ISSN: 2584-0495 Vol. 1, Issue 6, pp.342-350

International Journal of Microsystems and IoT

ISSN: (Online) Journal homepage: https://www.ijmit.org

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Cite as: Manoj, Chaba, Y., & Ganga. (2023). Integrating Machine Learning with Vanet for Enhanced Decision Making: A Review. International Journal of Microsystems and IoT, 1(6), 342-350. https://doi.org/10.5281/zenodo.10259813

Published online: 27 November 2023.

DOI: https://doi.org/10.5281/zenodo.10259813

International Journal of Microsystems and IoT
Vol. 1, Issue 6, pp. 342-350; DOI: https://doi.org/10.5281/zenodo.10259813

Integrating Machine Learning with Vanet for Enhanced Decision Making: A Review

Manoj, Yogesh Chaba, Ganga

Department of Computer Science & Engineering, GJUS&T, Hisar, Haryana, India

ABSTRACT
Transmissions are one of the most challenges to address in VANET. VANETs are subject to frequent topology and communication link modifications as a consequence of the rapid mobility of vehicles. The best routes may not be the most efficient if researchers are unable to get exact real time traffic densities because vehicle densities fluctuate so frequently; consequently, the best routes may not be the most efficient. By predicting automobile movements, research may then use machine learning to choose the most effective paths for transferring packets. VANET-based smart automobiles have made commuting safer, more efficient, more fun, more environmentally friendly, and more cost-effective than it has ever been. If crucial events are communicated on a regular basis, high safety may be attained in this setting. Reduced traffic and pollution, as well as more predictable travel times, are all necessary if we are to enhance productivity. Research paper focused on machine learning and wireless ad hoc networks, VANET and VANET routing protocols. Then past studies have been expressed along with methodologies and limitations. Vanet's routing protocols have been categorized and issues in prior studies are taken into account.

KEYWORDS
Wireless ad hoc Network, VANET and Routing Protocols, Machine Learning.

1. INTRODUCTION

VANETs' topology and communication connections change frequently due to vehicles' movement [1]. Transmission reliability is a challenging subject to tackle. As a result, many academics focus on determining the optimum paths to send packets, avoiding carry-and-forward instances, and lowering transmission delays [2]. Car movement prediction and machine learning route selection. [3, 4]

1.1 Machine Learning

Data may be given into computer systems and they can be taught to make more accurate predictions, which is the purpose of machine-learning. There are many other kinds of predictions that may be made, such as if individuals are crossing the street in front of an autonomous vehicle, whether the term "book" is being used to refer to paperbound or hotel reservation, or whether an email is a spam email. For the first time in the history of computer software, there is no human code that instructs the machine to discriminate between an apple and a banana. In other words, an enormous database of pictures tagged as containing either an apple or a banana was used to build a model for machine-learning that could accurately identify between the two fruits. An abundance of information is required for machine learning to work. [5]
Because of its potential to boost productivity, artificial intelligence has the potential to transform a variety of industries. There will be more and more reliance on machine learning as computing power improves. Computers may one day be able to exceed us in mental tasks.

Computer algorithms are better than radiologists in detecting cancers. On the other hand, the field of radiology is just getting started. As automation and artificial intelligence become more common, millions of jobs would go. It represents any form of computer program that can "learn" autonomously without the intervention of someone. In the context of big data analytics and data mining, the phrase "machine learning" is often used to refer to a wide range of software applications. When it comes down to it, the "brains" of most predictive programs—including spit filters, device recommendation engines, and scam detection systems—are machine learning algorithms [7]. Deep learning is one of the numerous kinds of machine learning methods available. [6, 8]

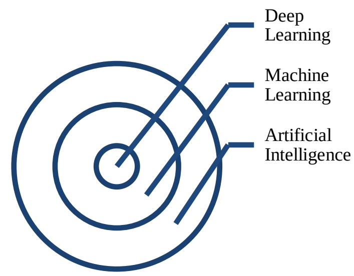

Fig. 1 Depicts interrelationship among AI, ML and Deep Learning

1.2 Wireless ad hoc network

Due to the absence of routers and access points in wired networks, the network might be considered ad hoc. As a result, the decision as to which nodes are responsible for forwarding data is made dynamically based on the connectivity of the network and the routing algorithm being used. Even though theoretical and practical constraints have been established to the overall network capacity, wireless ad-hoc networks may have advantages over wireless managed networks in certain function where central nodes cannot be common. Ad hoc networks are well-suited for use during times of crisis, such as natural catastrophes or military conflicts, because to their simple setup and rapid deployment. [13, 15,16]

