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Evaluating The Efficiency Of Genetic Algorithm-Based Routing In MANET's

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Abstract

Due to the inherent instability of mobile ad hoc networks (MANETs), frequent node mobility, bandwidth constraint, and energy constraint are some of the problems that render effective routing an uphill task. Although the standard routing systems such as the AOMDV provide reliable path solutions, they do not necessarily provide the best solutions to optimizing the performance of networks in circumstances where the environment is becoming volatile. This paper uses the Network Simulator 2 (NS2) simulation to compare the performance of an AOMDV-based routing strategy with that of a Genetic Algorithms (GA)-based routing strategy. The simulation parameters are a node range of 40-120, a size of 1250 x 1250 m, the IEEE 802.11 MAC protocol and a transmission range of 250 m. Performance is measured by three major measures, which include end-to-end latency, packet delivery ratio, and throughput. The GA-based protocol based on the outcomes of the experiments minimizes the delay in high mobility situations and attains better rates of packet delivery and throughput. To enhance the efficiency and stability of MANET, the findings suggest that improvement of adaptability and robustness of routing solutions can be provided by evolutionary computation methods.

Keyword: Genetic Algorithm, Evolutionary Routing, Performance Evaluation, Packet Delivery, Throughput, Wireless Communication.

Introduction

Smart, bio-inspired technologies have a huge potential in the next-generation wireless communication systems as this paper reveals. Mobile ad hoc networks (MANETs) due to its ability to establish networks without an underlying infrastructure have made it a desirable communication paradigm. These networks are particularly effective in cases such as disaster recovery, military operations and remote location communications where fixed infrastructure is either unavailable or not feasible. With numerous positive characteristics, including low energy consumption, high turnover of topology, and the mobility of the nodes, the creation of efficient and reliable routing protocols is not an easy task in the creation of MANETs. Due to the inefficient adaptation, the classic routing algorithms often fail to perform well in these dynamic environments and this leads to lower network lifetime, end to end delay, and packet delivery ratio.

Thus, to enhance the effectiveness of MANET, the new, flexible and smart routing algorithms need to be considered. Evolutionary computing, more so Genetic Algorithms (GAs) have also been explored in recent times to enhance the efficiency of MANET routing. GAs solve optimization problems with high efficiency, taking information in genetics and natural selection, by over generations of execution, slowly converging on better solutions of the problem. Unlike in traditional protocols where only one metric is used such as energy consumption, link reliability, shortest distance or delay, GAs applied to MANET routing can optimize routes based upon many metrics at the same time. Due to this optimization capability, the routing of GA is able to react immediately to the topology changes and reroute data packets by taking the most optimal paths that are currently available.

The studies of the effectiveness of GA-based routing in MANETs are therefore of paramount importance. Measures of efficiency such as energy consumption, overhead of control, mean end-to-end latency, proportion of packets delivered, and throughput are typically the focus of such tests. By comparing the metrics of GA-based routing to those of established routing protocols, such as AODV, DSR, or OLSR, researchers can determine whether GA-based routing will enhance performance in a wide range of traffic scenarios, node densities, and mobility patterns. Besides an increase in performance, other areas of efficiency evaluation involve computational overhead, scalability, and adaptability of the algorithm to heterogeneous situations. The importance of this evaluation is that it can bridge the gap that exists between theoretical optimization models and actual network performance. The performance of GAs in MANET routing is determined by factors such as chromosome encoding, fitness functions formulation, and convergence rate, but GAs offer an innately robust and versatile model of optimization. The suggested GA-based routing is suited for mobile devices with limited resources because it not only finds optimal routes but also uses reasonable amounts of energy and computes little. In order to prove that GA-based routing in MANETs is a viable next-generation solution that can beat conventional approaches in extremely dynamic wireless settings, it is crucial to study its efficiency in these networks.

