Design and Simulation of Efficient Dynamic Data Forwarding Protocol towards Route Optimization in VANET Infrastructure

Dr. D. Maheshwari[1], K. E. Hemapriyai[2], Dr. M. Savithri[3]

[1] *Associate Professor, Department of Computer Science with Data Analytics, KPR College of Arts Science and Research, Coimbatore, India. maheshgkrish@gmail.com & maheshwari.d@kprcas.ac.in*

[2] *Assistant Professor, Department of Computer Science and Computer Application, Sri Krishna Arts and Science College, Coimbatore, India. kehemapriya@gmail.com*

[3] *Assistant Professor, Department of Data Science, Christ –Deemed to be University, Lavasa, Pune, India. savithri.m@christuniversity.in*

Abstract: The VANET, which consists of the Internet and the Internet of Things (IoT), has recently been implemented with the Internet of Vehicles (IoV). Through the use of a car network and an AdHoc approach, it provides the user with environmental traffic information. Combining the networks of cars, known as VANETs, allows for infrastructure-free data transfer, particularly for entertainment and emergency vehicle notification. The data or packet delivery ratio, data communication latency, data transmission faults, and details of vehicle collisions are among the traffic information provided by the internet of vehicles. In this work, an unmanned aerial vehicle (UAV) is used to solve the problem of route optimisation in VANET topologies for effective data transfer. Many routing protocols are used to improve the effectiveness of the packet or data routing process. In order to alleviate the routing issue and generate an effective way for efficient data transfer with strong network stability, the Optimised Link State Routing (OLSR) Protocol is used in this study with energy-saving techniques on many parameters. To evaluate the efficacy of the suggested routing technique on various network sizes, extensive simulations are carried out on the NS2 simulator with various network parameters. When compared to traditional routing protocols along UAV-based protocols for data transmission, the performance results of the suggested data routing solution employing OLSR protocol achieve higher efficient pathways. Ultimately, the suggested routing system produces superior outcomes in terms of message throughput, message delivery ratio, latency and network overhead on comparing with existing routing protocols.

Keywords: Internet of Vehicles, VANET, Route Optimization, Unmanned Aerial Vehicles, Artificial Intelligence

1. INTRODUCTION

IoV is a contemporary VANET implementation that combines the Internet with the Internet of Things (IoT) for effective data exchange. The Vehicle Adhoc Network (VANET) is a type of wireless network that operates without any infrastructure and facilitates data transmission between automobiles interacting with one another close to the roadside [1]. VANET is categorised as a subclass of Wireless Adhoc Networks (WANET) and belongs to the class of Mobile Adhoc Networks (MANET). Vehicle-to-vehicle (V2V) and Vehicle to Infrastructure (V2I) communication architectures are the two main representation modalities used by mobile cars in VANET architecture [2]. In the vehicle-to-vehicle architecture, the cars use the Dedicated Short Range Communication (DSRC) protocol to send messages and exchange data with every other vehicle in the network, whereas in the vehicle-to-vehicle infrastructure[3]

The configuration of the vehicular adhoc network is incredibly good at preventing vehicle speed, count, and direction changes [4]. The purpose of VANET is to collect roadside traffic data in order to reduce problems such as traffic jams and collisions between vehicles by offering a more dependable route that reduces network latency brought on by traffic congestion [5]. Along with other crucial issues like road obstacles that make communication difficult due to physical hindrance for vehicles to communicate efficiently, routing protocols can also effectively handle a number of network issues that result in unreliable communication, such as mobility issues, short vehicle ranges, and infrastructure installation costs[6].

Several artificial intelligence-based routing techniques, including as genetic algorithms, particle swarm optimisation, and ant colony optimisation, are used to carry out efficient data transmission [7]. In order to provide reliable and stable data transfer, an unmanned aerial vehicle (sink) has been integrated with VANET in this research. To find the quickest path for data transfer, routing is done using the optimised link state routing protocol. In addition, it is optimised utilising a variety of techniques and network parameters, producing superior results than the conventional optimisation routing model. Lastly, different network parameters have been evaluated on differing network sizes to assess the efficacy of the proposed model [8].

