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Original Article

Mobility Prediction and Enhancement of Link Stability in VANET using MGPSR and MAODV Protocol

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***Abstract* — *Vehicular Ad-hoc Network (VANET) is a promising network technology in which cars are used as mobile nodes to establish a communication network. VANET can be deployed in an urban area as well as on highways. In VANET, a significant role is played by the routing protocols to enhance the performance. In this paper, the issue of mobility prediction and link stability in VANET is addressed. Performance of Greedy Perimeter Stateless Routing protocol (GPSR) and proposed Modified Greedy Perimeter Stateless Routing protocol (MGPSR) over parameter matrix using different speeds are observed and analysed. Further Multicast Ad-hoc On-Demand Distance Vector routing protocol (MAODV) is used to reduce link failures. The performance metric parameters Packet Loss Ratio, Delay, Packet Delivery Ratio, Link Expiration Time and Latency are used to evaluate the performance with respect to speed. The objective of this work is to identify the best-suited neighbour node using mobility prediction and select the most stable link to improve the overall performance. Based on the verified findings, the routing performance is improved in terms of predicting mobility of neighbour node and connectivity is enhanced with reduced link breakages by using a combination of MGPSR and MAODV.*

Keywords — *ITS, LET, MANET, MAODV, RSU, VANET.*

I. INTRODUCTION

In India, road travel is the most common method of transportation, both in terms of traffic percentage and impact on the economy of the country. Road mishaps continue to be the country's largest source of death, disability, and hospitalization. As per the Road Accident Report for 2019, Among the 199 countries, India has the highest number of road accident deaths, and nearly 11 percent of all deaths in the world are caused by accidents [1]. In metro cities, citizens spend most of their time in vehicles after home and office. VANET has piqued the interest of both academia and industry because it is the foundation for many innovative services and applications targeted at enhancing the quality of traffic and the traveller's lives [2]. Because of its high mobility and quick topology changes, VANETs is prone to link failures and data loss as a result of poor communication between nodes. The problem of link failure caused by fast topology changes decreases vehicular communication reliability. VANETs provide a variety of services through communication between roadside units and cars. Vehicle mobility is used for geo-positioning to broadcast locations in a particular city region [3].

The geographical information of moving vehicles is used to build position-based routing. Instead of using the network address, the sender node uses the GPS position of the receiving node to transmit messages [4]. It is the best routing technique for developing a modified routing protocol based on mobility prediction. The method retains network resilience while reducing communication delays and the burden of retransmission. The stability of the link between two neighbour nodes is determined by Link Expiration Time (LET).To avoid message loss, links designated as 'expired' will be removed from the routing table. The LET is calculated using the mobility prediction of the neighbours [5][12].

To design a modified routing algorithm based on vehicle location, a greedy-forwarding technique is adopted [13]. It reduces connection failures resulting in more stable routing and higher packet delivery ratio and throughput. Fig. 1 depicts a VANET architectural diagram. By using OBU, RSU and AU nodes along the road, vehicles can communicate with each other. As cars move faster, VANET routing becomes more crucial. The VANET implementation's main goal is to increase road safety by reducing the number of mishaps. The ability to estimate route stability in a VANET is achieved by node mobility prediction. Mobility prediction is an important feature that affects the ad-hoc network's connection stability and topology.