1. REVIEW OF LITERATURE

Obeidat, Alaa & Shalabi, Mohammed. (2022). There has been a lot of buzz and interest among academics in the network discipline as of late. The network needs to be able to function with different types of infrastructure and adjust to changes in topology quickly. Analysis and study can be aided by visualizing the networks using a series of edges that change over time. This research introduces a new approach to dynamic and adaptive network routing that takes into account network delays and is based on a Regenerate Genetic Algorithm (RGA). If not the shortest route, then at least a good one can be identified from the starting point to the destination with the help of RGA. Solving the shortest path (SP) problem is a common algorithmic task; for example, the Dijkstra algorithm can handle polynomial SP problems. These operate just as effectively in wireless networks that use fixed infrastructure as they do in wired ones. Confronting real-time communication for dynamic network topologies, however, uses the same procedures, which introduce exponential processing complexity. Regardless of the network's structure, volume (with many routes), deletion of links or nodes, or other modifications, the suggested genetic algorithm (GA) offers more efficient and dynamic solutions.

Alsaqour, Raed et al., (2021). A time-variable infrastructure mobile ad hoc network, or MANET, is a wireless network that may be reconfigured dynamically. The topology of a MANET is dynamic since nodes in the network are mobile. The complexity in determining the routes used by packets during routing has increased due to these modifications. In order to enhance the efficiency of MANET routing protocol, this paper proposes a technique known as GALAR that is an abbreviation of genetic algorithm-based location-aided routing. The GALAR algorithm uses a genetic optimization policy to maintain node location information adaptively up-to-date; by inserting the location of the transmitting node in the routing packet and selecting the transmitting node to send packets to the destination node, the GALAR algorithm considers all the parameters that influence the delivery behavior. Simulation results revealed the GALAR algorithm could provide a probability ratio of more than 99 percent in the delivery of packets with a network overhead of not so high. Moreover, the comparison of GALAR to other methods was also done using other network evaluation metrics. In comparison with the other algorithms applied in the research, GALAR performed significantly better.

Biswas, Satarupa. (2020). The MANETs also face topology dynamics, energy conservation and node migration due to lack of infrastructure design. To address these fears, MANETs resort to using the concept of dynamic load balancing based routing, which is a concept of big data analytics. The longevity of the network is affected by efficient routing, load balancing and quality-of-service (QoS) based data transfer. Network performance can be optimized by computing evolutionary algorithms and adding topological modifications to the topology. To maintain the load balance and data pathways, a genetic algorithm can be used in selecting the most energy-efficient cluster. According to the simulation data, Genetic Algorithm Based Optimized Routing Methodology through Big Data Analytics in MANET extends the life of networks through the quality-of-service optimization.

Pawan, et al., (2018). Genetic algorithms are one of the most popular tools when it comes to optimization of AI. All its devices in the mobile ad hoc networks (MANETs) use battery power. The power efficiency of the nodes when transporting data is an important issue in MANETs. In the current work, a new genetic algorithm-based routing protocol of MANET is presented. To calculate the most energy-efficient method of transmitting data between one node and another, this protocol utilizes genetic algorithms. The simulations indicate that the proposed strategy is more superior to the previous algorithms.

Franciszek. Pilski, Marek & Seredynski. (2008). Ad hoc networks Mobile ad hoc networks have a highly dynamic topology. Due to this, maintenance of a constant state in the name of routing may prove to be a bit difficult. The key goal is to create a path between two nodes in an effective and efficient way. An even more daunting task is the provision of energy efficient routing protocols. This research introduces the concept of genetic algorithm (GA) based energy efficient routing algorithm. The eventual aim of the algorithm is to maximize the lifetime of the network. The longer the time that a network can remain online is directly proportional to the size of the energy that each node is capable of storing in its batteries. Routing metric is a measure that follows the duration over which the network takes before the battery of the first node exhausted. The aim of the suggested algorithm is to maximize the lifetime of the network. We would advise to use one of the various heuristics to choose a route. In this article, we describe the GA-based approach of finding a heuristic combination which solves the power-aware routing problem. One of the solutions to a problem is a heuristic combination that chooses the most appropriate paths depending on the current condition of the network (the energy of the nodes).

2. SIMULATION SETUP

This study compares the proposed evolutionary algorithm to the AOMDV and uses Network Simulator 2 (NS2) to mimic results. In figure 1, we can see the scenario and the simulation parameters.