The remainder of the paper is divided into the following sections: The standard data routing method, optimisation tactics, and clustering structures for unmanned aerial vehicles are covered in Section 2. In section 3, a thorough description of the suggested architecture for a dependable and stable path planning routing approach is provided. In Section 4, the findings of the VANET network simulation and the performance evaluation utilising several performance metrics in comparison to conventional were emphasised. In Section 5, the article is finally finished with recommendations for further investigation.

2. RELATED WORK

This section delves further into the investigation of the Efficient Message routing strategy for unmanned aerial vehicle network route planning, based on UAV deployment, vehicle node clustering, and optimal path finding for vehicle-to-vehicle message transmission. The effectiveness of each of the routing strategies has been evaluated by changing the node direction and network size. Additionally, the routing model that is almost identical to the suggested model is explained as follows:

2.1 U2RV: UAV-assisted reactive routing protocol for VANETs

Stable data routing and long-term connection have been improved in this architecture to enable point-to-point communication. Network problems including frequent connection failures and network partitions on networks with moving mobile vehicles and frequent direction changes are managed by the proposed models[9]. The suggested model would react rashly to different topological modifications in order to get over the path planning restriction when including an ad hoc mode with drones, also known as unmanned aerial vehicles (UAVs).

3. PROPOSED MODEL

This section describes the efficient infrastructure that has been built using the VANET architecture and the integration of unmanned aerial vehicles (UAVs) as message sinks for efficient data transfer between moving vehicles. Furthermore, it has been anticipated that a variety of routing algorithms would create an architecture with an optimisation methodology that uses artificial intelligence to provide the best path for message delivery. This particular architecture is

3.1 Network Infrastructure

Vehicles Nodes and Aerial node acting as Sinks used for data communication details of the specified infrastructure has been provided as follows

- **Node Deployment**

Vehicle Adhoc Networks in this work are composed of a set of moving vehicles, denoted by M = {m1, m2,.., m}. Different transmitter and receiver components, which together make up the various data collecting and transmission modes, may be implanted in different vehicles. All of the vehicles in the network are dynamically deployed within a defined region R of UAV. The vehicle's data collecting and communication radius is denoted by r and $2\boldsymbol{U}$, correspondingly [10].

Unmanned Aerial Vehicles

M = {m1, m2,..., mn} represents Unmanned Aerial Vehicles (Sink) that is formed of dynamic moving vehicles that are intended to approach vehicles and collect message from the vehicles. The battery-operated UAV is designed to go in a circular path to each car. When the UAV departs from the source vehicle and returns to the destination vehicle, a circle is formed. Let N0 represent the source vehicle nodes. To gather messages from source vehicle nodes and transfer them to the collection point, which serves as the destination vehicle node, tree topology will be built[11].

- **Message Collection Point**

The list of collection points for UAVs that have been found to collect messages or information from vehicles using UAVs is represented by the variable C = {c1, c2, ⋯, cm}. The established path that passes through each $pi\square P$ and arrives at the target vehicle node p0 is represented as π = (p0, p1, …, pm, p0). The UAV collecting sites will oversee all messages received from other vehicles and use UAVs to transfer the gathered information to the intended vehicle. From the source vehicle to the UAV collection location, the message will be sent in a hop-by-hop fashion to the decision vehicle [12].

3.4. Path Selection

This section outlines the clustering of vehicles for effective UAV-based data transmission. Using KNN clustering, vehicle nodes are grouped into clusters based on vehicle movement and the accuracy of the vehicle link calculation [13]. Each vehicle node is distributedly represented as a cluster head or a cluster member depending on how many vehicle nodes there are and how frequently they change directions. The cluster head will arrange the route for data transmission by UAV that includes environmental traffic information.