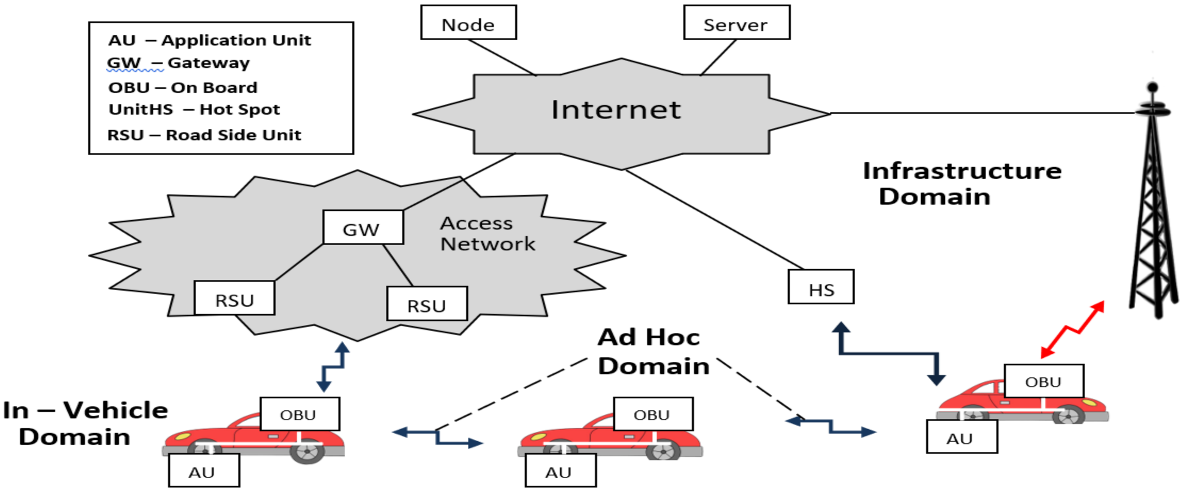

Fig. 1 VANET Architecture

II. RELATED WORK

A number of researchers from all around the world have worked on the stability of links and routing in VANETs. Some relevant research articles are considered for the implementation of mobility prediction and link stability in VANET.

In [4], the authors introduced a modified Road Segment based Geographical Routing (ISR) protocol that focuses on improving head-node identification for information sharing. The results demonstrate that ISR had a greater ratio of data delivery, reduced delay, and faster output. The authors of [6] proposed a new mobility-predictive and effective clustering approach using the Voronoi diagram. The results confirm that clustering structure stability increased in terms of average cluster-head lifetime and average rate of cluster-head changes reducing clustering cost.

A novel Mobility Prediction Based Routing Protocol (MPBRP) is designed in [7] to transmit a packet, recovery of path and neighbourhood identification by using positioning systems. It produced better results by avoiding the local maximum by choosing the optimal neighbour node. [8] proposes an accident avoidance strategy based on a prototype of predicting mobility of nodes in VANET utilizing TDMA. The proposed approach avoids collisions by distributing TDMA time slots. Simulation results demonstrate that the approach would reduce collisions. Route Conscious GPSR is introduced in [9], a new approach (PA-GPSR). Results demonstrate that the proposed PA-GPSR technique outperformed the usual GPSR and MM-GPSR approaches.

In [14], the authors projected an improvement in the GPSR protocol used for VANETs by improving link reliability. The new protocol outperforms standard GPSR protocol by improved packet delivery ratio and reduced link failure rate, but the delay is slightly longer.

The Maxduration-Minangle GPSR (MM-GPSR) protocol was suggested in [15]. MM-GPSR uses greedy forwarding to define the cumulative communication period for representing the neighbour nodes stability. Experimentation demonstrated that this unique strategy could successfully design a stable route and prevent routing reconfiguration.

Literature survey for the proposed solution of position-based routing protocols is primarily focused on information of vehicles location and GPS to forward data packets [11]. It is observed that mobility prediction in vehicular ad hoc networks is a very important factor to improve routing by selecting a stable route minimizing route failure. It is further revealed to address the problem of high vehicle mobility and frequent connection failure in VANET.

III. METHODOLOGY

Understanding the dynamic behaviour of VANET topology requires a robust routing protocol, node quality, as well as a range of internal elements that affect routing protocol performance. An algorithm is proposed to predict mobility, make routing better and reduce the number of routing failures. Fig.2 reveals the flow diagram of the proposed work. A packet is transferred from sending node to receiving node. While transferring the packet to the neighbour node, there are various problems: the mobility of the node, link stability, link breakage, and transmission delay are the major problems. To overcome this issue, a mobility prediction algorithm based on a position-based routing protocol is proposed. In this, Greedy Perimeter Stateless Routing is utilized. It identifies the stable path for packet transmission. To maintain a reliable link, the Link Expiration Time (LET) is used. A multicast Ad-hoc On-Demand Distance Vector (MAODV) is included to prevent link breaks data loss and achieve higher throughput. Finally, a Greedy forwarding method is introduced to minimize transmission delay.

Initially, check nodes are at the same road location. If not in the same road segment, the list of intersection locations along the route is transmitted. If the node is on the same road, it performs a position-based routing [4].

Position based routing protocols identify stable rout by checking nodes are in the same group or not. If the nodes are in the same group, a high level of stability occurs. When the nodes do not belong to the same group, then vehicles in the same direction are grouped. Greedy perimeter stateless routing[7][8] protocol finds the possible route.