No. of Nodes	40, 60, 80, 100, 120
Area Size	1250 X 1250
Mac	IEEE 802.11
Transmission Range	250m
Simulation Time	50 sec
Traffic Source	CBR, Video and TCP
Packet Size	512
Routing Protocol	AOMDV and GA based Protocol
Speed	10,20,30 and 40 m/s
Rate	250kb
Initial Energy	10.3 J
Transmission Power	0.660
Receiving power	0.395

Figure 1: Simulation parameters

In order to evaluate the AOMDV in relation to the suggested genetic algorithm-based routing system, we employ the following metrics.

- **Packet delivery ratio**, this counts both the sent and received packets.
- **Throughput**: The throughput of a packet is the ratio of the overall time it takes to transmit a packet to the number of packets that are successfully delivered.
- **Delay:** Delay is the amount of time it takes for information to get from one place to another.

3. EXPERIMENTAL RESULTS

In this simulation experiment, you can utilize any number of nodes from 40 to 120. To evaluate the AOMDV protocol's efficacy, we can compare it to a genetic algorithm-based protocol using measures such as packet delivery ratio, throughput, and delay.

The scenario for AOMDV and genetic algorithm-based protocols is illustrated in Figure 2. In comparison to AOMDV, the genetic algorithm based protocol clearly performs better on the delay measure, as shown in the previous example. It results in shorter latency as compared to AOMDV.

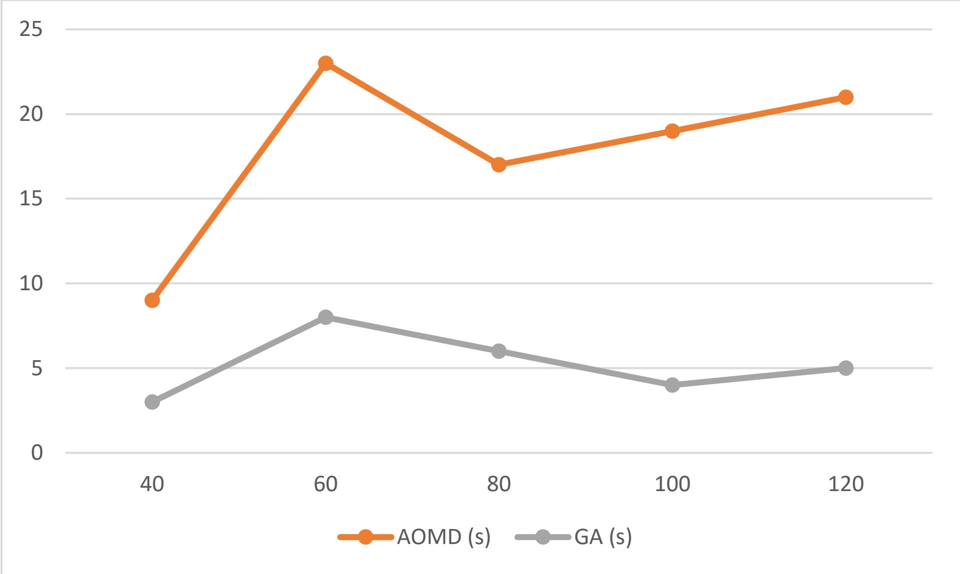

Figure 2: Variation of Delay with Number of Nodes

In Figure 3, we can see how AOMDV stacks up against evolutionary algorithm protocols in terms of packet delivery ratio vs. node count. In comparison to AOMDV, the genetic algorithm based protocol clearly achieves a higher Packet Delivery Ratio, as shown in the previous example. Its packet delivery ratio is better than that of AOMDV.