Algorithm 1: Path Planning Algorithm

Network Projection
    V is number of Network composed of Vehicle
    C is path clusters for route planning
Fix Path =V/C
Compute ()
    for J =1 to V
{
    for K = 2 to x
{
    Include the Vehicles Nodes in the Cluster groups with respect to UAV
}}

3.5. Dynamic data forwarding strategies

UAV visits every moving vehicle as a sink based on how frequently its direction changes. It was calculated using the best possible parameters and approaches. Rather, it computes some movement about the important concerns on the chosen spots that are reachable by the UAV and other nodes. Furthermore, the routing algorithm's fitness function optimisation establishes the order in which UAV sinks gather node information, hence improving data communication by delivering messages with minimal latency and high stability[14].

Algorithm 2: Dynamic data forwarding algorithm

For UAV=1 to Max Node
    For each Vehicle Node
do
    Calcuate node Fitness F(vehicle Nodes) = $\sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k}$
    If Fitness is better than Threshold

Communicate the Data
end
end
Strageies = S(s1,s2,s3);
For each Strageies S_n in S
Compute the optimal Route

In a multi-hop vehicle AdHoc Network communication model, the lesser the difference in communication distance among vehicle, the suitable the reliable and stable data delivery on vehicle AdHoc model.

4. SIMULATION RESULTS

This section uses the NS2 Simulator to simulate the proposed VANET architecture and provides a detailed overview of the UAV-assisted VANET [15]. Numerous performance results are exploited through extensive experimentation and comparison with traditional procedures. The network attributes and metrics of the network performance in terms of Message Throughput, Message Delivery Ratio, Network Overhead, and latency have been used to highlight the performance of the suggested technique. The network configuration and specification of the network parameters used in this simulation are listed in table 1 below.

Table 1: Simulation Parameters

Simulation Parameter	Value
Network Simulator Tool	NS2
Network Topology Size	300m *500m
Number of vehicles	50
Network Bandwidth	2Mbps
Message length	100 bytes
Simulation Time	30 minutes

In order to choose a path, the mobile sink's moving path for message delivery has been computed with reference to the cluster head. The simulation of the suggested network model using a UAV as sink is shown in Figure 1.

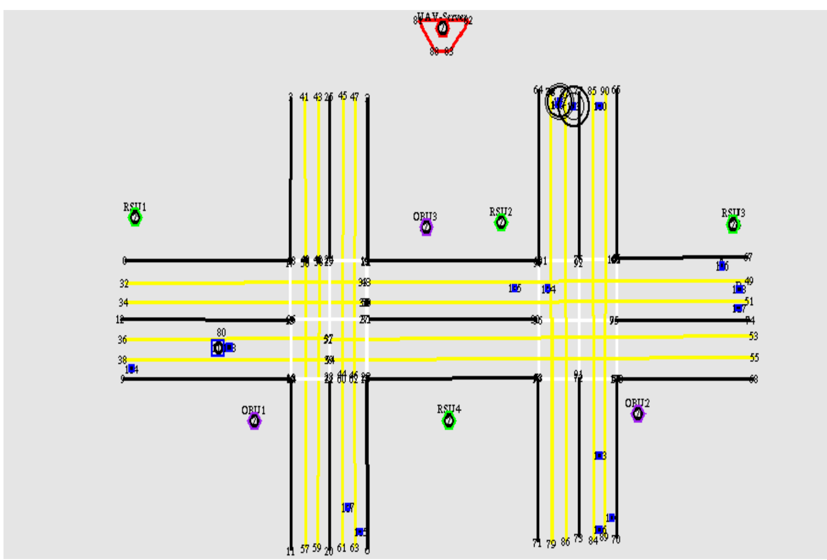
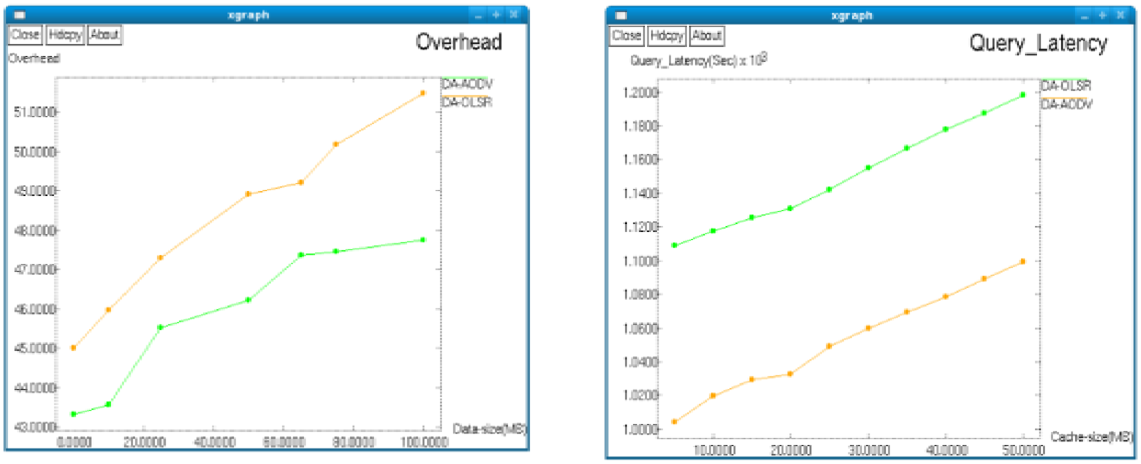