1.3 Vehicular ad hoc networks (VANETs)

MANET is a new technology that combines a WLAN with an ad hoc network (MANET). VANET is a subtype of the MANET (WLAN). These vehicles have the ability to communicate with RSUs or other vehicles via wireless communication. Internet access is always available to drivers, so they may take advantage of the services they want whenever they want. VANETs can be used for a variety of purposes. [9]

VANETs have sparked a new wave of research and commercial activity because of their prospective applications [10]. VANETs can be used for a variety of purposes, including safety, traffic congestion and emergency notice, electronic toll collection, and the distribution and media and application layer [11]. To communicate between automobiles and roadside equipment, VANETs are utilized. AI in form of intelligent vehicular in VANETs [12] aids in the intelligent operation of vehicles in the event of a collision or an accident. With the use of radio waves, automobiles can now connect with one another as they travel along the road, instantaneously establishing wireless communication networks. To protect the VANET, lightweight protocols must be used.

Vehicle ad hoc networks (VANETs) have develop as a distinct subcategory of dynamic wireless networks in the wake of technological advancements [14]. Through the use of VANET, automobiles and roadside infrastructure can communicate with one another. It's a part of ITS (Intelligent transportation system). Nodes in a VANET exchange data wirelessly with other nodes in the network that support mobility. VANET focuses on mobile communication, traffic surveillance, and public utility management. In V2V & V2V communication modes are used in VANET. VANET's lack of infrastructure, such as access point, is one of its most distinguishing features. It can be found in the GSM or UMTS networks. Communication via automobiles explains a wide range of efforts by the government.

1.4 VANET Routing Protocols

Several routing protocols have been developed to improve the efficiency and reliability of VANET routing. These protocols are being utilized to enhance performance by reducing packet loss, security risks, and interference, as well as managing overhead. In VANETs, routing techniques have to cope with the increased mobility of nodes. The dynamic nature of the network causes frequent link disconnections. Choice of routing protocol is greatly influenced by this. There is no single routing protocol that can handle all of the different forms of traffic. [16]

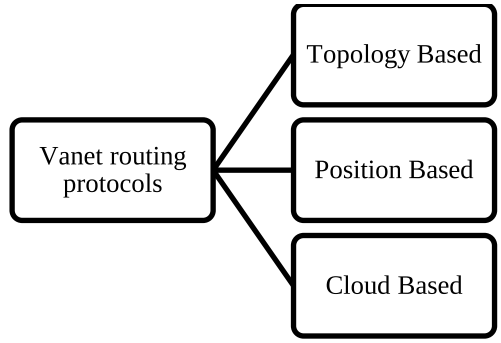

Fig. 2 Taxonomy of VANET Routing Protocols

1.4.1 Topology Based

Proactive and reactive routing protocols are included under it. DSDV and OLSR are examples of proactive routing systems that use the Distance Vector routing standard (OLSR). As a result, Distance Routing Effect Algorithm for Mobility outlines a positional routing method that relies on a greedy forward mechanism. As a result, the next hop location is always closer to the final destination than the present hop position. Stateless routing, also known as perimeter routing, does not take into account this greedy perimeter since the breadth of the roadway is even lower than its transmission range. Reactive routing protocols, on the other hand, require and maintain routes, which reduces the network's weight. There are just a few routes that the vehicles under the communication use.

1.4.2 Position Based

The position-based routing protocols query information for the physical position of the involved nodes for the availability of their direct neighbor than a request may be made by the sender for the position which contain in that packet. The packet which is transmitted with no knowledge of map to one neighbor who is quite close to the destination. These routing is lucrative till the source to the target path is correctly maintained and built.

1.4.3 Cloud Based

For intra- and inter-cluster management, cluster-based routing protocols use nodes with comparable characteristics to establish a cluster and select a cluster head. Cars' destinations are taken into account while arranging clusters in a vehicular network (AMACAD) and an efficient messaging system is implemented so that clusters may reply and prevent re-clustering. For example, it aims to keep track of the network's mobility patterns and extend the cluster's lifespan while reducing the overall overhead. In contrast, MOBIC employs a signal power mobility measure obtained from sequential receptions rather than the Lowest-ID technique. Each mobile node's neighbor's mobility variance is calculated by MOBIC, and a small variance implies that the mobile node is moving less than its neighbors'. However, approach still results in a significant increase in variance when only a few nearby nodes move differently.

