Multipath Protocol Improvement Comperasion in SMMSN-AOMDV and MAN-AOMDV for Stable Nodes Election in Ad-Hoc

Shian Safar Sulaiman[1†], Saad Sulaiman Naif[2††], Barzan Abdulazeez Idrees[3†††], and Abdulraheem Jamil Ahmed[4††††]

Abstract
The future of wireless networks in networks and communications is quite promising, which has sparked the academics' intense interest in the field. Better performance is required in MANETs as a result of the users' growing diversity and breadth as well as their greater use of MANETs for various purposes. Applications require QoS for effective communication, and load balancing is a characteristic of the routing protocol that can support in improved resource management and boost network performance. we present a novel technique for load balancing in the AOMDV routing protocol for MANETs by choosing pathways employing parameters for each path on the intermediate nodes and by dispersing the burden among the free nodes while transmitting data, which is demonstrated by simulations in NS-2.35.
Keywords:
AOMDV, NS-2, load balancing, QoS, wireless networks, MANETs.

1. Introduction

Mobile Ad-hoc Network (MANET) [1]is a group of self-configuring[2], constantly changing, and multi-hop mobile devices that connects to each other wireless to create a communication network[1], [3], without any centralization. MANET is a self-organizing network, where nodes that are within one another's communication may communicate with one another in the network[4]–[7]. Both civilian and military settings might benefit from the use of mobile ad hoc networks. Routing is a difficult issue since the present path is rendered ineffective and impractical by the dynamic changes in the topology of MANET[8]–[12]. Routing, security, and QoS (Quality of Service) provisioning are the core problems for mobile Ad-hoc networks, which are mostly caused by node mobility, connection failure, and constrained bandwidth. With limited power, processing, and memory capacity, the routing issue in MANETs is to offer an efficient path for data forwarding in a shorter amount of time[13]–[15]. The issue with current routing protocols is that traffic is not fairly distributed throughout the pathways in the network, as a result, nodes located in densely populated regions are utilized more frequently by various paths and eventually reach their capacity, which lowers the routing protocol's performance. In order to divide the burden in the network equitably, a load balancing capability has to be introduced to the current protocols. AOMDV and other multipath routing protocols can assist in maintaining backup routes in the event of a route breakage, but they do not yet offer any load balancing features because they only use the primary path for the purpose of transmitting data in less mobile environments where there is little to no chance of a route breakage. The method of routing involves sending packets along the most efficient link to their destination. According to the availability of the route, MANET routing is divided into two categories. 1. Proactive routing: Nodes in a wireless Ad-hoc network should maintain a list of routes to all potential destinations so that, in the event that a packet has to be sent, the route is already known and may be utilized right away. 2. Reactive routing: A node starts the network's route discovery process when it has to deliver packets to a destination but lacks a route there. Once formed, a route is kept up by a route maintenance process until the destination is longer reachable or the route is longer required.

2. Related Work

For the aim of balancing on multi-path in MANETs routing, there have been several ideas. In [16], EHO is By dividing nodes' populations into two clans depending on nodal energy, which is sometimes referred to as the separation operator, EHO is primarily used to optimize nodes' energy usage. The first clan will consist of nodes with more energy than is required to transport the complete amount of packets through the node, while the second clan will consist of the remaining nodes. Compared to the ACO-FDRPSO and AOMDV protocols, the routing overhead for the proposed EHO-AOMDV protocol

Manuscript received March 5, 2025
Manuscript revised March 20, 2025
https://doi.org/10.22937/IJCSNS.2025.25.3.15

grows more slowly. The three BIAs protocols EHO-AOMDV, ACO-FDRPSO, and FF-AOMDV all achieved higher delay than the AOMDV while EHO-AOMDV spent less energy and the AOMDV attained the maximum energy consumption. In terms of routing overhead, packet delivery ratio, average energy consumption, and number of dead nodes, the suggested EHO-AOMDV has surpassed the ACO-FDRPSO, FF-AOMDV, and AOMDV, while AOMDV has improved in terms of end-to-end delay. The authors attribute this to the fact that the AOMDV requires less computation and processing to find paths and route packets across them than the other three protocols, which prioritize node energy before finding paths and routing packets. Through this investigation, the authors came to the conclusion that the EHO separating and clan updating operators can improve the AOMDV protocol's performance when it comes to delivering the most packets with the fewest dead nodes and, thus, with the least amount of energy consumption. Finally, the authors advise using EHO-AOMDV in systems like banking, marketing, and management that demand a higher delivery rate while using less energy and tolerable latency.

