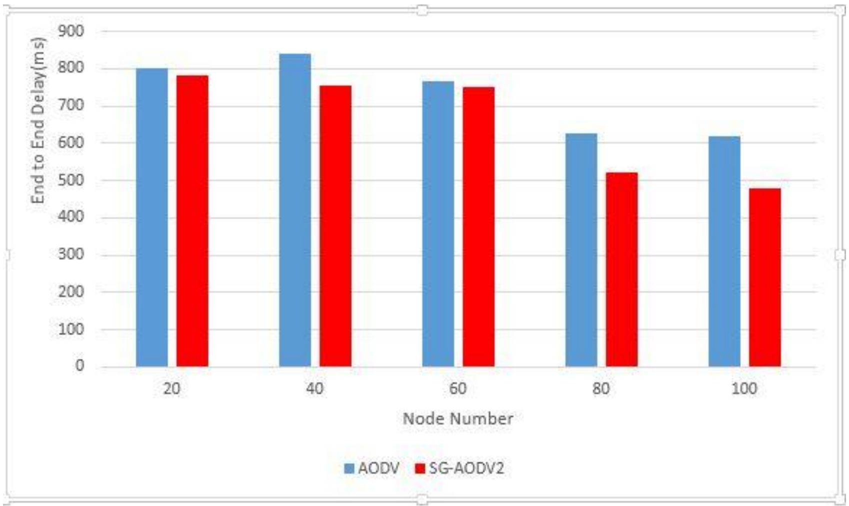

Fig. 7 Average of End to End Delay

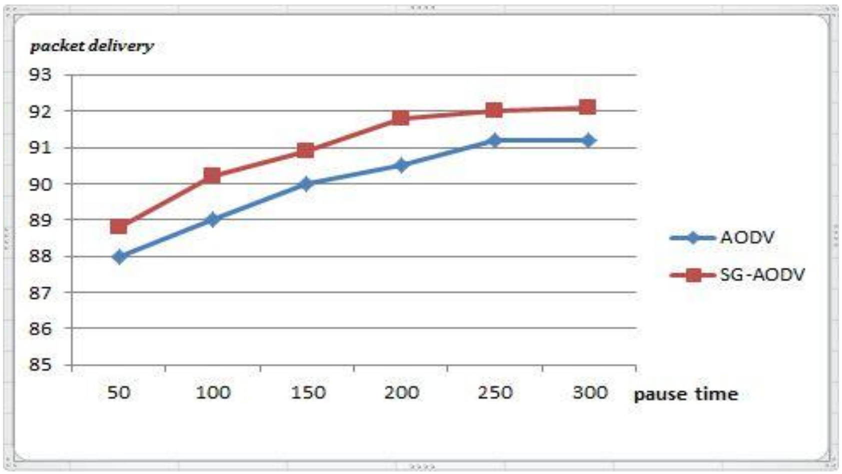

Fig. 8 Packet Delivery of Protocols for 10 Nodes

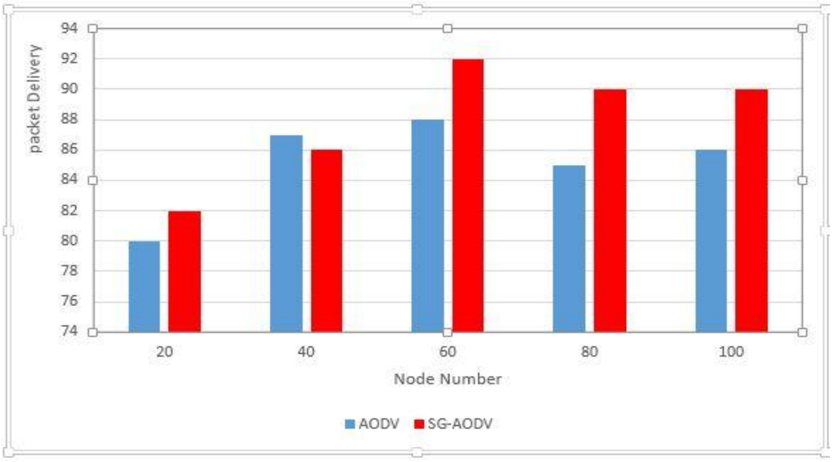

Fig. 9 Packet Delivery of Protocols

From Table 1, we see that although the AODV has a higher routing overhead than SG-AODV, it has a better performance in terms of packet delivery ratio.

