The Importance of Vehicle Mobility Settings for VANET: Review

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Abstract—**With the increase in vehicles, it has become imperative to manage road traffic accordingly. The configurations of nodes transmitting information on-the-air show a considerable effect in evaluating vehicle ad hoc networks (VANET). Although significant research has led to more relevant simulations for real-world mobility, the level of information required to demonstrate VANET remains open. VANET characteristics for mobility require consideration in terms of density, setting, and speed that can significantly affect the performance of a network. Therefore, this paper aims to discover the significance of vehicle mobility in VANET that depends on vehicle density, environmental settings, and vehicle speed. The findings in the literature were assessed using PRISMA criteria in this work. As a result, this work can considerably help researchers better characterize vehicle mobility for VANET deployments in future transportation systems.**

Keywords—VANET, density, setting, speed, urban

I. INTRODUCTION

A VANET is a term that refers to an ad hoc network made up of vehicles that communicate wirelessly. VANETs are developed by integrating the concepts of Mobile Ad Hoc Networks (MANETs) [1] [2] [3]. VANET improves driving safety and comfort. These include lane change warning, front collision warning, and infotainment for backseat passengers [4] [5] [6]. These applications successfully disseminate critical information to all vehicles on a road segment [7] [8]. It is difficult for vehicles to communicate with one another because of restricted or intermittent traffic, which is the main communication limitation of such networks [9] [10] [11]. For example, when traffic is low, there may be no neighbors to communicate with. However, in an irregular traffic environment, vehicles are not uniformly distributed on the roads, as shown in Fig. 1 [12] [13] [14] [15]. Hence, network connectivity is a significant determinant dictated by considerations such as the number of vehicles, movement of vehicles in certain areas, and the mode of transmission of vehicles through any route.

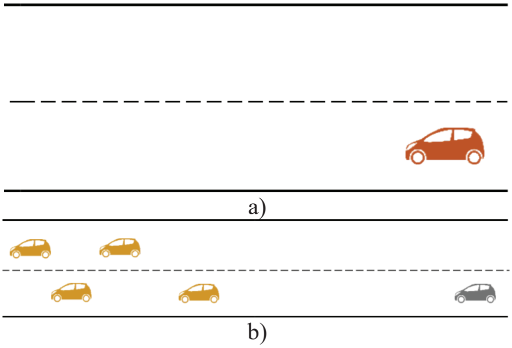
a)
b)

Fig. 1. A) Limited and B) Irregular Traffic

This paper explores the impact of vehicle mobility on VANET and depends on vehicle density, environmental setting, and vehicle speed. Our approach is to distinguish vehicle mobility based on previous research studies and their simulation settings. The following is the structure of this paper. Section II provides an outline of the relevant literature. Section III

Article history: Manuscript received 14 March 2021; received in revised form 14 October 2021; Accepted 15 October 2021.

deliberates on the methods used in this study. Section IV reflects on the significant mobility attributes such as density, setting, and speed. Finally, in Section V, conclusions are made.

II. RELATED WORKS

VANET is an individual class of ad hoc networks, hence the contrary requirements of VANET applications, making designing a comprehensive communication system a very complex subject [16]. In developing VANET applications, all crucial aspects of the application should be considered [17] [18]. Therefore, node density, environmental settings, and node speed are essential in connectivity, particularly when considering communications in VANET [19] [20]. Table I presents several density, settings, and speed studies to improve vehicle communication depths through experimental and performance measures.