In [17], The main issue arises from energy-efficient experiments using the AOMDV routing protocol in the presence of malicious nodes using packet loss, jitter, throughput, and energy parameters. The authors discovered that the more malicious nodes there are in a network, the more frequently the routing process must be carried out because the malicious nodes discard a large number of packets. According to the simulation data, as there are more malicious nodes present, the throughput value keeps dropping, packet loss value keeps rising because more malicious nodes are discarding packets, energy value keeps rising as there are more malicious nodes present due to the increased number of packets that are being discarded by malicious nodes, and node lifetime value also keeps rising. Due to the malicious nodes' tendency to discard packets from the source, the nodes do not need to utilize much energy. Therefore, it can be inferred that the energy consumed becomes efficient because the quantity of living nodes would rise in the presence of malicious nodes. But since the throughput figure is constantly dropping as a result of the attack from the rogue node, the output is given a bad value. The multipath routing protocol is performing better thanks to the hybrid DMR protocol that has been presented in [18]. The multipath AOMDV handles additional network load effectively and more effectively than the unipath routing protocol, but it is feasible to improve protocol performance in a dynamic network by using DREAM. Every node's most recent location in relation to every other node is maintained by the hybrid DMR work. The number of nodes that are actively involved in the routing process and that just keep the routing table while routing. Because we are utilizing the reactive routing protocol, once the routing process is complete, the routing information from the nodes memory is erased. Using the Ad hoc On-demand Multipath Distance Vector (AOMDV) routing protocol, a new fitness function (FFn) is developed in [19] as an optimization tool to find the optimum path between the source and the destination.

Following that, they suggest a routing protocol called AOMDV with FFn (AOMDV-FFn). AOMDV-GA, based on the FFn, is another combination of the AOMDV mechanism and genetic algorithm that is suggested. AOMDV-FFn does not engage in any of the GA phases, such as crossover, mutation, etc.; it merely uses the fitness function. The multipath algorithm's dedicated route is chosen by the FFn. To choose the best path from source to destination in this task, consider three parameters. In order to prevent congestion, the chosen route should cover the shortest distance to the destination while passing through nodes with the highest residual energy. In order to use the fitness function, they create the TCP Congestion Control Enhancement for Random Loss (TCP CERL). In the chosen efficient route, TCP CERL is able to differentiate between random loss and congestion loss. When it comes to throughput, packet delivery ratio, energy usage, and end-to-end delay, the routing protocols based on the suggested fitness function perform better than those of existing routing mechanisms. In situations where there is random loss and network congestion, the protocols operate flawlessly. the remainder of the paper In order to choose the optimal routes with the highest fitness, it combines new fitness function (FFn) and suggests AOMDV-FFn. Even if a random loss of data packets occurs, the route with the best fitness implies the shortest route, the most residual energy, and the least amount of data traffic. They also introduced our genetic algorithm-based AOMDV-GA methodology (GA). Both protocols outperform alternative routing techniques in our simulated tests. In [18] PDR characteristics, and routing cost metrics are used to assess the features of AOMDV and the proposed

DMR. A multi-path protocol is unquestionably superior to a one-way routing system, and it is also a better choice for network communication in dynamic environments. The DREAM protocol archives node mobility and location data. The AOMDV protocol seeks to strengthen a dependable link between transmitter and recipient. The optimum routing strategy for numerous routes is multiple routes. Superior results are produced by DMR performance, and these findings demonstrate better sending, receiving, and data loss performance. The network's routing expenses and packet loss are reduced, and data packet reception is enhanced. As a result of nodes in MANET being aware of one another's locations, network overhead is kept to a minimum and data packets are sent directly rather than flooding routing packets. Because the network packets it receives are better, performance and PDR are improved. Better outcomes and less needless overhead are produced by routing performance in multipath routing.