Table I 100-Nodes, 3 Traffic Sources

Metric	SG-AODV	AODV
Packet Delivery Ratio	91.83	99.23
Control Packets	143	425
Message Packets	19846	19994
Routing Overhead	0.70%	1.2

Ratio of number of control packets to number of messages sent is tested and entitled routing overhead. Initially, given that SG-AODV protocol send more packets to intelligent selection of the path, the overhead is higher, but over time and after the network become stable and given that the nodes have alternative paths in their temporary memory and less need to send package for routing, routing overhead in SG-AODV protocol is reduced than AODV protocol.

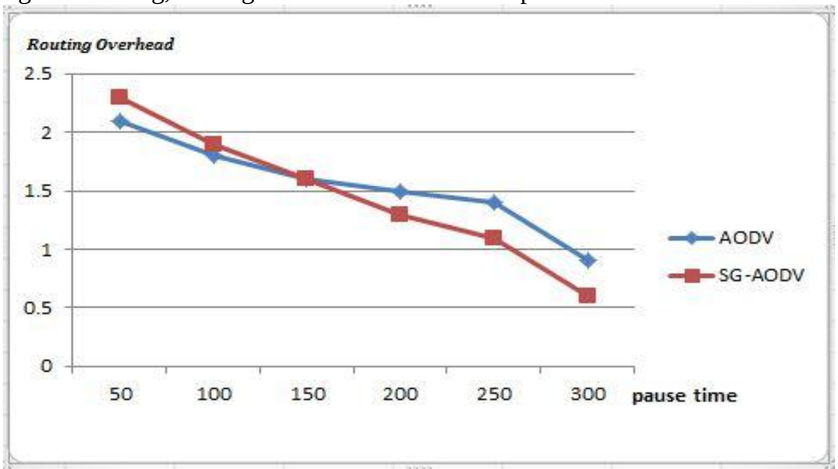

Fig. 10 Routing Overhead of Protocols for 10 nodes

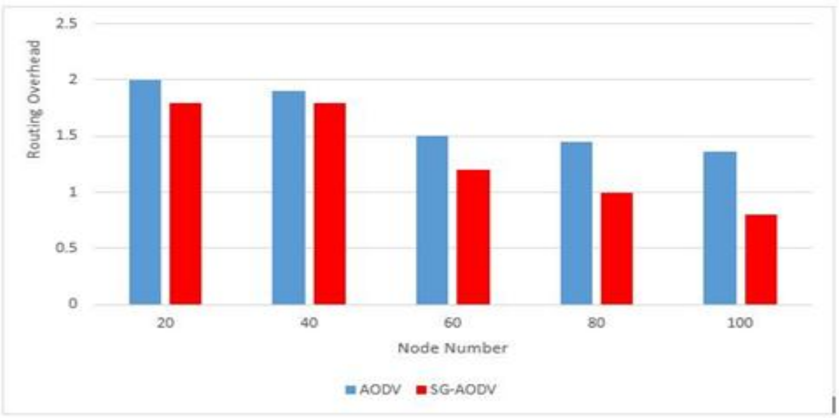

Fig. 11 Routing Overhead Of Protocols

Analysis of the results and comparison of protocols performance showed that SG-AODV routing protocol is better than AODV routing protocol in terms of reduction of delays in sending packets, reduction of routing overhead and increase of delivered packets percentage, and also it has the ability to be implemented in actual environments.

VI. CONCLUSIONS

There are many challenges associated with routing in ad hoc networks due to the mobility of nodes. In the proposed method in this study, an intelligent routing is practiced by considering the following factors: energy, the status of communication links, and congestion of nodes. By allocating temporary memories to the nodes, it is possible to use and access to suitable alternative routes that can be used in cases that main routes are cut. Research results revealed that the performance of the algorithm was improved as compared to the AODV algorithm and thus it can be applied to real life conditions.

Since the proposed method assumes temporary memories for nodes to store alternative routes, it is possible to distribute network traffic load in different routes based on their scores to control network congestion.

REFERENCES

[1] I. Panda, "A survey on routing protocols of manets by using qos metrics," *International journal of advanced Research in computer science and software engineering,* vol. 2, 2012.

[2] A. Kaur and R. Mahajan, "Survey of QoS Based Routing Protocol for MANET's," *International Journal of Advanced Research in computer science and software engineering,* vol. 3, no. 7, 2013.

[3] A. K. Bhatt, C. Mohini and S. Thakur, "A New Efficient and Reliable On-Demand Routing Protocol for MANET (ERORPM)," *International Journal of advanced research in Computer Science and software engineering,* vol. 3, no. 5, 2013.

[4] R. Shorey, A. Ananda, M. C. Chan and W. T. Ooi, Mobile, wireless, and sensor networks: technology, applications, and future directions, John Wiley & Sons, 2006.