1.5 Smart Vehicles

VANETs are essential for a safe, informative, and enjoyable transportation system. Cars are a common mode of transportation for today's folks. With the advent of VANET-based smart cars, that time has never been safer, more efficient, more enjoyable, cleaner, or more cost-effective. High safety can be achieved in this context if critical events are exchanged consistently. To increase productivity, traffic congestion and pollution must be reduced, and travel times must be more predictable. Additionally, VANETs can be linked to Internet to provide passengers with entertainment options such as file downloads and social media access. Both beacon and safety messages are used in VANETs. Beacons are used by vehicles to broadcast and advertise their status to nearby vehicles at 100 ms intervals. Beacon messages are used to communicate the sender's speed, & pseudo-ID to other vehicles. But instead of causing problems on the road, these warnings enable motorists to take immediate action to avoid accidents and save their passengers' lives when an emergency arises.

1.6 Essentials for efficient VANET

This section sheds light on the basic requirements for efficient and efficient application of VANET.

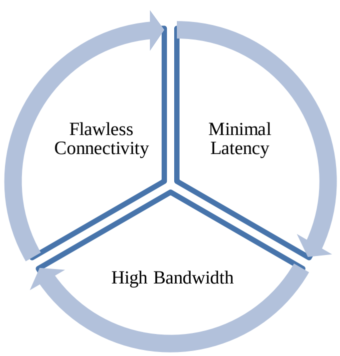

Fig. 3 Essential requirements for efficient VANET

1.6.1 Minimal Latency

Real-time applications require minimal latency, and future VANETs will have to meet this criterion if they are to be successful. There should be low latency for real-time applications, such as safety messages, in the future VANETs.

1.6.2 High Bandwidth

High-bandwidth applications, like as great-definition video streaming, will be in high demand in the future. Traffic applications also necessitate frequent.

1.6.3 Flawless Connectivity

Future VANETs required flawless connectivity between connected vehicles to handle the increased communication requirements. Connected and self-driving vehicles must communicate constantly and reliably with fog sensors. It should be able to prevent communication system failures.

Section 2 has explained the literature review part. Section 3 has explained the Vanet routing protocol classification part. Section 4 has focused on a problem statement. Section 5 has focused on need of research techniques. Section 6 is ex-pressing the scope of research in VANET.

2 LITERATURE REVIEW

There have been several researches in field of machine learning, wireless ad hoc networks and VANET. Prior researches in these fields are discussed in this section.

Autonomous and human-driven vehicle communication routing methods' performance in Madinah city under varied traffic situations has been documented by **Mohammad A. R. Abdeen et al. (2022)**. Three ad hoc routing protocols were evaluated in two different application scenarios with a mix of traffic and network simulation tools utilizing an extracted map of Madinah city to mimic various traffic distributions and densities. At high traffic densities, the average travel time was found to be reduced by 7.1% when using a fully autonomous vehicle scenario; nevertheless, the findings also indicated that the reactive ad hoc routing protocols caused the least delay in getting network packets to their neighbors VANET cars. Both of the reactive ad hoc routing protocols may be used for the VANET deployment in Madinah city, as can be inferred from these findings: autonomous cars save journey time significantly. In addition, they used an ANOVA test to look at how the variables they studied affected the variability of the results. [1]

Auto-tuning parameters of the OLSR routing protocol was studied by **Ravie Chandren Muniyandi et al. (2021)** in order to improve the performance of routing protocols for automotive ad hoc networks, demanding features, as well as to discover the optimal configurations. An effective and reliable routing strategy has to be devised as one of the most difficult challenges in the field for this type of network because of these properties. The VANET's dynamic features, including its architecture, density, and high speed, necessitated a system for flexible routing. Harmony Search Optimization, a meta-heuristic algorithm based on the combination of two selection techniques, was created by their study and is being used to optimize OLSR parameters. [2]

GAACO, introduced by **Gagan Deep Singh and his colleagues in 2021**, were incorporated into an optimal routing algorithm in three distinct realistic VANET network traffic situations. Among other things, their research compares and contrasts the classic VANET routing method with metaheuristics techniques. To ensure the accuracy of the findings, the recommended strategy was put to the test using open-source network and traffic simulation tools. On SUMO, the three distinct traffic situations were set up and then tried out using NS3.2. The GAACO algorithm was shown to perform better in all three traffic circumstances when compared to the other algorithms. Using data from Dehradun City, the realistic traffic network scenarios included average throughput, packet delivery ratio, end-to-end latency, and packet loss in the network as four performance metrics. [3]