Link Expiration Time checks the LET is longer or not. If it is no longer, the packet is again transferred to the recheck LET. Longer LET is considered to be a stable link. A greedy forwarding algorithm reduces transmission delay. The basic components of the proposed system are mobility prediction, link stability and transmission delay.

A. Mobility Prediction

In a vehicular ad-hoc network, path stability is estimated by a mobility prediction algorithm. A mobility pattern is a set of snippets of the same trajectory sequences in w time slots. As a result, the probability of mobility patterns appearing in the vehicle's trajectory t is given by (1).

$$f_w(d_i) = \frac{g}{l - w + 1} \qquad (1)$$

Where the mobility patterns identity is d_i and in the trajectory R^s, the total amount of snippets is $l - w + 1$. In a prediction cycle of w time slots, the marginal entropy of t's mobility pattern can be calculated by (2).

$$E(w) = -\sum_{i=1}^{n} f_w(d_i) * \log_2 \left(f_w(d_i)\right) \qquad (2)$$

Within the trajectory R^s, the total amount of different mobility patterns are n.

B. Link Stability

The link expiration time is calculated to accommodate the mobility of nodes between two nodes and to provide a stable link [9].

Let i and j be two nodes in range R, node speed p_i and p_j, and the direction of nodes movement is φ_i and φ_j. $(x_i, y_i)$and (x_j, y_j) are initial locations already have known within the transmission range v of each other that the l_i and l_j are the length of the time for two nodes. At time t and its new coordinates would be (x_1,y_1) and (x_2,y_2), respectively.

Assuming that two nodes, which are in the transmission range of one another. The two nodes like source node and destination node or neighbour node. Let (x_i, y_i) be coordinates of movable host i and (x_j, y_j) are of j. Let p_i and p_j be the speed and φ_i, φ_j are moving direction of node i and j respectively. After that, (3) predicts how long two vehicles would stay connected.

$$\text{LET} = \frac{-(\text{ef} + \text{gh}) + \sqrt{(\text{e}^2 + \text{g}^2) - (\text{eh} - \text{fg})^2}}{\text{e}^2 + \text{g}^2} \qquad (3)$$

Where, $e = p_i \cos(\varphi_i) - p_j \cos(\varphi_j)$, $f = x_i - x_j$, $g = p_i \sin(\varphi_i) - p_j \sin(\varphi_j)$, and $h = y_i - y_j$. Note that e and g become zero when $p_i = p_j$ and $\varphi_i = \varphi_j$.

C. Greedy Forwarding Approach

The position and velocity of all neighbour vehicles collected from source vehicle. All neighbour link weights are calculated by exchanging hello messages are implicated in the proposed system [15][16].

Initially, angle direction φ is calculated between the destination node and each next-hop candidate by using (4).

$$Q_{nd} = \cos^{-1} \frac{((nVelocity.x * dVelocity.x) + (nVelocity.y * dVelocity.y))}{(\sqrt{n(Velocity.x + dVelocity.x^2)} * \sqrt{(nVelocity.y^2 + dVelocity.y^2)})} \qquad (4)$$