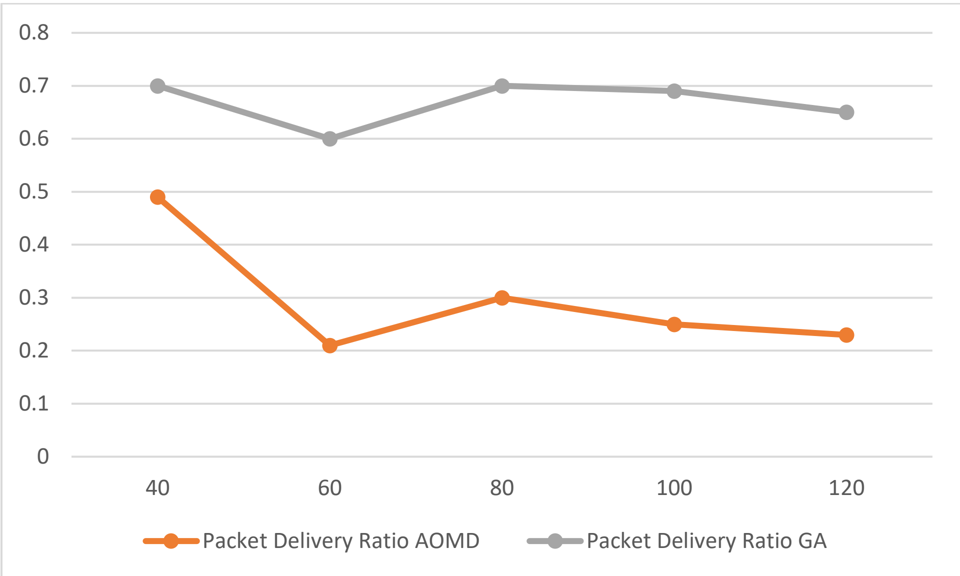

Figure 3: Variation of Packet Delivery Ratio with Number of Nodes

As shown in Figure 4, AOMDV is compared to evolutionary algorithm protocols with respect to the throughput to node ratio. Everything said so far points to the genetic algorithm based protocol having superior throughput performance than the AOMDV. When it comes to throughput, it beats AOMDV.

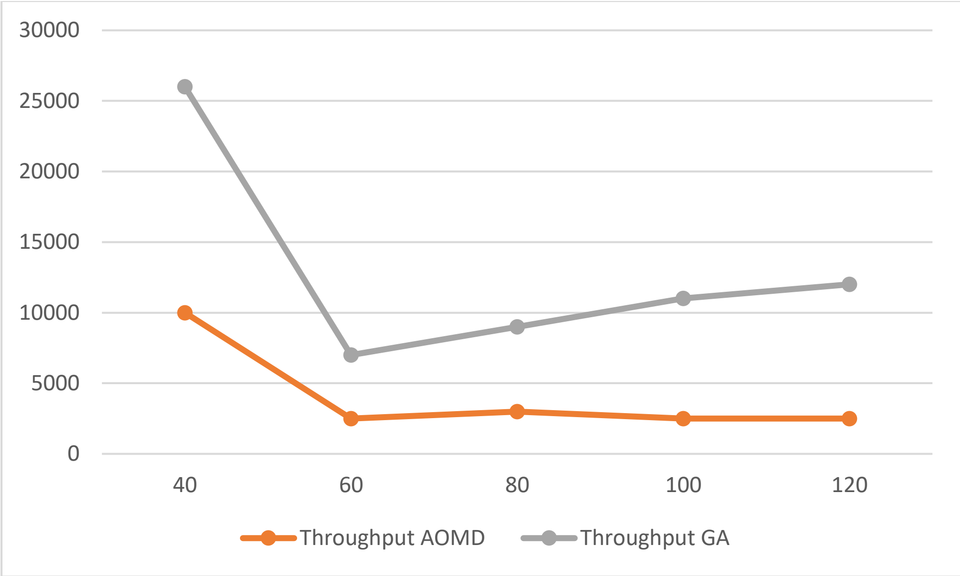

Figure 4: Variation of Throughput with Number of Nodes

The comparison between AOMDV and evolutionary algorithm protocols in terms of delay vs. node speeds is shown in Fig. 5. Using the preceding scenario as a benchmark, we can see that the genetic algorithm based protocol achieves better performance than AOMDV with respect to the delay metric. It results in shorter latency as compared to AOMDV.