Using a coaxial wire to power a circular patch, six fish-shaped radiating devices, and a circular planar ground**, Rahmani Faouzi et al. (2021)** A Rogers RT5880 substrate was used to build the antenna. To put it another way, its dimensions are 0.81-by-0.81-by-0.03. Six PIN diodes may be activated and deactivated to vary the beam's direction at the same frequency, allowing for six different working modes. The antenna was converted into a theoretical comparable circuit model. There was a detailed breakdown on how to improve the antenna's performance. [4]

Security vulnerabilities in VANET are developing as a result of their dependence on network infrastructure, and control technologies, according to **Muhammad Haleem Junejo et al. (2021)**. The use of machine learning and artificial intelligence on road transport networks might significantly reduce security risks. A comparison of cryptography and trust based on VANET applications and security needs was offered in their study. [5]

Researchers **Muhammad Asim Saleem and colleagues (2021)** investigated the use of four measures, to determine the best way to pick cluster heads for interviews. CH's stability is influenced by the vehicle's speed, distance, velocity, and rate of acceleration change. They all counted toward the overall benefit. Changing the model necessitated pinpoint accuracy for the vehicle's position. A prediction of CH stability was made with the Kalman filter's aid. For the benefit factor, the outcomes outperformed the current state of the art. Changes in dynamics and frequent disconnections in communication links were expected owing to the vehicle's speed. [6]

Modern vehicle network topologies were examined by **Anum Talpur et al. (2021)** Security threats on vehicle networks were classified according to a taxonomy developed by the authors. Based on their applicability in vehicular network applications, they categorized the ML approaches published in the literature ML methods were used to handle a wide range of security issues, and the authors went into great detail on how they worked. A discussion was held on the constraints and problems of utilizing ML-based approaches in vehicular networks." Finally, they shared their thoughts on what they had accomplished. [7]

Edge AI and VANET were proposed by **Rozi Bibi et al. (2021)** for the identification of road abnormalities by autonomous cars and the dissemination of road information to incoming vehicles. Reduce the number of accidents and dangers on bad roads by using camera-captured road photos and a vehicle-mounted trained algorithm for detecting road anomalies. For the automatic identification and classification of roads with anomalies such as potholes, bumps, cracks, and plain roads devoid of anomalies, datasets from various internet sources were used to the methods Residual CNN and VGG-11. Research indicated that models used to identify road irregularities performed better than others. [8]

Ranjit Sadakale et al. (2020) discussed that Even though VANET was classified as a Mobile Ad hoc Network (MANET), none of the MANET routing protocols are applicable to VANET because it is not a MANET network. The VANET network is constantly changing because of the increased speed and mobility of today's vehicles. Conventional routing was affected by vehicle mobility in VANETs. When it comes to a network node's dynamic behavior, algorithm performance is an important consideration.

One of the most effective MANET protocols was Ad hoc On-Demand Distance Vector (AODV); use as well as effective network adaption was provided. The AODV protocol has proven to be a success because of its efficiency. For VANET, it is regarded as a useful routing protocol + Ad-hoc TROPHY routing was proposed in their study (TAD-HOC). The efficiency and effective resource usage of the VANET network using a protocol. The goal of their project was in conjunction with Trustworthy VANET Routing and group authentication keys ad-hoc network (TROPHY). The proposed TAD-HOC protocol used the VANET network's time demand to transport data authentication. Using their proposed method, the VANET network's performance with packet delay was improved. [9]

Sara FTAIMI et al. (2020) cited an introduction to VANET networks was followed by a discussion of a range of assaults that may affect them. This was followed by an introduction to machine learning ideas and the most often used AI algorithms in VANET networks. The intrinsic nodes of VANET, like any other network, have difficulties and weaknesses that put their dependability in jeopardy. Machine learning techniques have been studied extensively in an effort to increase the dependability of the VANET network by detecting intrusions and generating predictions, and they have thus far produced excellent results [10].

2.1 Problem Statement

There is lack of real-life application in the previous researches. The scope of previous researches was very limited. There is need to enhance accuracy and efficiency in the field of VANET. Also, past studies overlooked the potential of integrating deep learning, machine learning with VANET. In other words, prior studies have not been able to apply their findings in the actual world. Previous studies only looked at a small portion of the bigger picture. In VANET, accuracy and efficiency must be improved. Furthermore, previous research failed to consider the potential benefits of VANET-integrated deep learning and machine learning.

Table. 1 Existing researches in area of VANET along with Year, Author, Title, Objective and Limitations.

