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Ameliorated Location Aided Routing Protocol in VANET

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Abstract

Vehicular ad hoc network comprises vehicles having high mobility that results in alteration in the routes frequently. This results in the need of such a mechanism that can cope up with determination of new routes for highly dynamic network. There is a variety of routing protocols for vehicular environment. Yet location based routing protocols are considered to be most advantageous because these utilize location information of the vehicles. In this paper, an Ameliorated Location Aided Routing (ALAR) has been proposed in order to improve the efficiency of LAR scheme by using multicasting. The simulation results show the outperformance of ALAR.

Keywords: Location Aided Routing, Greedy approach, VANET, Routing Protocol.

I. INTRODUCTION

A new class of the Mobile ad hoc network is advancing as the Vehicular Ad hoc Networks (VANET) for the safety purpose as well as for [1]. Intelligent Transportation Systems (ITS) promotes Inter Vehicular Communication (IVC) and Roadside units to Vehicle Communication (RVC). It uses IEEE 802.11p standard along with Dedicated Short Range Communications (DSRC) [2]. As vehicles move at a very high speed, it varies the topology of the network. The comfort and safety can potentially be improved for the drivers as well as for the passengers. Thus, the communicating vehicles can help in situations of traffic congestion and in cases of accidents. For rescuing, this proves to be beneficial as it can provide the exact location where accident happens. It conveys the faster information to the emergency units along with traffic management system so that the certain affected route can be avoided by other vehicles as their route. Intersection traffic can be handled more accurately. As moving vehicles communicate in VANET with each other, they also need to interact with the roadside units which are conversely fixed [15]. These fixed units provide a large number of facilities to vehicular networks and the drivers as it serves an Internet gateway.

This paper addresses an extension to LAR which reduces network overhead and packet delay, hence, enhancing the performance of the Location Aided Routing protocol [3]. The Route discovery for the proposed scheme uses a baseline between source and destination vehicles. The forwarding of the packet is carried out in such a way that firstly it is send to the roadside unit in its range instead of broadcasting the packet to all the vehicles around it. Then after, roadside unit decides to send the packet to the farthest vehicle in its vicinity. This vehicle employs the same procedure as the roadside unit does to find the next hop until it finds the roadside unit which covers the destination. At last, it transmit packet to the destination. In this way, a better route can be found than that of LAR scheme which decreases the network overhead. As a vehicle stops, this information is updated in the network so that it cannot be used in the routing process. It helps in route maintenance.

The advantage of position based routing is that it makes use of the local information rather than keeping record of topology at global level [4]. This is more suitable for vehicular environment as vehicles are only concerned to their surroundings for safety purposes. The usage of local information limits the searching space for the next forwarding node. Therefore, it lessens the network overhead and the end to end delay. One more benefit of position based routing is that it relies on the scheme of greedy forwarding which ensures transmission in loop free manner [5]. Global Positioning System (GPS) provides coordinate data of each vehicle.

The forthcoming paragraphs are managed as follows: related work is elaborated in section 2 and approach to ALAR is discussed in section 3.The analysis of the performance is carried out in section4 and at last section 5 gives the overall precise conclusion of the study.

II. RELATED WORK

There is variety of routing protocols but among all of them, position based routing protocols cope best with the dynamic network [13]. In this section, we discuss about the existing Location Aided Routing (LAR) and the Directional Greedy Routing (DGR).

- **Location Aided Routing (LAR)**

Young-Bae Ko and Nitin H. Vaidya have introduced the LAR protocol [7] which is GPS based protocol that restricts the search space by decreasing the area of request zone as demonstrated in Fig.1. The overall network overhead gets reduce as the local information of the location of the vehicles is used. Thus, it improves the performance of the routing protocol.

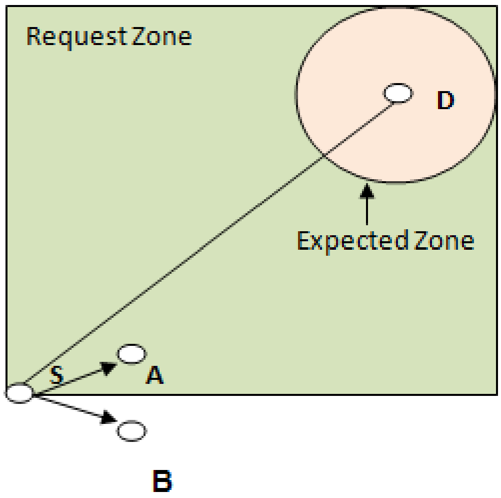

Fig.1: Location Aided Routing

LAR does not broadcast the request packet to whole of the network instead source forwards it to the packets which are in the vicinity of the request zone. There are two of the zones in this routing protocol, namely, expected and request zone [8]. The destination is estimated with a circular area where it is expected to be found by the source node. This is the expected zone. The request zone is the smallest rectangular area covering the expected zone as well as source node. The request packet is broadcasted but it has restricted area that is the request zone. As the node within request zone receives packet, it forward it to the next intermediate vehicle in the request zone. Otherwise, in case, if it encounters the nodes out of the request zone, then it will drop the packet. However, the network overhead due to control packets get reduced.