3. Proposed Methodology

AOMDV preserves many pathways for data transfer, but it only utilizes one path while it is still active and stores the others as a backup. If the primary path does not fail and the other pathways are never utilized if the primary path remains valid, this might result in substantial overhead on a single path and resource waste. To overcome this problem, we propose two Protocols : 1-A Suitable Multi-path of More Stable Nodes on AOMDV (SMMSN-AOMDV), 2- A Multi-path of Available Nodes on AOMDV (MAN-AOMDV). In order to distribute the data and the load along the paths, the first Protocol considered the hop count, source path number, destination path number, and the current node as a metric for suitable path selection by more stable Nodes in the path. This would eliminate potential bias of the path usage in the network. While the second protocol considers the hop count and Source path number to get multi-path depending on the available Nodes. Furthermore, in the RREQ packet, the hop count and Source path number fields are added. These parameters in the request are used to determine the route.

3.1 SMMSN-AOMDV

The Source node starts to send RREQ packet to transmit the data while there is no specific route selected to the destination. then each neighbor node assigns a self Id in Source path number of RREQ to identify the current reverse path which is path number that defers from another reverse path. The Source neighbor node is assigned when the hop count equals to zero. by the time the node receives RREQ, if there is a fresh route, then it sends a reply to the source, otherwise, it compares the available reverse path in routing table with the Source path number and current Node (Neighbor Node) in RREQ to obtain a fresh route.

The node will accept and forward RREQ if it is the first time or if it exists in the same path of the routing table. this shows that the current node is stable, otherwise, the node will not be selected due to high mobility, means the node came from different path. As a result, the quality of the path will be affected by confusing the sequence of the nodes and leads to the chaos. the same process happens during the RREP control Packet. If the destination node sends RREP and stores Destination path number. here each node sends the next reply to the same source node only with the same RREP destination path number or first RREP.

3.1.1 A.1 SMMSN-AOMDV Algorithm At RREQ

```
If (path exists for destination) {distribute data
amongst multiple paths}
Else {find route discovery}
 Route discovery process Send RREQ();
//Source_path_number is initiated 0
 If (RREQ_Hop_Count == 0 ){
 Source_path_number = Index;}
Insert_RREQ_path (Source,  Source_path_number,
Current_Node,Hop_Count+1);
Current_Node = Index;
If ((RREQ_Destination == Index) or lookup
(RREQ_Destination ==  Table_ Destination )){
 //If (I am Destination) or I have a route to
destination //
Route discovery process Send RREP(); } //
Destination_ path_number is initiated 0
If lookup(( Source_path_number ≠Table_
Source_path_number)& (Current_Node ≠Table_
Current_Node)) //Not stable Node //
Delete (path);
```

```
Drope RREQ; }
At RREP:
If (RREQ_Hop_Count == 0 ){
Destination_path_number = Index;
 }
Insert_path(Destination, Destination_path_number,
Current_Node ,Hop_Count+1);
Current_Node = Index;
}
```

From the point of view of system optimization, media coding/decoding scheme should be considered in the similar way as channel coding/decoding scheme in telecommu-nications. However, there is a very significant difference between the restrictions imposed on the two systems. Indeed, in telecommunication systems an important design issue which restricts channel coding efficiency is a trade-off between embedded redundancy needed for error control and the required channel capacity (bandwidth and/or power) due to the increased signaling rate. In public communications, the amount of the embedded redundancy is not commonly a restricting factor which makes the media MAP decoding even more powerful. It could be said that in human communications the embedded redundancy is “gratis” since people use to repeat sentences, data, photos etc. Generally, in public communications embedded redundancy is “gratis” since different printed and electronic media are practically competing in publishing information interesting for people (users).

In addition, since media decoder works with symbols from the same alphabet as used by the source, media decoder may entirely exploit the source redundancy to minimize error probability.

3.2 MAN-AOMDV

The Source node sends the RREQ packet to find the route to destination. every neighbor node assigns self Id in the Source path number of RREQ to identify the current reverse path which is path number that defers from another reverse path. While the node receives RREQ, if it is a fresh route then it sends a reply to the source node, otherwise it compares the available reverse path in routing table with the source path number in RREQ to obtain the route. in case this was the first RREQ, the node will accept the RREQ and update the routing table information’s for the second RREQ of the same path. furthermore, the exact procedure will happen at RREP control Packet. If the node is a destination node, then sends RREP and stores the destination path number. here each node sends the next reply to the same source only with the same RREP Destination path number.