Figure1: Proposed Protocol Simulation

Each node calculates the traffic information for its surroundings and broadcasts it as a message when another vehicle requests data. On the basis of the latency and overhead in Figure 2 for frequency changing node direction, the network performance for different network size and moving node speed has been calculated.



(a) **(b)**

Figure 2: Performance Analysis of the protocols with respect to (a) Overhead and (b) Latency

The findings suggest that in the event of an unplanned node loss, the suggested method may quickly determine the best route for message transmission. The integration of path planning techniques as protocol optimisation will lead to an additional boost in the model's performance. Consequently, for efficient data transmission on the UAV sinks, the number of engaged vehicle nodes is computed. The model's performance in relation to throughput and delivery rate is shown in Figure 3.

(a) **(b)**

Figure 3: Performance Analysis of the protocols with respect to (a) Delivery Rate and (b) Throughput

For the purpose of guaranteeing data dependability and network stability, the suggested routing approaches assess the vehicle's efficiency and choose the best route for message delivery with the fewest number of hops.

Table 2 – Performance Evaluation of the protocols against various data traffic in the network

Technique	Message Throughput in mbps	Network Overhead in mbps	Message Delivery Ratio	Routing Latency
DA-AODV- Existing	66.58	14.23	96.78	0.34
DA-OLSR- Proposed	68.26	13.59	98.85	0.29

The routing performance of the UAV-assisted VANET is greatly impacted by changes in network size because higher transmission delays are caused by increased network density and overall traffic loads.

5. CONCLUSION

In this work, an optimised routing protocol—also known as multiple strategies inferred Optimised Link state Routing protocol—has been proposed and implemented by taking into account several UAV-assisted routing distance and time factors. In order to configure the node for effective message delivery with good connection quality, it uses the KNN model. Artificial intelligence approaches have been employed to estimate the multiple UAV propagation in order to facilitate efficient path planning. The network overhead is decreased by the proposed network paradigm. In the end, the network's performance was evaluated by adjusting the network's size, the vehicle's speed, and its direction. The simulation results show that the suggested architecture is more effective than the standard method in terms of throughput and latency.