S.No	Year	Author	Title	Objective	Limitations
1	2022	M.A. R. Abdeen	Performance Evaluation of VANET Routing Protocols in Madinah City	Routing in VANET	Research did not considered security
2	2021	R. Chandren	An Improved Harmony Search Algorithm for Proactive Routing Protocol in VANET	Searching algorithm in routing	Limited factors have been considered in research work.
3	2021	G. D. Singh	A Novel Routing Protocol for Realistic Traffic Network Scenarios in VANET	Routing in VANET	Security has been ignored
4	2021	R. Faouzi	Pattern Reconfigurable Antenna for VANET, Wi-Fi, and WiMAX Wireless Communication Systems	Pattern reconfiguration in VANET	Need to consider routing and security
5	2021	M. H. Junejo	Lightweight Trust Model with Machine Learning scheme for secure privacy in VANET.	Machine learning and security	There is lack to technical feasibility
6	2021	M. A. Saleem	Deep Learning-Based Dynamic Stable Cluster Head Selection in VANET	Deep learning	Need to improve accuracy
7	2021	A. Talpur	Machine Learning for Security in Vehicular Networks: A Comprehensive Survey	Machine learning	Need to do more work on performance
8	2021	R. Bibi	Edge AI-Based Automated Detection and Classification of Road Anomalies in VANET Using Deep Learning	AI based automation	Limited scope of research
9	2020	R. Sadakale	TAD-HOC Routing Protocol for Efficient VANET and Infrastructure-Oriented Communication Network	Routing for VANET	Concept of Security is missing
10	2020	S. Ftaimi	A comparative study of Machine learning algorithms for VANET networks	Machine learning for VANET	Lack of technical work
11	2019	M. S. Sheikh	A comprehensive survey on VANET security services in traffic management system	VANET Security	Need to do more technical work
12	2018	R. Shrestha	Challenges of Future VANET and Cloud-Based Approaches	VANET	Need to improve performance of routing mechanism.
13	2017	B. Marzak	Performance analysis of routing protocols in vehicular ad hoc network	Routing protocol	Security should be enhanced.
14	2015	A. Kukade	A Glance over the Working Methodology of VANET	VANET	Need to integrate smart approach
15	2015	W. K. Lai	A Machine learning system for routing decision-making in urban vehicular ad hoc networks	Machine learning	Need improve accuracy by data filtering.
16	2014	A. Jalooli	Retracted: Intelligent advisory speed limit dedication in highway using VANET	VANET	Lack of technical feasibility

Table. 2 Comparative analysis of Features

S. NO	Vanet	Routing features	Performance	Search algorithm	Machine learning
1	✓	✓	✓	✗	✓
2	✓	✓	✗	✓	✗
3	✓	✓	✗	✗	✗
4	✓	✗	✗	✗	✓
5	✓	✗	✗	✗	✓
6	✓	✗	✗	✗	✓
7	✓	✗	✗	✗	✓
8	✓	✗	✗	✗	✓
9	✓	✓	✗	✗	✗
10	✓	✗	✗	✗	✓