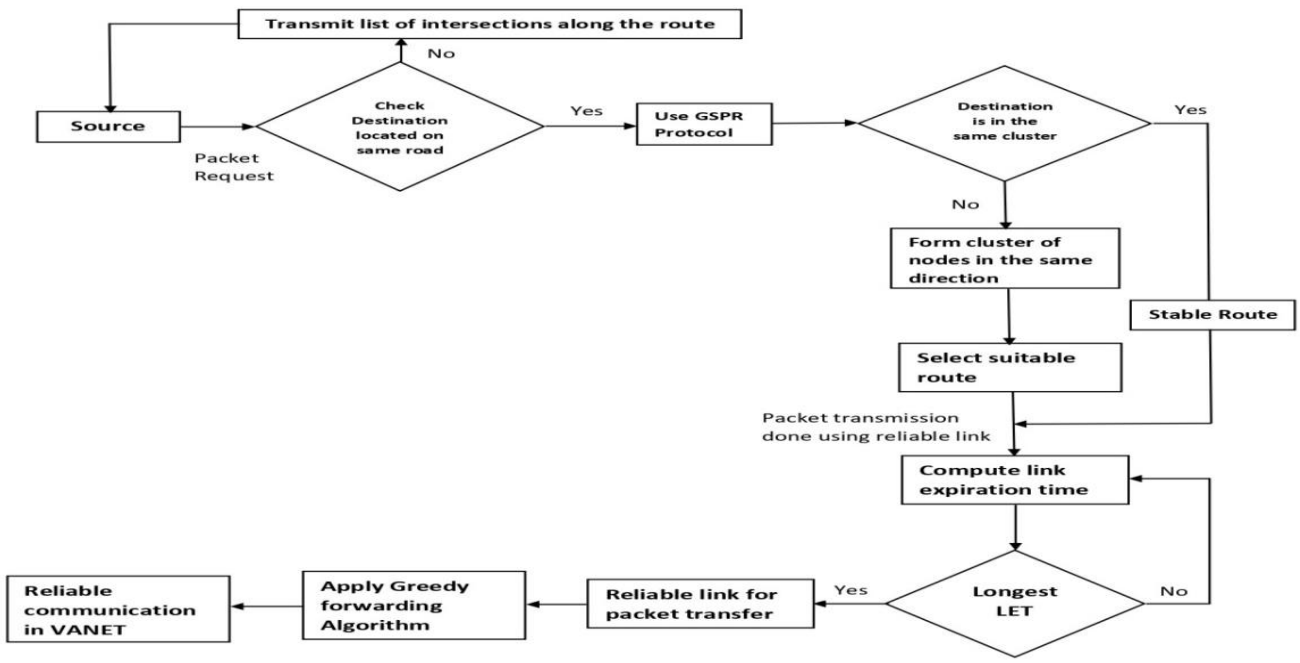

Fig. 2 The workflow of the proposed system

nVelocity is the Next-hop candidate's velocity and *dVelocity* is destination velocity. A small value of all calculated φ_{nd} is chosen to maintain inter-vehicles connectivity. This Greedy Forwarding Approach reduces packet transmission delay between vehicles.

IV. RESULTS AND DISCUSSION

The proposed modified GPSR algorithm is implemented and tested by using NS 3.32 and Python 3.6. Table-1 describes the system configuration for simulation. Open-source operating system Ubuntu is used, and the simulation time for execution is 200 seconds.

TABLE I
SYSTEM CONFIGURATION FOR SIMULATION

Simulation System Configuration	
NS, Python	Version 3.32, 3.6
Operation System	Ubuntu
Memory	4GB
Processor	Intel Core i5, 3.5GHz
Simulation Time	200 second

The vehicle simulation was carried out by observing the initial positions of cars that were randomly distributed, and vehicle mobility was prohibited on the roadways along the street.

A. Scenario Generation

SUMO (Simulation for Urban Mobility) traffic simulator and NS3 network simulator used for evaluating the performance of GPSR and M-GPSR protocol in an urban area. Table 2 shows the parameters used to generate the scenario.

TABLE II
PARAMETERS FOR SCENARIO GENERATION

Scenario coordinate	Longitude: 77.757857 Latitude: 20.930637
Simulator	NS3 3.23
Traffic-Simulator	SUMO 0.25.0
Map Model	Irvin Square, Amravati
Routing Layer	IEEE 802.11 p
Total Vehicles	81
Speed of Node	5, 10, 15,20,25, 30, m/s
Pause Time (Node)	0
Propagation loss Model	Nakagami, Two Ray Ground
Routing protocol	GPSR, M-GPSR
Transport protocol	TCP
Packet Size	512 bytes
Transmission rate	512 kbps
Simulation time	200s

The map of Irvin square, Amravati city, is downloaded using OpenStreetMap [16]. In SUMO, a road traffic scenario is generated with 81 cars, as depicted in Fig.3. NS3 receives mobility traffic data generated by SUMO and trace exporter. It is used to evaluate the GPSR and MGPSR routing protocol network performance.