6. REFERENCES

1. M. Houmer and M. L. Hasnaoui, “A qualitative assessment of VANET routing protocols under different mobility models,” Journal of Computer Science, vol. 15, no. 1, pp. 161–170, 2019.
2. J. Wang, X. Xiao, and P. Lu, “A survey of vehicular ad hoc network routing protocols,” Journal of Electrical and Electronic Engineering, vol. 7, no. 2, pp. 46–50, 2019.
3. S. K. Lakshmanaprabu, K. Shankar, S. Sheeba Rani et al., “An effect of big data technology with ant colony optimization based routing in vehicular ad hoc networks: towards smart cities,” Journal of Cleaner Production, vol. 217, pp. 584–593, 2019.
4. N. Melaouene and R. Romadi, “An enhanced routing algorithm using ant colony optimization and VANET infrastructure,” MATEC Web of Conferences, vol. 259, Article ID 02009, 2019.
5. S. R. Yahiabadi, B. Barekatain, and K. Raahemifar, “TIHOO: an enhanced hybrid routing protocol in vehicular ad-hoc networks,” EURASIP Journal on Wireless Communications and Networking, vol. 2019, no. 1, p. 192, 2019.
6. M. Arif, G. Wang, M. Zakirul Alam Bhuiyan, T. Wang, and J. Chen, “A survey on security attacks in VANETs: communication, applications and challenges,” Vehicular Communications, vol. 19, Article ID 100179, 2019.
7. Yookesh, T. L., et al. "Efficiency of iterative filtering method for solving Volterra fuzzy integral equations with a delay and material investigation." Materials today: Proceedings 47 (2021): 6101-6104.
8. K. Prakash, P. C. Philip, R. Paulus, and A. Kumar, “A packet fluctuation-based OLSR and efficient parameters-based OLSR routing protocols for urban vehicular ad hoc networks,” in Recent Trends in Communication and Intelligent Systems, pp. 79–87, Springer, Berlin, Germany, 2020.
9. X. Bao, H. Li, G. Zhao, L. Chang, J. Zhou, and Y. Li, “Efficient clustering V2V routing based on PSO in VANETs,” Measurement, vol. 152, Article ID 107306, 2020.
10. M. T. Abbas, A. Muhammad, and W.-C. Song, “Road-aware estimation model for path duration in Internet of vehicles (IoV),” Wireless Personal Communications, vol. 109, no. 2, pp. 715–738, 2019
11. D. Zhang, T. Zhang, and X. Liu, “Novel self-adaptive routing service algorithm for application in VANET,” Applied Intelligence, vol. 49, no. 5, pp. 1866–1879, 2019.
12. M. Elhoseny and K. Shankar, “Energy efficient optimal routing for communication in VANETs via clustering model,” in Emerging Technologies for Connected Internet of Vehicles and Intelligent Transportation System Networks, pp. 1–14, Springer, Berlin, Germany, 2020.
13. Reddy, C. S., Yookesh, T. L., & Kumar, E. B. (2022). A Study On Convergence Analysis Of Runge-Kutta Fehlberg Method To Solve Fuzzy Delay Differential Equations. Journal of Algebraic Statistics, 13(2), 2832-2838.
14. N. Lin, L. Fu, L. Zhao, G. Min, A. Al-Dubai, and H. Gacanin, “A novel multimodal collaborative drone-assisted VANET networking model,” IEEE Transactions on Wireless Communications, vol. 19, no. 7, pp. 4919–4933, 2020.
15. A. Kumar, K. Rajalakshmi, S. Jain, A. Nayyar, and M. Abouhawwash, “A novel heuristic simulation-optimization

method for critical infrastructure in smart transportation systems," International Journal of Communication Systems, vol. 33, no. 11, Article ID e4397, 2020.
16. M. Arif, G. Wang, M. Zakirul Alam Bhuiyan, T. Wang, and J. Chen, "A survey on security attacks in VANETs: communication, applications and challenges," Vehicular Communications, vol. 19, Article ID 100179, 2019.
17. O. Sami Oubbati, N. Chaib, A. Lakas, S. Bitam, and P. Lorenz, "U2RV: UAV-assisted reactive routing protocol for VANETs," International Journal of Communication Systems, vol. 33, no. 10, Article ID e4104, 2020.

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