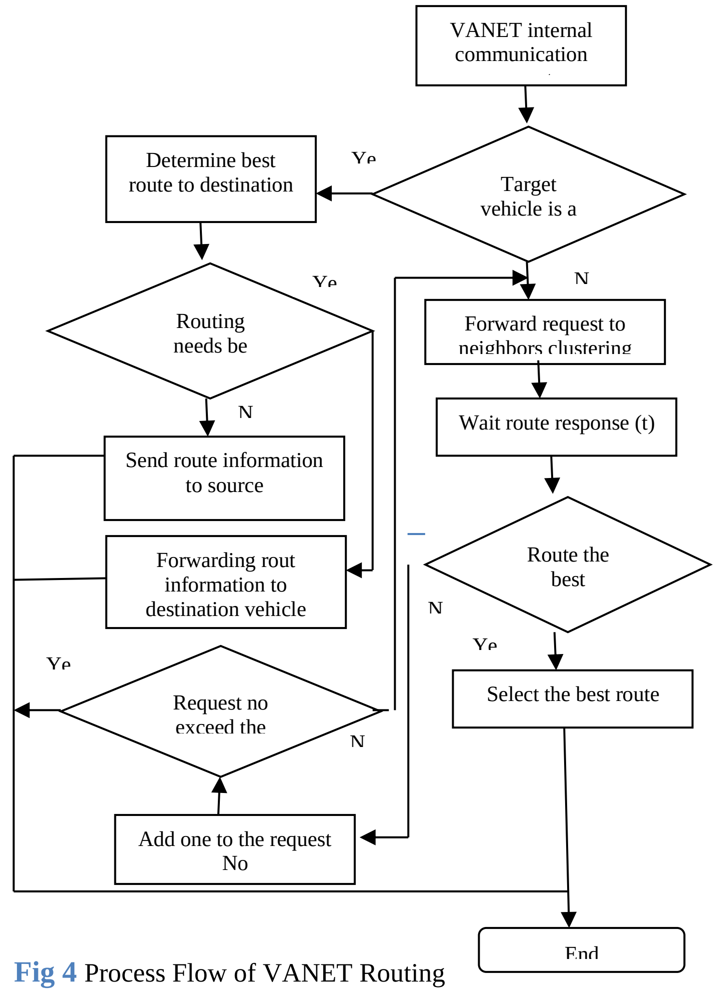

Fig 4 Process Flow of VANET Routing

3 VANET ROUTING PROTOCOL

As the nodes move about at a random rate, it is difficult to know where to send data packets in a desert or other communication circumstances where DSRC is not available. The proactive way of maintaining a routing table is not the best answer, and the reactive method of identifying the best route before each packet delivery may also be exhausting. As a result, special routing solutions are required. VANETs in the desert may be served by a routing approach that only relies on node position information. Location-based protocols depend on RSUs, intersections and other assumptions that may not be accessible in the desert, which is an issue. Cluster-based VANET routing protocols are proposed in this study (CBVRP). Three communication contexts are covered by the proposed method.

To create a connection, a cluster member must contact the CH. Upon receiving a request from a member of the cluster, the CH checks to see whether that vehicle is part of the group. In the event that both cars are in the same cluster, the CH locates the source and destination vehicles and begins the process of selecting the optimum route based on their respective positions. As seen in Figure 4, the whole technique is depicted.

3.1 VANET Routing Protocol Classification

Classification of Vanet routing protocol has been shown in figure 4. This figure is presenting protocol characteristic such as topology, position, Geocast, Broadcast. Moreover information routing techniques are classified as geographic and topology based. Network architecture has been classified as hierarchical, flat, position based routing.

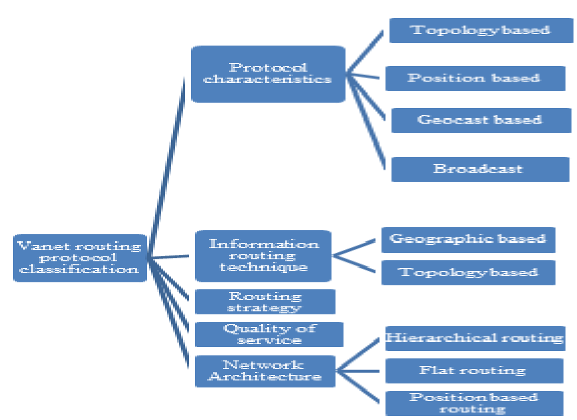

Fig. 5 Classification of VANET Routing Protocol

3.2 Challenges for Existing Routing Protocols

This sort of wireless communication between cars on the road or between vehicles and roadside devices (VANETs) is the most recent form of a mobile ad hoc network (MANET). This is a dynamic network, hence routing methods play a critical role in network performance. These networks have been studied and researched extensively, but there is no one protocol that works well in every situation. Only in sparsely populated areas can the current algorithms be effective. When the topology changes quickly and information exchange is taking place, proactive routing protocols fail. Due to the splintered nature of the network, the reactive routing protocol is unable to locate a complete route. Nodes on the road need to know their exact locations in order to use position-based routing protocols. Because of the high degree of mobility in VANETs, routing techniques based on topology are ineffective. Researchers have a number of issues in developing a routing system for VANETs because of this.

Table. 3 Comparison of various VANET routing protocols

Protocols	Reactive protocols	Proactive protocols	Geo cast based	Cluster based	Position based	Broadcast based
Prior Forwarding Method	Wireless multi hop forwarding	Wireless multi hop forwarding	Wireless multi hop forwarding	Wireless multi hop forwarding	Heuristic method	Wireless multi hop forwarding
Realistic Traffic Flow	Yes	Yes	Yes	No	Yes	Yes
Virtual Infrastructure Requirement	No	No	No	Yes	No	No
Digital Map Requirement	no	no	no	Yes	no	no
Recovery Strategy	Carry & forward	Multi hop forwarding	flooding	Carry & forward	Carry & forward	Carry & forward
Scenario	urban	high	urban	urban	urban	highway

wa y

3.3 Parameters for Performance

Performance parameters are used to measure routing protocol performance: Ratio of received packets to total packets transmitted by all sources of internet traffic Received packets create a percentage of the total number of generated packets. In order to build and maintain routes between mobile nodes, a certain number of packets is necessary from each node. All the Way to the End (E2E) It computes the typical amount of time it takes to receive the right data packets that the sources have sent, and displays it. The entire amount of time spent in the simulation is known as the maximum simulation time. For each of the protocols, the parameter provides us with an estimate of how long it will take to establish communication.
Dropped Packets are packets that have been lost in transit. The packet's 'hopes' count is expressed as an integer between 0 and 1.