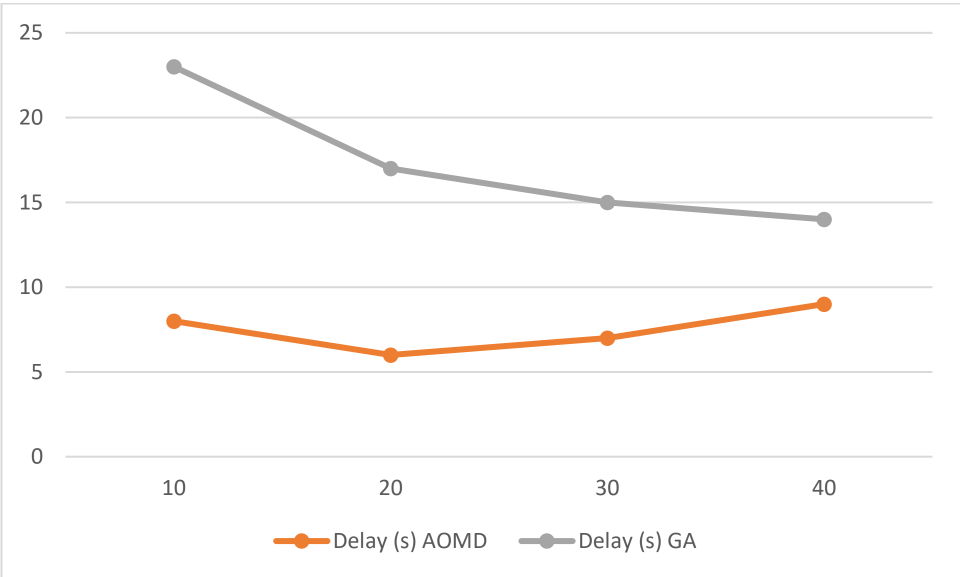

Figure 5: Variation of Delay with Node Speeds

With regard to packet delivery ratio versus node speeds, Fig. 6 compares protocols based on AOMDV and evolutionary algorithms. In comparison to AOMDV, the genetic algorithm based protocol clearly achieves a higher Packet Delivery Ratio, as shown in the previous example. It outperforms AOMDV in terms of Packet Delivery Ratio.

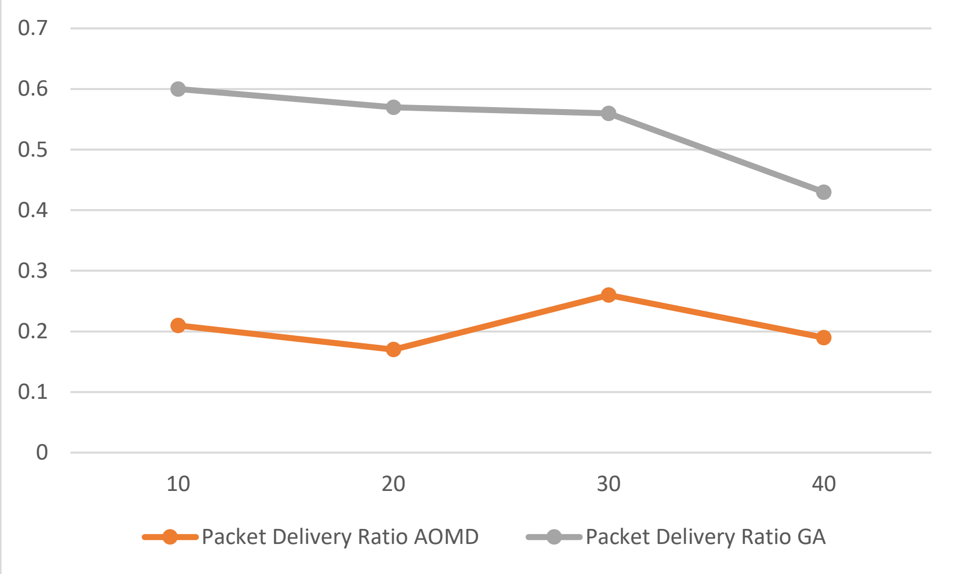

Figure 6: Variation of Packet Delivery Ratio with Node Speeds

With regard to throughput against node speeds, Figure 7 shows a hypothetical comparison of AOMDV and evolutionary algorithm protocols. Everything said so far points to the genetic algorithm based protocol having superior throughput performance than the AOMDV. When it comes to throughput, it beats AOMDV.