- **Predictive Directional Greedy Routing (PDGR)**

It is essential for the performance of a routing protocol especially in case of VANET, where the vehicles mobility is comparatively higher than that of nodes in MANET, that source sends packet to destination with minimal hop count and least delay. Thus, hop count decreases by opting an intermediate node which is going in direction of the destination using the approach of greedy forwarding. It can be reinforced by approximating the future environment change. The predicable mobility helps in these predictions which are generated by patterns of the traffic as well as the mapping of the streets. Collectively, it forms an approach known as Predictive Directional Greedy Routing (PDGR). The motion and direction of the vehicle decides the forwarding of packet. The prime focus is on the concept of carry and forward as it takes advantage of the high dynamics of the vehicular environment. The strategy for this routing takes in account the directional first node moving towards destination. However, this process of forwarding makes loop free execution of routing operation. It adjoins two of the schemes, namely, direction-first and position-first. Only the neighbours of the current node are considered for forwarding the packet. PDGR surpasses Greedy Source Routing protocol in performance and it also outperforms Directional Greedy Routing protocol as it uses prediction strategy [10].

- **Manhattan Mobility Model**

The mobility model assists the driver with safe and comfortable approach. There are numerous such models, among all of them, Manhattan mobility model is grid based road topology model as shown in Fig. 2 [11]. The organization of the roads in this model is in accordance with the urban area. In either vertical or horizontal direction of this grid map, the vehicle moves. The approach for the respective mobility model is based on probability of movement of the node. At each intersection, vehicle decides to move in a certain direction.

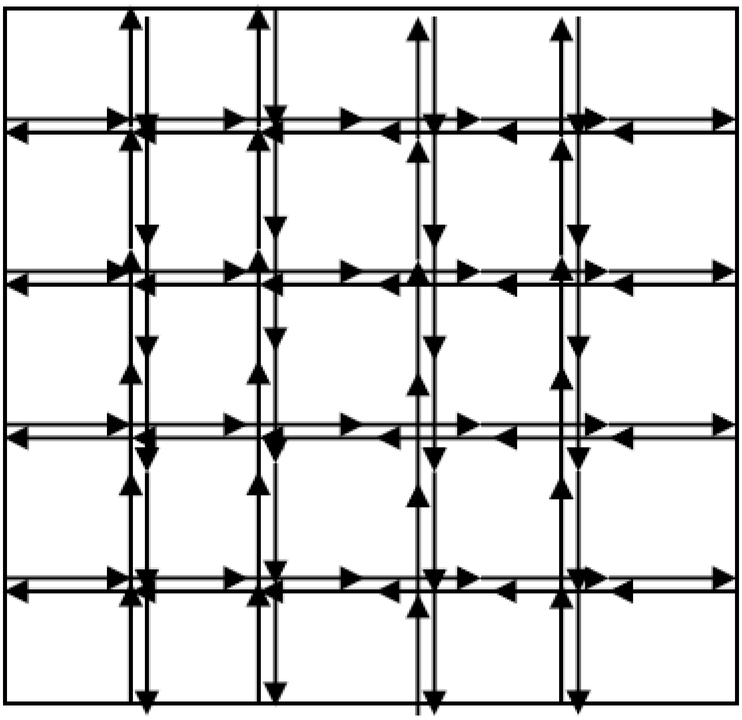

Fig.2: Manhattan Mobility Model

- **Roadside Unit connectivity**

The impact of the roadside units on VANET has largely depends on the denseness and the position of the RSU [12]. The optimal placement of RSU is essential within an urban area. These roadside units plays significant role in packet forwarding in various ways.

III. PROPOSED SCHEME

- **System Model**

Considering the challenges [16,18], the enhancements in the existing LAR protocol are proposed based on the Predictive Directional Greedy Routing as well as the localization, following assumptions are made:

- There is defined layout of roads with fixed number of vehicles.
- The packet forwarded by each node is in ad hoc mode.
- Each vehicle gets its location information from the GPS equipped with the vehicle.
- There are roadside units which participate in the packet transmission.