Table. 4 Comparison Analysis of VANET simulators on various parameters

	NCTUns	TraNS	GrooveNet
Type of License	Version 7 is not	Open Source	Open Source
GUI	Yes	Yes	Yes
Continuous Development	Yes	Yes	Yes
Output	NS-2	NS-2	….
Mobility Generator	NCTUns	SUMO	GrooveNet
User Friendly	Moderate	Good	Good
Ease of Setup	Hard	Moderate	Moderate
Ease of use	Easy	Moderate	Hard
Programming	C++	Java	C++
Topology View	User difined	Google Earth	Street view

3.4 Performance matrices with formula

Throughput: the quantity of anything that flows through a machine or system.

$$T = \frac{\text{Number of Packet sent}}{\text{time period}}$$

Delay: is the process of making an event take longer than it would normally.

$$D = \text{Packet Departure Time} - \text{Packet Arrival Time}$$

Packet delivery Ratio: When calculating the Packet Delivery Ratio. Maximum number of data packets must be sent to the target.

$$PDR = \frac{\text{Number of packet receiverd}}{\text{Total packets sent}}$$

4 NEED OF RESEARCH

The suggested work is applicable to a wide range of industries. It's more adaptable, too. As a result of the suggested work, both precision and efficiency have been improved. This study is more relevant to real-world situations. VANET routing decision making was improved by the use of machine learning. In combination with our suggested machine learning system, VANETs can significantly enhance routing efficiency.

5 CONCLUSION

It is concluded that there is limited work in field of VANET and there is need to do more work to make routing decision making more efficient. Moreover, there is need to improve the performance of machine learning mechanisms that are used in VANET routing. The future of VANET is very bright. By supplementing it with artificial intelligence, machine learning and deep learning; the benefits can be multiplied. With integration of machine learning, the information provided ad hoc networks can be utilized in better manner for decision making. In other words, VANET has a bright future ahead of it. AI, ML, and DL can be used in conjunction with this to enhance the results. The data produced by ad hoc networks may be better exploited for decision-making with the inclusion of machine learning.