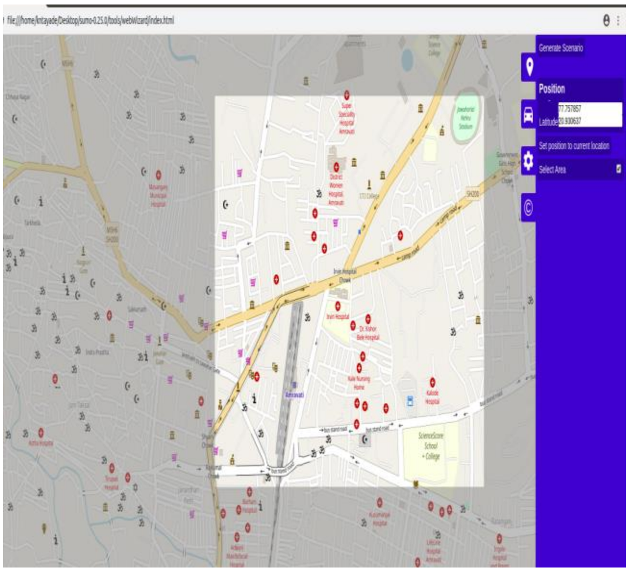

Fig. 3 Scenario generated for Irvin square Amravati City

B. Packet Loss Ratio(PLR)

Fig. 4 reveals the packet loss rate analysis; packet loss ratio reduces for both routing protocols in a given scenario. MGPSR performs better for the velocity 10, 15, 20, 25, and 30.

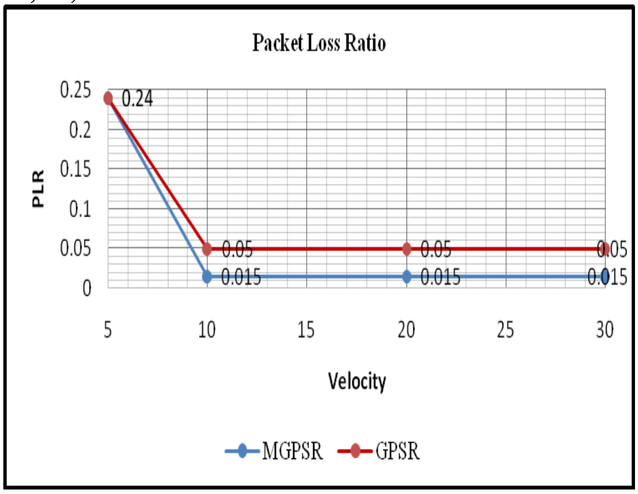

Fig. 4 Packet Loss Ratio

Thus the packet loss ratio for velocity 5 is nearly 0.25. When the velocity is 10, 15, 20, 25, 30, the packet loss ratio is slightly higher than the value of 0.01. It can aid in the reduction of channel congestion, balancing the network's workload and minimizing packet loss. This evaluation shows

C. Average Transmission Delay

Fig. 5 discloses delay with different velocities. The GPSR has a shorter delay time. The delay time for this method is 0.7, while the velocity of the vehicle is 5.

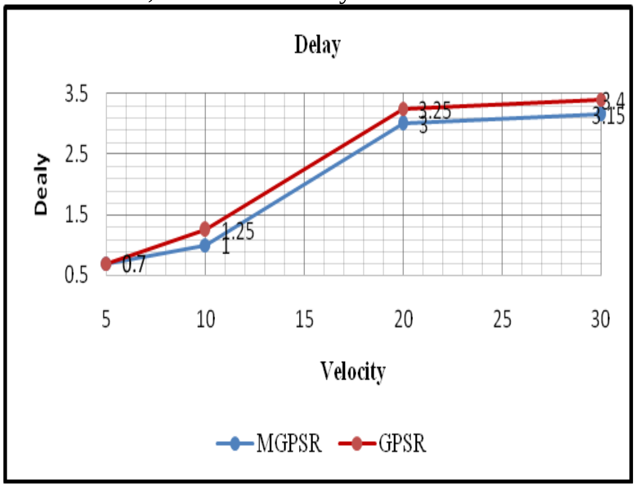

Fig. 5 Average Transmission Delay

If the velocity of the vehicle is 10, the delay for this method is 1. When the vehicle's velocity is 20, then the delay time is 3, and for the vehicle, velocity is 30, the delay time is less than 3.2.

D. Packet Delivery Ratio

Fig.6 depicts the high packet delivery ratio for the proposed method. If the PDR increases, the network performance also increases.