- **Ameliorated Location Aided Routing Protocol**

This section proposes an improved LAR scheme named as Ameliorated Location Aided Routing (ALAR) as shown in Fig.3. It is an adoption of Predictive Directional Greedy Routing Protocol (PDGR) in the urban scenario using Manhattan Mobility Model for Location Aided Routing protocol. In PDGR, the vicinity of the current node is analyzed and the neighbour of it which is moving towards the destination node is selected as the next hop. The position and the movement of the neighbours are used for the prediction and selection of the closest vehicle for further transmission. The location information of vehicles obtained by GPS is the factor that affects packet delivery ratio in such protocols. Packet transmission in highly dynamic environment tends to have high network overhead. Hence, such a scheme is required which can cope up with this problem of overhead. On that account, we propose a scheme that forwards the packet in such a manner that it involves the least number of intermediate vehicles, consequently tends to have lesser network overhead and reduce the packet delay.

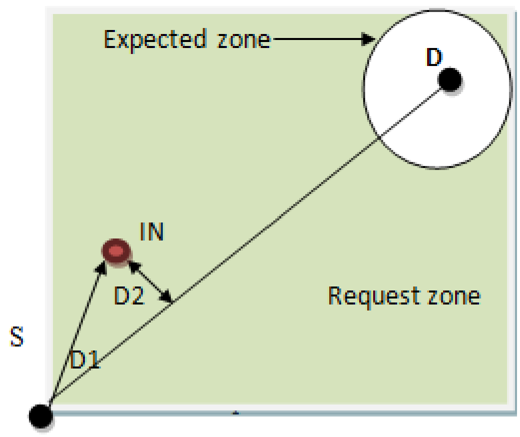

Fig.3: ALAR

In ALAR, the RSU plays important role for packet forwarding [14]. The forwarding of the packet is from the source to RSU of its range. This RSU have the location information of all the vehicles in its vicinity. As the packet is received by RSU from sender, it checks for the farthest node in its proximity in the direction of destination vehicle.

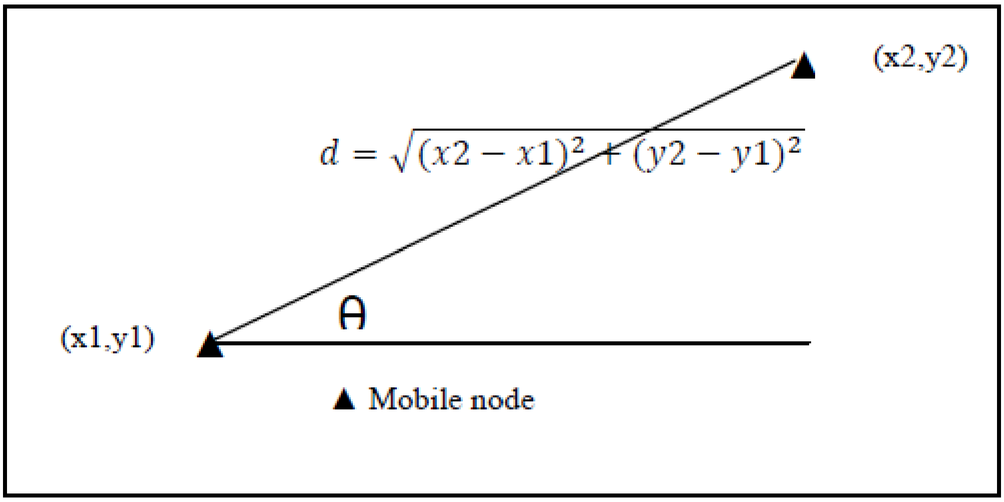

Fig.4: determining RSU to farthest vehicle distance

This is checked by considering a baseline from source to destination and then after the distance from destination is checked for all the neighbours of the current vehicle as revealed by Fig. 4. Further, direction is checked, if it is moving in similar direction then the packet will be forwarded to that vehicle.

The baseline of source to destination as well as distance between two vehicles, one is current vehicle and another is the next intermediate vehicle, is calculated by using this formula:

$$D^2=(x_1-x_2)^2 + (y_1-y_2)^2$$

Here D signifies the distance between two positions. In this way, the number of intermediate vehicles becomes less and the search zone keep minimized due to the directional greedy approach.

The Manhattan mobility model has been used for the urban scenario [17] where the grid based topology maps the street layout and the probabilistic approach is used for estimating the movement and direction of the vehicle or destination vehicle. The directions are provided with the probability of movement when encountering the intersection. The probability of moving straight in same direction is decided to be 0.45 and to return back is 0.05 while to turn left or right is set to be 0.5 for each. Thus, in this manner the mobility model is designed.

The route of packet transmission is completely in adhoc manner as shown in Fig.5. It uses RSU twice in single transmission. Firstly, the source sends the packet to RSU in its proximity which is carrying all the information of the vehicles in its range.