3.2.1 MAN-AOMDV Algorithm At RREQ

```
If (path exists for destination) {distribute data
amongst multiple paths}
Else {initiate route discovery}
 Route discovery process Send RREQ();
//Source_path_number is initiated 0
 If (RREQ_Hop_Count == 0 ){
 Source_path_number = Index; }
Insert_RREQ_to_Node_Table (Source,
Source_path_number,Hop_Count+1);
If ((RREQ_Destination == Index) or lookup
(RREQ_Destination ==  Table_ Destination )){
 //If (I am Destination) or I have a route to
destination //
Route discovery process Send RREP(); } } //
Destination_ path_number is initiated 0
If lookup (( Source_path_number ≠Table_
Source_path_number) {
Delete (path)
Drope RREQ }
At RREP:
If (RREQ_Hop_Count == 0 ){
Destination_path_number = Index; }
Insert_RREP_to_Node_Table (Source,
Destination_path_number,Hop_Count+1);
If lookup( Destination_path_number ≠Table_
Destination_path_number){
Drope RREP; }
```

4. Simulations and results

To minimize the issue of hidden terminals in wireless networks, a comprehensive simulation model based on NS2 is utilized. It conducts virtual sensing and medium reserve. With a maximum data rate of 2 Mbit/s and a 250 m radio range, WaveLAN is modeled as shared media. Traffic sources with a CBR (Continuous Bit Rate) are employed. Over the network, the source-destination pairings are disseminated at random. The data packet size is 512 bytes. The mobility model employed uses random waypoints with 60 nodes in a 1500 by 1500 square-foot rectangular space. The node has a distinct mobility that involves brief halt followed by rapid movement. There are 300 simulated seconds in the simulation run. Tab. 2 provides a thorough overview of the simulation scenario.

4.1 Performance indicators

4.1.1 Packet delivery ratio

In this simulation, the ratio of packets received by the CBR at the destination to those transmitted by sources with (CBR, application layer). It indicates the packet loss rate, which restricts the network's top throughput.

4.1.2 End-to-end delay

This indicator shows the average end-to-end latency and the time it takes for a packet from the source to the destination's application layer.

4.1.3 Throughput

The total number of packets successfully delivered through all time to each particular destination. Table 2 Dimensions of the parameters utilized in the simulation are 1500 x 1500 x 1500 (m x m). number of nodes 60 simulation time 300 traffic type CBR number of connections 20, packet size 512 bytes MAC layer IEEE802.11b. SMMSN-AOMDV and MAN-AOMDV are being evaluated in a situation where there are mobile connections between network nodes. The addition of a new field in RREQ packet results in an overhead, however it can be accepted as normal as we employ paths with minimal load as well as the amount of packet loss in the network will decrease. Furthermore, since the field is only added in route request packets, which are only sent out when route discovery is necessary, it won't have a significant impact on the network's performance unless there is a path breakage. SMMSN-AOMDV in Fig. 2 has a shorter end-to-end delay than MAN-AOMDV since we are employing stable nodes to choose an appropriate routing. As a result, the path's delay reduces, and the overall delay ends up being less than MAN-AOMDV.

In Fig. 3, the packet delivery ratio is roughly identical when using paths with minimal network load, however as the load in the network increases, the performance of MAN-AOMDV declines and SMMSN-AOMDV takes control as the load in the network is low, network load balancing is not as necessary because the resources in the network can meet the needs of the communications, However, when network traffic grows and one link cannot support communication with sufficient resources, load balancing becomes necessary. SMMSN-AOMDV distributes traffic to several pathways that are selected based on reliable nodes to share the load on the network, thus improving the packet delivery.

The throughput of the network for both SMMSN-AOMDV and MAN-AOMDV is almost the same in Fig. 4, but when the load on the network grows, the throughput drops because a high load causes congestion, as a result the packets are not received by destinations. Therefore, when using a node for transmission, the possibility of a packet dropping is high when congestion occurs along that path, which is the reason that the throughput of MAN-AOMDV drops. In contrast, SMMSN-AOMDV has a higher throughput since it uses multiple paths and distributes the traffic, which lowers the chances of packet drops. The end-to-end delay findings for SMMSN-AOMDV and MAN-AOMDV are shown in Fig. 2. The end-to-end latency also increases when a node leaves the channel and chooses a different path since only delivered packets are taken into account when calculating the end-to-end delay. The throughput data are displayed in Fig. 4. As we use less loaded pathways with fewer packets, the throughput and packet delivery ratio rise.