TABLE I. PREVIOUS STUDIES ON VANET RESEARCH

References	Contributions	Density	Settings	Speed	Metrics
[21]	Two routing protocols DYMO and OLSRv2, were compared. The simulation result shows an optimal choice for DYMO in terms of packet delivery ratio and throughput. Whereas OLSRv2 superiors in terms of jitter and delay.	30	Urban	3 m/s ~ 12 m/s	Throughput, Delay Jitter, and Packet Delivery Ratio
[22]	Three routing protocols OLSR, DSR, and AODV, were compared. The simulation results show an optimal choice for DSR than OLSR and AODV in terms of packet delivery ratio, jitter, delay, and throughput.	30 ~ 80	Urban	40 ~ 120 km/h	Packet Delivery Ratio, Jitter, Delay and Throughput
[23]	Three routing protocols DSDV, GPSR, DYMO, and GREDDLEA, were compared. The simulation results show an optimal choice for GREDDLEA than DSDV, GPSR, and DYMO in terms of packet delivery ratio.	30 ~ 60 (U) 20 ~ 40 (H)	Urban / Highway	40 ~ 60 km/h (U) 80 ~ 110 km/h (H)	Packet Delivery Ratio
[24]	Two routing protocols VMRP and DSDV, were compared. The simulation result shows that VMRP is superior to DSDV in terms of data rate and packet loss.	2 ~ 50	Urban	5 ~ 15 m/s	Date Rate and Packet Loss
[25]	An ant colony algorithm was proposed with the AODV routing protocol. The simulation results prove that the algorithm superiors by producing lower packet loss and better throughput.	10 ~ 500	Urban	40 ~ 120 km/h	Throughput and Packet Loss
[26]	Five routing protocols DSDV, AOMDV, AODV, DSR, and GPSR, were compared. The simulation results prove that DSDV is suitable for normalized routing load and lower delay. AOMDV is ideal for better throughput and less packet loss ratio. AODV and DSR are relatively average in throughput, packet loss, normalized routing load, and delay.	20 ~ 80	Urban	10 ~ 90 m/s	Throughput, Normalized Routing Load, Packet Loss Ratio, and Delay
[27]	Three routing protocols OLSR, AODV, and DSDV, were compared. The simulation results define OLSR performed better than AODV and DSDV in terms of goodput, lower delay, packet delivery ratio, and routing overhead.	30 ~ 50	Urban	15 ~ 55 m/s	Goodput, Delay, Packet Delivery Ratio, and Routing Overhead
[28]	A proposal of Multi-Metric Geographic Distance Routing (M-GEDIR) was presented. The simulation effects indicate that the proposed protocol superiors improved throughput, lower delay, and less link failure.	300 ~ 500	Urban	10 ~ 60 km/h	Throughput, Delay and Link Failure
[29]	An Angle-Based Clustering Algorithm was proposed. The simulation result proves that the proposed algorithm outperforms in terms of cluster lifetime.	20 ~ 300	Urban	120 – 150 km/h	Cluster Lifetime
[30]	A proposal of Multi-Protocol Label Switching (MPLS) based on roadside backbone network was presented. The simulation results prove that the model is optimal for a better packet delivery ratio, lower delay, and better throughput.	16	Urban	30 km/h	Packet Delivery Ratio, Delay and Throughput