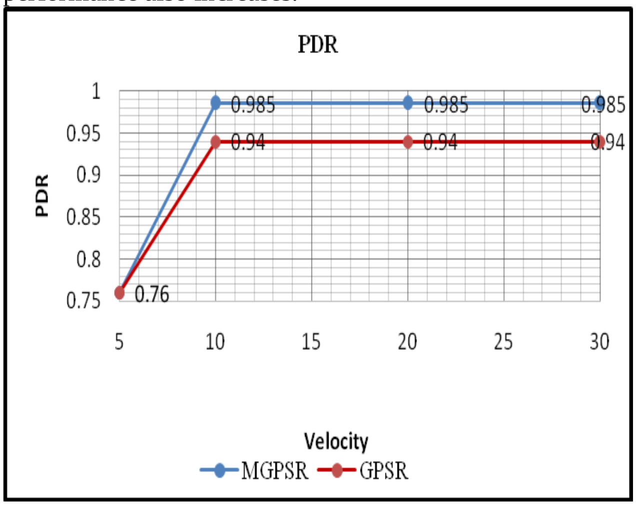

Fig. 6 Packet Delivery Ratio

The PDR value is 0.76 for the vehicle velocity as 5. If vehicle velocity is 10, 15, 20, 25, 30, this proposed method performs as the same value as greater than 0.98 respectively.

E. Link Expiration Time

Fig. 7 demonstrates the result of link expiration time. The LET for the proposed system is high. The link expiration time is gradually increased for increasing velocity.

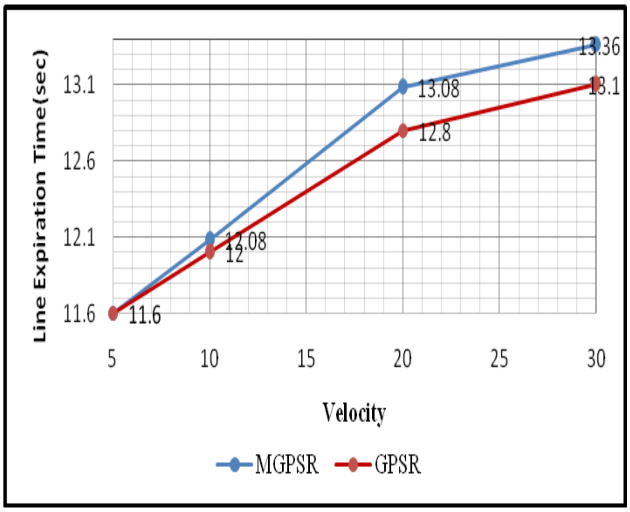

Fig. 7 Link Expiration Time

The value for the link expiration time is 11.6 sec when the velocity of the vehicle is 5. If the velocity of the vehicle is 10, this gradually increases to 12.1 sec. When the vehicle's velocity is 20, then the link expiration time is nearly 13.1 sec. After that, the vehicle velocity is 30. The LET is high at nearly 13.5 sec, respectively.

F. Latency

Fig. 8 illustrates the lower latency of the proposed methodology. During the vehicle velocity of 5, the latency is 0.163 sec.

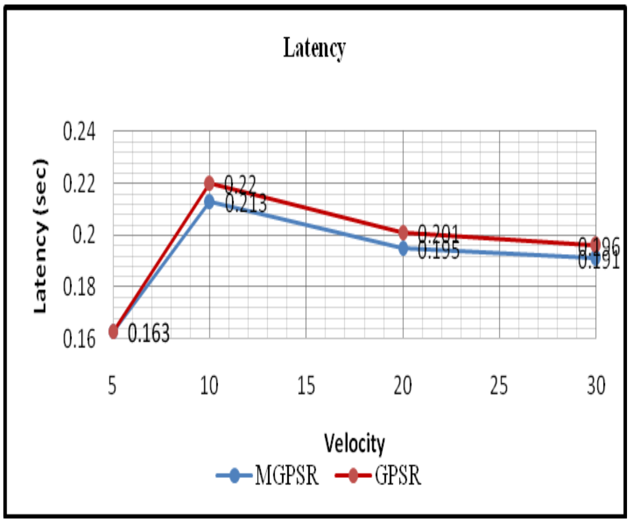

Fig. 8 Latency of the Proposed Method

When the velocity of the vehicle is 10, the latency is 0.213 sec. The latency is 0.195 sec when the vehicle velocity is 20, and while the velocity is 30, the latency slightly decreases to 0.191sec respectively.

V. CONCLUSION

In the proposed approach, position-based routing algorithm MGPSR is presented to select a stable link that improves routing. Maximum LET is used to provide a stable link. Link breakages are avoided by using MAODV, and throughput is improved by reducing data loss. A Greedy forwarding approach is used to reduce the transmission delay.

The performance of the MGPSR produces improved results as compared to GPSR for PLR, Delay, PDR, LET and latency. The improvement in results is an average of 2-4 percent.