Because SMMSN-AOMDV has more robust Intermediate Nodes than MAN-AOMDV, there have been less packet losses, which has improved network performance and packet delivery. The comparative of MAN-AOMDV and SMMSN-AOMDV with regard to packet deliver ratio utilizing perfect pathways is shown in Fig. 3. SMMSN-AOMDV chooses stable Intermediate Nodes since they allow for less packet processing at each node, which improves the packet delivery ratio. The chances of a packet dropping at the intermediate node are even lower as more stable intermediate nodes are added and the packets are distributed because congestion will be avoided until the most stable intermediate nodes are chosen to receive perfect paths with low loads and achieve the highest packet delivery ratio. The primary advantage of the suggested plan is that the protocol may offer an acceptable improvement in average end-to-end delay without sacrificing any other QoS metrics.

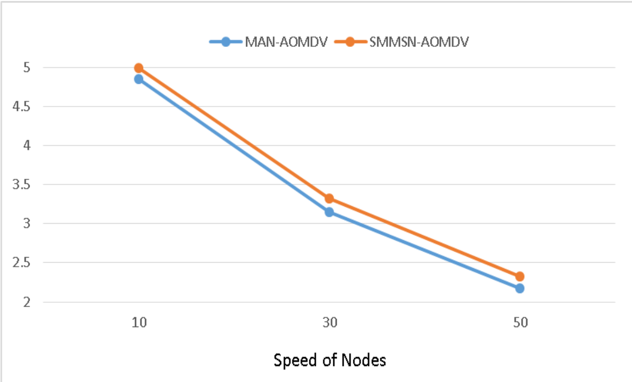

Fig 1. Packet delivery ratio

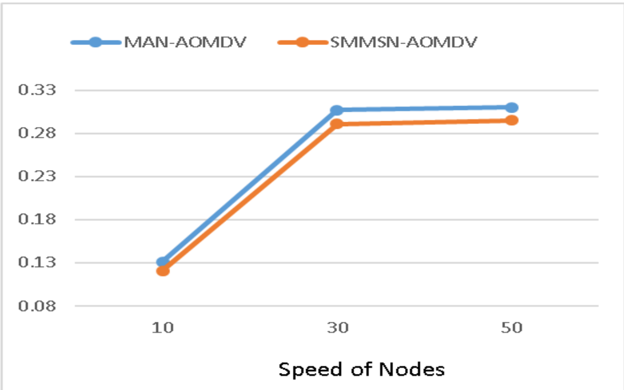

Fig 2. End-to-End Delay

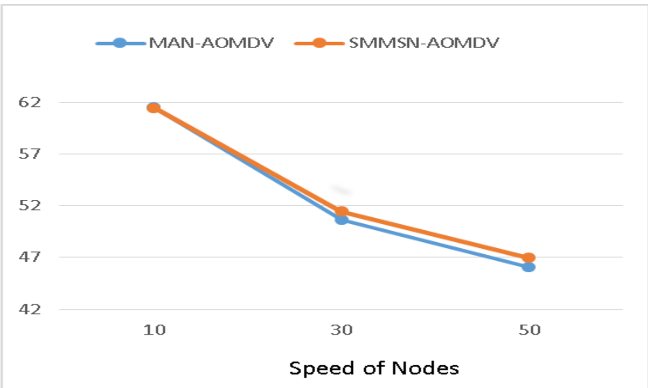

Fig 3. Throughput

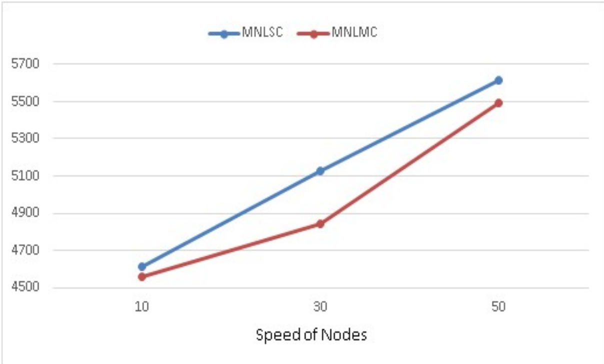

Fig 4. Packet Loss

I. Conclusion

As AOMDV only uses one path at a time, the suggested technique improves MAN-AOMDV protocol at higher loads. In contrast, SMMSN-AOMDV divides traffic into several suitable paths, which helps distribute the load across more nodes, which is leads to better resource utilization, and increases network lifespan as well as promotes balanced power consumption.