[31]	Four routing protocols AODV, DSDV, DSR, and TORA, were compared based on density and speed. The simulation results show that TORA works superior in lower packet loss, low delay, and moderate normalized routing load than DSDV, AODV, and DSR.	4 ~ 28	Urban	20 ~ 100 km/h	Packet Loss, Delay and Normalized Routing Load
[32]	OLSR, AODV, DSDV, and DSR were compared based on the propagation model and different speeds. The simulation result indicates that different propagation model has resulted in showing variation in routing protocol used. The exceptional result has demonstrated that OLSR is better executed in Friss Propagation Model.	30	Urban	30 ~ 100 m/s	Throughput, Goodput and Receive Rate
[33]	Two routing protocols OLSR and DSR, were evaluated under different circumstances. The simulation result shows that DSR has given a significant impact in terms of lower overhead, whereas OLSR observes better receive rates.	20 ~ 60	Urban	20 m/s	Receive Rate and Overhead
[34]	Three routing protocols OLSR, AODV, and DSDV, were compared based on density and speed. The simulation results have shown that OLSR provides better input than AODV and DSDV at 30 km/h. However, AODV shows a better packet delivery ratio as compared to OLSR and DSDV.	102	Urban	10 ~ 30 km/h	Goodput and Packet Delivery Ratio
[35]	OLSR, AODV, and DSDV were analyzed for the VANET environment based on density, speed, mobility, and network size. The simulation result shows that OLSR moderately superiors to AODV and DSDV in terms of better packet delivery ratio, low delay, and better throughput.	10 ~ 100	Urban	5 ~ 80 m/s	Packet Delivery Ratio, Delay and Throughput
[36]	A DSDV routing protocol was evaluated for the VANET environment based on density. The simulation result shows that DSDV shows a significant difference as the density increases in higher throughput and lower delay.	20 ~ 80	Urban	20 m/s	Throughput and Delay
[37]	TORA, ZRP, and MDART were compared and evaluated based on the propagation model. The simulation result indicates that different propagation models have resulted in showing variation in the routing protocol used. The exceptional result has demonstrated that TORA and ZRP are better executed in Nagakami Propagation Model. In contrast, MDART is better achieved in Freespace Propagation Model.	25 ~ 70	Urban	50 ~ 100 km/h	Throughput, Packet Delivery Ratio and Delay
[38]	An enhanced GPSR routing protocol was proposed to be suitable for the VANET environment. The enhancement version was called E-GPSR and DVA-GPSR. The simulation result has shown that the proposed version has a better packet delivery ratio and lower overhead than the traditional GPSR.	30 ~ 50	Urban	20 m/s	Throughput, Packet Delivery Ratio and Overhead
[39]	An enhanced version of GPSR was proposed for better routing in the VANET environment. The improved performance was called A-GPSR. The simulation result has shown that enhanced version superiors than traditional in terms of lower delay and better packet delivery ratio.	5 ~ 30	Urban	30 ~ 50 km/h	Packet Delivery Ratio and Delay
[40]	A cluster-based OLSR routing protocol was proposed for the VANET environment. The simulation results have shown that the proposed protocol outperforms better throughput, hop count, packet delivery ratio, and lower delay than traditional OLSR.	150 ~ 300	Urban	60 km/h	Throughput, Delay, Hop Count, and Packet Delivery Ratio

Based on Table 1, we examine the mobility settings that have been applied in prior studies. Identical in all previous studies linked to the deployment of simulation-based investigation. In general, it has become apparent that the existing approach of using network simulators could only offer summarized assumptions in modelling the features of actual systems. This is very important as the researcher must examine the impact and influence of settings due to mobility and topology changes on the VANET's connections and communication quality.

III. METHOD

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed in this research. This is an established technique for locating relevant papers in the published literature. The structure was chosen following PRISMA guidelines for theoretical concepts and anticipated research review findings.

A. *Selection Criteria*

The inclusion and exclusion criteria are chosen following the Participants, Interventions, Comparisons, Outcomes, and Study Design (PICOS) standards, as indicated in Table II. The articles included in this review study were all authored in English, and no other languages were used.

TABLE II. PICOS CRITERIA SELECTION

Description	**Inclusion**	**Exclusion**
Participants	Vehicle or nodes	Other entities
Interventions	VANET	Irrelevant concept
Control	Mobility	N/A
Outcomes	Density, settings, speed	No related outcomes
Study Design	Simulation	Real-world

B. *Search Strategy*

The literature search was carried out using several databases, including Google Scholar and Scite. The final evaluation was completed on January 30, 2021, as shown in Fig. 2.

C. *Data Extraction*

The following information has been extracted:

1) *Authors.*
2) *Contributions;*
3) *Type of Mobility, and*
4) *Performance Metrics*