In particular, mobility Prediction and enhancement of Link Stability is achieved by using MGPSR and MAODV protocol. This paper demonstrated that the proposed approach's performance gain is enhanced in road conditions where traffic density and vehicle mobility is high.

REFERENCES

[1] Annual report, Government of India, Ministry of Road Transport & Highways, New Delhi (2021).

[2] Safae Smiri, Abdelali Boushaba, Rachid Ben Abbou, Azzedine Zahi, Geographic and Topology based routing protocols in Vehicular Ad-hoc Networks, Performance evaluation and QoS analysis, IEEE, (2018) 987-1-5386-4396-9/18.

[3] Abdel-Halim and H. Fahmy, Mobility Prediction in Vehicular Ad-hoc Networks, Prediction Aims, Techniques, Use Cases, and Research Challenges, IEEE Intelligent Transportation Systems Magazine,(2019) 1-1, **DOI**, 10.1109/MITS.2018.2889708.

[4] K. Qureshi, F. Islam, O. Kaiwartya, A. Kumar and J. Lloret, Improved Road Segment-Based Geographical Routing Protocol for Vehicular Ad-hoc Networks, Electronics, 9(8) (2020) 1248, DOI,10.3390/electronics9081248.

[5] 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, 33(10) (2019) e4104, https,//hal.archives-ouvertes.fr/hal-02301888.

[6] I. Abdel-Halim, H. Fahmy and A. BahaaEl-Din, Mobility prediction-based efficient clustering scheme for connected and automated vehicles in VANETs, Computer Networks, 150 (2019) 217-233, https,//doi.org/10.1016/j.comnet.2018.12.016.

[7] Ye, M., Guan, L. and Quddus, M, MPBRP-Mobility Prediction Based Routing Protocol in VANETs In CommNet, (2019) 1-7 DOI,10.1109/COMMNET.2019.8742389.

[8] N. Al-Kharasani, Z. Zukarnain, S. Subramaniam and Z. Hanapi, An Adaptive Relay Selection Scheme for Enhancing Network Stability in VANETs, IEEE Access, 8 (2020) 128757-128765, Digital Object Identifier 10.1109/ACCESS.2020.2974105

[9] J. Bang and J. Lee, Collision Avoidance Method Using Vector-Based Mobility Model inTDMA-Based Vehicular Ad Hoc Networks, Applied Sciences, 10(12) (2020) 4181, https,//doi.org/10.3390/app10124181.

[10] A. Silva, N. Reza and A. Oliveira, Improvement and Performance Evaluation of GPSR-Based Routing Techniques for Vehicular Ad Hoc Networks, IEEE Access, 7 (2019) 21722- 21733, DOI,10.1109/ACCESS.2019.2898776.

[11] Nair, C.R., Analysis and comparative study of topology and position-based routing protocols in VANET, International Journal of Engineering Research and general science, 4(1) (2016) 43-52, ISSN 2091-2730.

[12] Chunlin Wang, Quanrun Fan, Xiaolin Chen, WanjinXu, Prediction based Greedy Perimeter Stateless Routing Protocol for Vehicular Self-organizing Network, IOP Conf. Series, Materials Science and Engineering 322 (2018) 052019, DOI 10.1088/1757-899X/322/5/052019.

[13] Mingyang Zhong, Yunqing Fu, Xinqiang Jia MAODV multicast routing protocol based on node mobility prediction IEEE. (2011), 978-1-4244-8694-6/11, DOI, 10.1109/ICEBEG.2011.5881805.

[14] A. Bengag, A. Bengag and M. Elboukhari, A Novel Greedy Forwarding Mechanism Based on Density, Speed and Direction Parameters for Vanets, International Journal of Interactive Mobile Technologies (iJIM), 14(8) (2020) 196, DOI,10.3991/ijim.v14i08.12695.

[15] Siddharth Shelly and A. V. Babu, Link Reliability-Based Greedy Perimeter Stateless Routing for Vehicular D Hoc Networks, Hindawi Publishing Corporation, International Journal of Vehicular Technology, (2015) 921414, 16pages, ttps,//doi.org/10.1155/2015/921414.

[16] Xiaoping Yang, Mengjie Li, ZhihongQian, Te Di, Improvement of GPSR Protocol in Vehicular Ad Hoc Network, IEEE Access (2018), DOI, 10.1109/ACCESS 2018.2853112.