5. Future work

The suggested method outperforms AOMDV, but it could perform even better by using routine updates on the node and packet information of the nodes in the paths so that the nodes can make dynamic decisions about using better routes while data is being transmitted, which can result in even better use of network resources. The proposed approach can help in extending the network lifetime if energy is additionally employed as a path selection parameter.

References

[1] B. C. Mallikarjun and V. Kapinaiah, "Mobile Agent Based Protocol for Location Management in Mobile Ad Hoc Networks," 2021 Int. Conf. Wirel. Commun. Signal Process. Networking, WiSPNET 2021, pp. 406–410, 2021, doi: 10.1109/WiSPNET51692.2021.9419424.

[2] A. S. Mustafa, M. M. Al-Heeti, M. M. Hamdi, and A. M. Shantaf, "Performance Analyzing the Effect of Network Size on Routing Protocols in MANETs," HORA 2020 - 2nd Int. Congr. Human-Computer Interact. Optim. Robot. Appl. Proc., 2020, doi: 10.1109/HORA49412.2020.9152838.

[3] R. E. Ahmed, "A low-overhead multi-hop routing protocol for d2d communications in 5g," J. Commun., vol. 16, no. 5, pp. 191–197, 2021, doi: 10.12720/jcm.16.5.191-197.

[4] M. Agrawal, V. Jain, and N. Mohan, "New Approach for Improving Battery Power Consumption of Wireless Mobile Adhoc Networks Nodes Using Genetic Algorithm," 2020 Int. Conf. Power Electron. IoT Appl. Renew. Energy its Control. PARC 2020, pp. 378–381, 2020, doi: 10.1109/PARC49193.2020.236630.
[5] A. Ngoc Le and V. Minh Le, "Design a simulation model of multi-radio mobile node in MANET," Int. Conf. Adv. Technol. Commun., vol. 2020-Octob, pp. 237–240, 2020, doi: 10.1109/ATC50776.2020.9255458.
[6] S. Kanthimathi and J. R. Prathuri, "Classification of Misbehaving nodes in MANETS using Machine Learning Techniques," 2020 2nd PhD Colloq. Ethically Driven Innov. Technol. Soc. PhD Ed. 2020, pp. 3–4, 2020, doi: 10.1109/PhDEDITS51180.2020.9315311.
[7] N. C. Brintha, J. T. W. Jappes, and M. S. Vignesh, "Managing & detecting fishy nodes in MANET using cloud concepts," Proc. 3rd Int. Conf. Smart Syst. Inven. Technol. ICSSIT 2020, no. Icssit, pp. 166–169, 2020, doi: 10.1109/ICSSIT48917.2020.9214093.
[8] S. Kurumbanshi, S. Rathkanthiwar, S. Patil, and P. Wararkar, "Deployment of Energy Efficient Network using Dynamic Source Routing," 2021 Int. Conf. Comput. Commun. Informatics, ICCCI 2021, pp. 1–5, 2021, doi: 10.1109/ICCCI50826.2021.9402595.
[9] M. Gao, B. Zhang, and L. Wang, "A dynamic priority packet scheduling scheme for post-disaster UAV-assisted Mobile Ad Hoc network," IEEE Wirel. Commun. Netw. Conf. WCNC, vol. 2021-March, 2021, doi: 10.1109/WCNC49053.2021.9417537.
[10] N. Sharma, M. Sharma, and D. P. Sharma, "A trust based scheme for spotting malicious node of wormhole in dynamic source routing protocol," Proc. 4th Int. Conf. IoT Soc. Mobile, Anal. Cloud, ISMAC 2020, pp. 1232–1237, 2020, doi: 10.1109/I-SMAC49090.2020.9243369.
[11] Y. Ma and M. Capili Kummer, "A Robust Routing Algorithm with Dynamic Minimum Hop Selection in Wireless Sensor Networks with Unreliable Links," Proc. - 2020 2nd Int. Conf. Inf. Technol. Comput. Appl. ITCA 2020, pp. 37–40, 2020, doi: 10.1109/ITCA52113.2020.00015.
[12] Y. M. Sharma, P. K. Saini, and P. Kumar, "ORSM: An optimized routing scheme for MANETs," Proc. 2nd Int. Conf. Inven. Syst. Control. ICISC 2018, no. Icisc, pp. 566–571, 2018, doi: 10.1109/ICISC.2018.8398863.
[13] T. P. Latchoumi, A. V. Vasanth, B. Bhavya, A. Viswanadapalli, and A. Jayanthiladevi, "QoS parameters for Comparison and Performance Evaluation of Reactive protocols," Int. Conf. Comput. Intell. Smart Power Syst. Sustain. Energy, CISPSSE 2020, pp. 29–32, 2020, doi: 10.1109/CISPSSE49931.2020.9212285.
[14] M. A. Azer, "Effect on QoS in MANETs," pp. 155–160, 2021.
[15] E. Grossi, M. Lops, and L. Venturino, "A New Look at the Radar Detection Problem," IEEE Trans. Signal Process., vol. 64, no. 22, pp. 5835–5847, 2016, doi: 10.1109/TSP.2016.2598312.
[16] S. Sarhan and S. Sarhan, "Elephant Herding Optimization Ad Hoc On-Demand Multipath Distance Vector Routing Protocol for MANET," IEEE Access, vol. 9, pp. 39489–39499, 2021, doi: 10.1109/ACCESS.2021.3065288.
[17] S. U. Masruroh, A. Z. S. Perdana, H. B. Suseno, A. Fiade, D. Khairani, and H. T. Sukmana, "Energy Efficient Routing Protocol AOMDV on MANET (Mobile Ad-Hoc Network) with Malicious Node," 2020 5th Int. Conf. Informatics Comput. ICIC 2020, pp. 3–6, 2020, doi: 10.1109/ICIC50835.2020.9288654.
[18] G. Soni, M. K. Jhariya, K. Chandravanshi, and D. Tomar, "A Multipath Location based Hybrid DMR Protocol in MANET," Proc. 3rd Int. Conf. Emerg. Technol. Comput. Eng. Mach. Learn. Internet Things, ICETCE 2020, no. February, pp. 191–196, 2020, doi: 10.1109/ICETCE48199.2020.9091778.
[19] A. Bhardwaj and H. El-Ocla, "Multipath routing protocol using genetic algorithm in mobile ad hoc networks," IEEE Access, vol. 8, pp. 177534–177548, 2020, doi: 10.1109/ACCESS.2020.3027043.