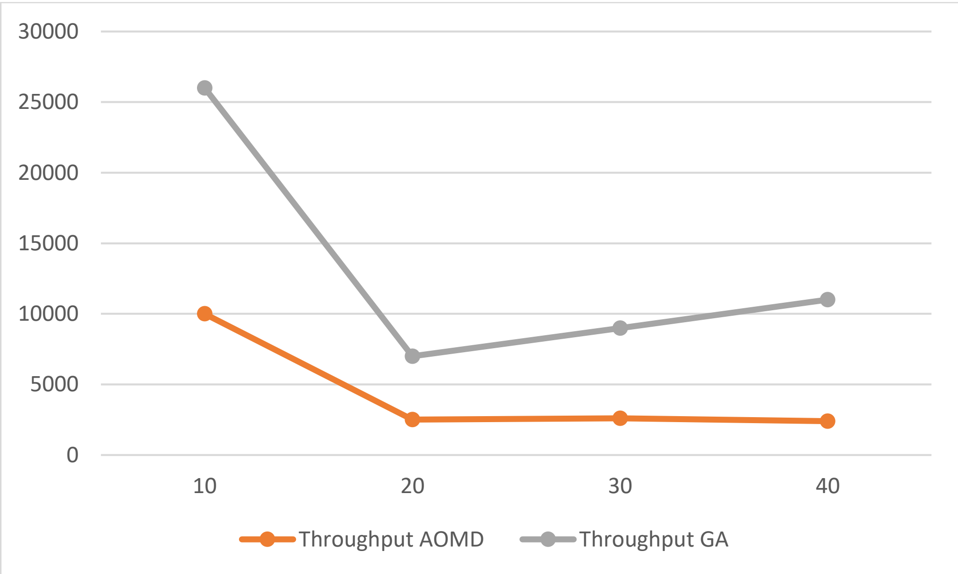

Figure 7: Variation of Throughput with Node Speeds

4. CONCLUSION

This research aimed to compare the performance of two commonly used MANET routing protocols with one being Genetic Algorithms (GA) based and the other on the more common Ad hoc On-demand Multipath Distance Vector (AOMDV) routing protocol. In NS2, we modeled various environments and mobility cases of network nodes and observed performance indicators, including packet delivery ratio, throughput and end-to-end delay. These findings indicate that GA-based technique is reliable to provide data transmission in highly dynamic scenarios and is better in throughput and packet delivery time than AOMDV over time. Moreover, the protocol based on the GA minimized the latency, which proves its ability to streamline routes and adjust to the topology changes that occurred on a regular basis.

As per the findings, Genetic Algorithms and other bio-inspired algorithms provide a clever and blended framework in enhancing MANET routing speed. In particular, GA-based routing is best adapted to routing in environments where the conditions of the network change rapidly, unlike the more traditional protocols which rely on unchanging methods. Despite these positive results of the study, it also demonstrates the importance of the balance between computing overhead and energy consumption in applying the evolutionary algorithm in the real world.

Overall, the results of the current research may be used to contribute to the growing body of evidence indicating that evolutionary optimization may be applicable to wireless networks. Improving the packet delivery, throughput and latency is one of the ways in which GA- based routing would improve the efficiency and reliability of MANETs. Future studies should explore the use of hybrid models that use genetic algorithms, along with other intelligent optimization techniques. The other option to consider is that of the validation of simulation findings through real-world test.

REFERENCES: -

[1] A. Bhattacharya and K. Sinha, "An efficient protocol for load-balanced multipath routing in mobile ad hoc networks," Ad Hoc Networks, vol. 63, pp. 104–114, 2017.

[2] A. Ghaffari, "Real-time routing algorithm for mobile ad hoc networks using reinforcement learning and heuristic algorithms," Wireless Networks, vol. 23, no. 3, pp. 703–714, 2017.

[3] A. Kout, S. Labed, and S. Chikhi, "AODVCS, a new bio-inspired routing protocol based on cuckoo search algorithm for mobile ad hoc networks," Wireless Networks, vol. 24, no. 7, pp. 2509–2519, 2018.

[4] A. Shaikh, D. Vasan, and K. Mohammadani, "Performance Analysis of MANET Routing Protocols A Comparative Study," International Journal of Computer Applications, vol. 83, no. 7, pp. 31–35, 2013.

[5] A. Taha, R. Alsaqour, M. Uddin, M. Abdelhaq, and T. Saba, "Energy efficient multipath routing protocol for mobile ad-hoc network using the fitness function," IEEE Access, vol. 5, pp. 10369–10381, 2017.

[6] Alsaqour, Raed & Kamal, Saif & Abdelhaq, Maha & Jeroudi, Yazan. (2021). Genetic Algorithm Routing Protocol for Mobile Ad Hoc Network. Computers, Materials & Continua. 68. 941-960. 10.32604/cmc.2021.015921.