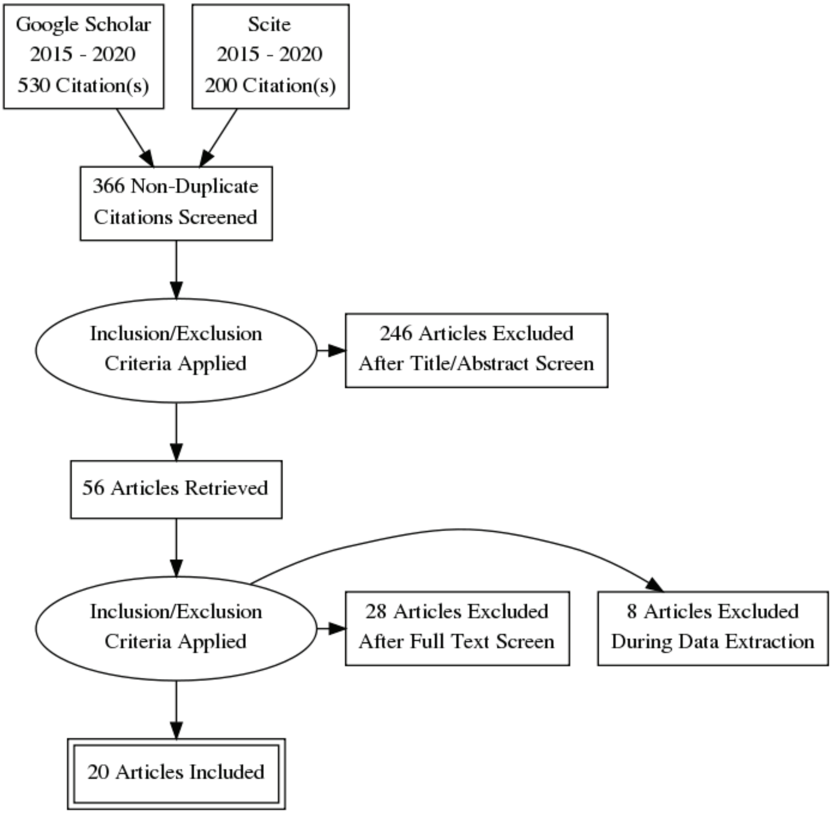

Fig. 2. PRISMA Flow Chart

IV. DISCUSSION

A. Density

In most approaches in the literature to minimize collisions and resolve the problem of communication in dispersed networks, the assessment of node density is a substantial obstacle. Generally, node density is defined through the access point with an infrastructure-based network. While in VANET, the environment is different, and a varied approach is needed to determine the density of nodes. In high vehicle density, broadcasting a message may lead to frequent disconnection due to congestion. As the number of vehicles in a given region increases, network utilization increases as more messages are needed to be disseminated between vehicles within a given time period. It is essential to study methods that are crucial for identifying congestion.

B. Setting

In general, VANET emphasizes road safety and the effective management of road traffic. There are two categories for environment settings that are urban and highway. In urban, the environment consists of obstacles in the form of buildings, streets, and junctions. On the other hand, on highways, the environment consists of straight roads without barriers. The characteristic of an urban environment is that it has low neighborhood stability and frequent change in network connectivity. The element of the highway environment is that it has high neighborhood stability and no frequent change in network connectivity. As a result, it is crucial to ensure the environment implements a VANET environment.

C. Speed

One of the crucial components of VANET mobility is the prospective node velocity. The nodes may be either vehicle or roadside units (RSU). Depending on the environment (urban or highway), the node speed may be less than 10 km/h, 10 to 40 km/h, or greater than 40 km/h. However, the node speed for RSU will constantly be zero or vary depending on the transmission of messages. Due to the relative speed between the vehicle and the RSU nodes, the interchanging of the various vehicles may differ significantly. This may interfere with the communication of a vehicle with the RSU. Vehicles may not obtain the information they want or need within an acceptable time frame without disrupting other vehicles. Therefore, this is a clear indication of the issue of equity in-vehicle mobility.

V. CONCLUSION

As more people use vehicles, VANET has the potential to optimize traffic conditions and reduce congestion. Many researchers have conducted performance analysis through simulation. However, it is still crucial to know the desires of these explorations. The effect of vehicle mobility on VANET is studied in this study, which is dependent on the density of vehicles, the surroundings, and the speed of the vehicles. Our aim is to differentiate between vehicle mobility based on prior research studies and the simulation settings used in those experiments. This research seeks to explore some of the relevant interrelationships that could directly or indirectly contribute to vehicular communication needs.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to everyone who has contributed to this study, whether directly or indirectly. We are grateful to the anonymous reviewers for their helpful comments, which we consider important.

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