Shian Safar Sulaiman She is assistant lecturer at University of Duhok, Iraq. Received high Diploma in computer science from collage of education,duhok university. His MSc in computer science from sam Higginbottom Institute of Agricultural,Technology and Sciences -Allahabad,India. and B.Sc in College of Computer Science and Mathematics from University of mosul , iraq

Saad Sulaiman Naif He is currently a lecturer at University of Duhok, Iraq since 2011. Received his Master of Technology (M.Tech) in Information Technology at Jawaharlal Nehru Technological University (JNTUH), India. His area of interest is Mobile Ad Hoc Networks (MANETs), Routing Protocols and the Internet of Things (IoT). He has multiple published papers in International and National Journals and Conferences.

Barzan Abdulazeez Idrees. Received MSc in Computer Networks and Information Security at Jawaharlal Nehru Technological University Hyderabad (JNTUH), India in 2011, and earned his BSc in computer science at University of Mosul, Iraq in 2006. His area of interest is computer networks, network security and machine learning. He has published several national and international articles in peer-reviewed and indexed journals and conferences.

Abdulraheem Jamil Ahmed Instructor at I.T Department, Duhok Polytechnic University. He received B. Eng. In Medical Instrumentation Technology Engineering, Mosul Technical College, Northern Technical University. He received a Higher Diploma Degree In Computer Aided Instructional Engineering, University of Technology, Baghdad, Iraq. He received a Master's degree in Information Technology, M-Tech (I.T.) from the Department of Computer Science and Engineering, JNTUH College of Engineering, Hyderabad, India. He is a member of the Zakho Technical Institute Committee 2011-present. His research interest is Wireless Networks, e-learning and neural networks..