[7] Biswas, Satarupa. (2020). GENETIC ALGORITHM BASED OPTIMIZED ROUTING METHODOLOGY THROUGH BIG DATA ANALYTICS IN MANET 3.

[8] D.-g. Zhang, P.-z. Zhao, Y.-y. Cui, L. Chen, T. Zhang, and H. Wu, "A New Method of Mobile Ad Hoc Network Routing Based on Greed Forwarding Improvement Strategy," IEEE Access, vol. 7, pp. 1–4, 2019.

[9] G. A. Walikar and R. C. Biradar, "A survey on hybrid routing mechanisms in mobile ad hoc networks," Journal of Network and Computer Applications, vol. 77, pp. 48–63, 2017.

[10] H. Khudayer, B. Alzabin, L. Anbar, M. Tawafak, R. Tawafak, T.-C. Wan, A. Al Sideiri, S. I. Malik, and T. Al-Amiedy, "A Comparative Performance Evaluation of Routing Protocols for Mobile Ad-hoc Networks," vol. 14, no. 4, pp. 438–446, 2023.

[11] J. Hong, "Efficient on-demand routing for mobile ad hoc wireless access networks," IEEE Journal on Selected Areas in Communications, vol. 22, no. 1, pp. 11–35, 2004.

[12] K. Thamizhmaran and A. Charles, "Comparative Study of Energy Efficient Routing Protocols in Manet," WSEAS Transactions on Communications, vol. 21, no. 1, pp. 55–67, 2022.

[13] M. S. Avhankar, D. J. A. Pawar, S. Majalekar, and S. Kedari, "Mobile Ad Hoc Network Routing Protocols Using OPNET Simulator," International Journal on Recent and Innovation Trends in Computing and Communication, vol. 10, no. 1, pp. 1–7, 2022.

[14] M. Uddin, A. Taha, R. Alsaqour, and T. Saba, "Energy Efficient Multipath Routing Protocol for Mobile Ad-Hoc Network Using the Fitness Function," IEEE Access, vol. PP, no. 99, pp. 1–4, 2017.

[15] Obeidat, Alaa & Shalabi, Mohammed. (2022). An Efficient Approach towards Network Routing using Genetic Algorithm. International Journal of Computers, Communications & Control (IJCCC). 17. 10.15837/ijccc.2022.5.4815.

[16] Pawan, & Sharma, Rajendra & Sharma, A. & Jain, Vinod. (2018). Genetic Algorithm-Based Routing Protocol for Energy Efficient Routing in MANETs. 10.1007/978-981-10-6005-2_4.

[17] Pilski, Marek & Seredyński, Franciszek. (2008). An energy efficient routing algorithm based on genetic algorithm for ad hoc networks. Annales UMCS, Informatica. 8. 10.2478/v10065-008-0004-6.

[18] R. Ema, A. Akram, M. A. Hossain, and S. Das, "Performance Analysis of DSDV, AODV AND AOMDV Routing Protocols based on Fixed and Mobility Network Model in Wireless Sensor Network," Global Journal of Computer Science and Technology, vol. 14, no. 6, pp. 1–10, 2014.

[19] R. Yadav, "Performance Comparison and Analysis of Table Driven and On-Demand Routing Protocols for Mobile Ad-hoc Networks," Information Technology - IT, vol. 4, no. 2, pp. 101–109, 2007.

[20] S. Kim, "An ant-based multipath routing algorithm for QoS aware mobile ad-hoc networks," Wireless Personal Communications, vol. 66, no. 4, pp. 739–749, 2012.

[21] S. T. Hasdemir, S. Yılmaz, and S. Sen, "A Novel Multi-Featured Metric for Adaptive Routing in Mobile Ad Hoc Networks," Applied Intelligence, vol. 49, no. 8, pp. 2823–2841, 2019

[22] T. A. Murshedi, X. Wang, and H. Cheng, "On-demand multipath routing protocols for mobile ad-hoc networks: a comparative survey," International Journal of Future Computer and Communication, vol. 5, no. 3, pp. 148–157, 2016.

[23] V. K. Quy et al., "Survey of recent routing metrics and protocols for mobile Ad-hoc networks," Journal of Communications, vol. 14, no. 2, pp. 110–120, 2019.