REFERENCES

1. Abdeen, M. A., Beg, A., Mostafa, S. M., AbdulGhaffar, A., Sheltami, T. R., & Yasar, A. (2022). Performance Evaluation of VANET Routing Protocols in Madinah City. Electronics, 11(5), 777. https://www.mdpi.com/2079-9292/11/5/777
2. Chandren Muniyandi, R., Hasan, M. K., Hammoodi, M. R., & Maroosi, A. (2021). An improved harmony search algorithm for proactive routing protocol in VANET. Journal of Advanced Transportation, 2021, 1-17. https://www.hindawi.com/journals/jat/2021/6641857
3. Verma, M. (2021). A Novel Routing Protocol for Realistic Traffic Network Scenarios in VANET. https://lrcdrs.bennett.edu.in/handle/123456789/594
4. Faouzi, R., Naima, A. T., Abdelmounaim, B., Noura, A., & Nihade, T. (2021). Pattern reconfigurable antenna for VANET, Wi-Fi, and WiMAX wireless communication systems. International Journal of Antennas and Propagation, 2021,1-12. https://www.hindawi.com/journals/ijap/2021/9973839/
5. Junejo, M. H., Ab Rahman, A. A. H., Shaikh, R. A., Yusof, K. M., Kumar, D., & Memon, I. (2021). Lightweight trust model with machine learning scheme for secure privacy in VANET. Procedia Computer Science, 194, 45-59. https://www.sciencedirect.com/science/article/pii/S1877050921020998
6. Saleem, M. A., Shijie, Z., Sarwar, M. U., Ahmad, T., Maqbool, A., Shivachi, C. S., & Tariq, M. (2021). Deep learning-based dynamic stable cluster head selection in VANET. Journal of Advanced Transportation, 2021,1-21. https://www.hindawi.com/journals/jat/2021/9936299/
7. Talpur, A., & Gurusamy, M. (2021). Machine learning for security in vehicular networks: A comprehensive survey. IEEE Communications Surveys & Tutorials, 24(1), 346-379. https://ieeexplore.ieee.org/abstract/document/9619465/
8. Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., ... & Khan, M. A. (2021). Edge AI-based automated detection and classification of road anomalies in VANET using deep learning. Computational intelligence and neuroscience, 2021, 1-16. https://www.hindawi.com/journals/cin/2021/6262194/
9. Sadakale, R., Ramesh, N. V. K., & Patil, R. (2020). TAD-HOC routing protocol for efficient VANET and infrastructure-oriented communication network. Journal of Engineering, 2020, 1-12. https://www.hindawi.com/journals/je/2020/8505280/
10. Ftaimi, S., & Mazri, T. (2020, March). A comparative study of Machine learning algorithms for VANET networks. In Proceedings of the 3rd International Conference on Networking, Information Systems & Security (pp. 1-8). https://dl.acm.org/doi/abs/10.1145/3386723.3387829
11. Sheikh, M. S., & Liang, J. (2019). A comprehensive survey on VANET security services in traffic management system. Wireless Communications and Mobile Computing, 2019, 1-23. https://www.hindawi.com/journals/wcmc/2019/2423915/
12. Shrestha, R., Bajracharya, R., & Nam, S. Y. (2018). Challenges of future VANET and cloud-based approaches. Wireless Communications and Mobile Computing, 2018. https://www.hindawi.com/journals/wcmc/2018/5603518/
13. Marzak, B., Toumi, H., Benlahmar, E., & Talea, M. (2017). Performance analysis of routing protocols in vehicular ad hoc network. In Advances in Ubiquitous Networking 2: Proceedings of the UNet'16 2 (pp. 31-42). Springer Singapore. https://link.springer.com/chapter/10.1007/978-981-10-1627-1_3
14. Kukade, A., & Sharma, T. (2015). A glance over the working methodology of VANET. Int J Adv Res Comput Commun Eng, 4(12), 322-326. https://www.ijarcce.com/upload/2015/december-15/IJARCCE%2074
15. Manoj, & Kumar, S. (2020). A survey on handover in LTE heterogeneous networks. In Proceedings of International Conference on IoT Inclusive Life (ICIIL 2019), NITTTR Chandigarh, India (pp. 111-125). Springer https://link.springer.com/chapter/10.1007/978-981-15-3020-3_11
16. Manoj, & Kumar, S. (2021). Efficiency evaluation of handover management techniques in LTE heterogeneous networks. In Artificial Intelligence and Sustainable Computing for Smart City: First International Conference, AIS2C2 2021, Greater Noida, India, March 22–23, 2021, Revised Selected Papers 1 (pp. 121-134). Springer International. https://link.springer.com/chapter/10.1007/978-3-030-82322-1_9
17. Lai, W. K., Lin, M. T., & Yang, Y. H. (2015). A machine learning system for routing decision-making in urban vehicular ad hoc networks. International Journal of Distributed Sensor Networks, 11(3), 374391. https://journals.sagepub.com/doi/full/10.1155/2015/374391
18. Journal, T. S. W. (2015). Retracted: Intelligent Advisory Speed Limit Dedication in Highway Using VANET. The Scientific World Journal, 2015. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4697660/

Manoj received the B.Tech degree from the Guru Jambheshwar University of Science and Technology, Hisar, India in 2009, the M.Tech degree from the Guru Jambheshwar University of Science and Technology, Hisar, India, in 2011, and the Ph.D. degree from the GJUS&T, Hisar, India, in 2022. He is currently an Assistant Professor in the Department of Computer Science and Engineering at GJUS&T, Hisar, Haryana, India. His research interests are in Wireless networks, Mobile Computing and machine learning. Presented many papers in Conferences and Seminars, and published a lot of papers in National and International Journals.
Email: manojkoslia91@gmail.com

Yogesh Chaba is currently a Professor in the Department of Computer Science and Engineering at GJUS&T, Hisar, Haryana, India. His research interests are in Wireless networks, Mobile Computing and machine learning. Presented many papers in Conferences and Seminars, and published a lot of papers in National and International Journals.
Email: yogeshchaba@yahoo.com

Ganga received the B.Tech degree from the Guru Jambheshwar University of Science and Technology, Hisar, India in 2018, the M.Tech degree from the Guru Jambheshwar University of Science and Technology, Hisar, India in 2022. He is currently an Assistant Professor in the Department of Computer Science and Engineering at Mahaveer Institute Science & Technology, Hisar, Haryana, India. His areas of interest are wireless network, internet of things, artificial intelligence & machine learning.
Email: gangagautam1996@gmail.com