[5] N. Pereira, C. J. Bastos-Filho and R. Moraes, "Improving AODV Route Recovery Mechanisms with Connectivity and Particle Swarm Optimization," *Journal of Communication and information systems,* vol. 1, no. 27, 2012.

[6] M. Rajabzadeh, F. Adibniya and M. Ghasemzadeh, "MA-DSR; Multi Agent based Adaptive DSR protocol with intelligent behavior in realistic environments," *International Symposium on Telecommunications,* pp. 306-311, 2008.

[7] S. Kurundkar and A. Maidamwar, "An Improved AODV Routig Protocol for Mobile Ad Hoc Networks," *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering,* vol. 2, no. 7, 2013.

[8] A. Biradar and R. C. Thool, "Effectiveness Of Genetic Algorithm In Reactive Protocols For MANET," *International Journal of Engineering Research and Technology,* vol. 2, no. 7, 2013.

[9] A. M. Anjum and G. Nagib, "Optimal Routing In Ad-Hoc Network Using Genetic Algorithm," *Advanced Networking and Applications,* vol. 3, no. 5, pp. 1323-1328, 2012.

[10] G. Jayakumar and G. Gopinath, "Ad Hoc Mobile Wireless Networks Routing Protocols – A Review," *Journal of Computer science,* vol. 3, no. 8, 2007.

[11] A. Malatras, g. Pavlou, S. Gouveris, S. Sivavakeesar and V. Karakoidas, "Self Configuring and Optimizing Mobile Ad Hoc Networks," *International Conference on Autonomic Computing,* 2005.

[12] A. Kumar, C. L. Reddy and P. S. Hiremath, "High performance Modified DSR with Power Consumption Optimization for Mobile Ad Hoc Networks," *International Journal of Computer Science and Network Security,* vol. 7, no. 5, 2007.

[13] N. K. Charles, B. Stephen and P. C. Reddy, "A New Power Conservative Routing for Wireless Mobile Ad hoc Networks using Cross Layer Design," *IJCSNS,* vol. 8, no. 3, 2008.

[14] S. Marwaha, C. K. Tham and D. Srinivasan, "A Novel Routing Protocol using Mobile Agents and Reactive Route Discovery for Ad hoc Wireless Networks," *10th IEEE International Conference on Networks,* pp. 311-316, 2002.

[15] C. Venkatesh, N. Yadaiah and A. M. Natarajan, "Dynamic Source routing protocol using Fuzzy Logic Concepts for Ad Hoc Networks," *Academic Open Internet Journal,* vol. 15, pp. 1-14, 2005.

[16] D. O. Jorj, "Performance Comparison Of MANET Routing Protocols In Different Network Sizes," *Computer Networks & Distributed Systems,* 2003.

[17] G. Wang, "MAC Layer and Routing Protocols for Wireless Ad Hoc Networks with Asymmetric Links and Performance Evaluation Studies," *PhD diss., University of Central Florida Orlando, Florida,* 2007.

[18] K. Nahm, A. Helmy and C.-C. Kuo, "Cross-layer Interaction of TCP and Dynamic Routing in Multi-hop 802.11 Networks," *IEEE Transactions on Mobile Computing,* vol. 7, no. 4, pp. 458-469, 2008.

[19] W. Yang, X. Yang, S. Yang and D. Yang, "A greedy-based stable multi-path routing protocol in mobile ad hoc networks,Adhoc networks," *Ad Hoc Networks,* vol. 9, no. 4, pp. 662-674, 2011.

[20] G. K. Amandeep, "Performance analysis of AODV routing protocol in MANETs," *International Journal of Engineering Science and Technology (IJEST),* vol. 4, no. 8, pp. 3620-3625, 2012.

[21] S. Mueller, R. P. Tsang and D. Ghosal, "Multipath Routing in Mobile AdHoc Networks: Issues and challenges," *Performance Tools and Applications to Networked Systems,* pp. 209-234, 2004.

[22] J. M. Sucec and I. Director-Marsic, "Routing in Mobile Ad hoc Networks: Scalability, Resource Management and Application," *University of New Jersey*, 2003.

[23] D. B. Johnson, D. A. Maltz and J. Broch, "DSR: The Dynamic Source Routing Protocol for Multi-Hop Wireless Ad Hoc Networks," *Ad hoc networking,* vol. 5, pp. 139-172, 2001.

[24] M. R. Kumar and N. Geethanjali, "A Literature Survey of Routing Protocols in MANETs," *International Journal of Science and research,* 2013.

[25] H. T. El-Kassabi, "A Load Balancing Algorithm Using Radio Signal Strength and Sensitivity for the Multipath Source Routing Protocol," *Ph.D Diss, Carleton University,* 2003.