It eases and reduces the searching overhead for the source vehicle, as there is no need to collect and analyze through the information of its neighbour that might cause delay. However, as RSU gets the packet it sends it further to the vehicle moving in similar direction of destination and also farthest in its range. This reduces the number of hops which may be more if transmission would be only through the vehicles. Then, this intermediate node sends the packet to next RSU of its proximity. It also leads to lesser use of intermediate nodes because this RSU will also transmit the packet to the farthest vehicle in its range. In this manner, the destination receives the packet finally when it is obtained by the RSU within its range. Unlike LAR, this scheme utilizes RSU effectively for the efficient transmission of the information.

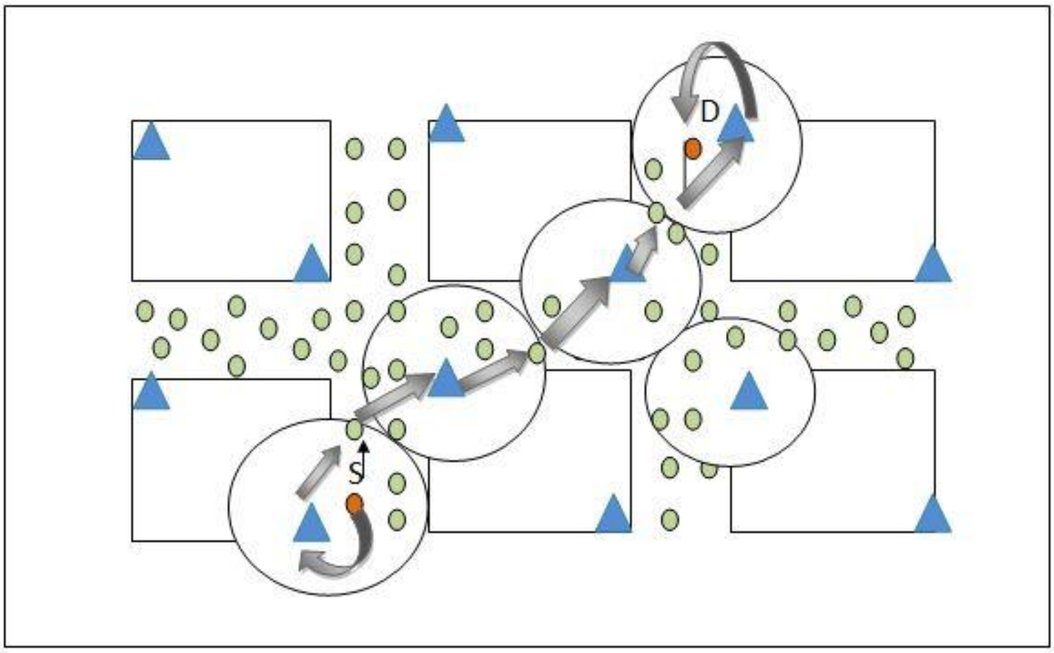

Fig.5: Route of Packet transmission from source to destination in ALAR

After studying the various features of VANET in case of urban scenario, ALAR has been justified. The analysis is carried out in terms of packet delivery ratio and the average delay.

IV. PERFORMANCE EVALUATION

For evaluation purpose, MATLAB (Matrix Laboratory) which is the environment for the numerical computing for multi paradigms. It provides interface for creating and comparing various routing protocols for the networks.

The network is comprised a total of 300 vehicles which are following the Manhattan mobility model. The vehicles' initial locations are randomly distributed over the region.

Table.1 Simulation Parameters and values

Parameter	**Specifications**
Standard	IEEE 802.11p
MAC protocol	IEEE 802.11 DCF
Data Type	Constant Bit Rate (CBR)
Channel type	Wireless
Antenna	Omni directional
Routing protocol	ALAR
Mobility model	Manhattan Grid

Table.2 Simulation Parameters with values

Parameters	Values
Simulation Area	1000x1000
Number of vehicles	50 75 100 200 300
Data packet sizes	512 bytes
Transmission Range	250 m
Number of blocks along x-axis	12
Number of blocks along y-axis	12

The assumption is made for each node that vehicle moves in continuous manner. If any of the vehicles encounters the wall then it bounces back and continues to move in reverse direction. This model defines the probability for going straight to be 0.45 and for moving in each of the left or right turn, it is 0.5 while for reverse direction is set to be 0.05. The area is 1200 unit x 1200 unit square having 9 roadside units of transmitting range of 250 units each. A sum of 500 combinations for the transmission is estimated among all the vehicles. The selection of the pair of the source and destination is completely random. If any vehicle stops that is carrying the packet and unable to transmit it to next RSU, it cause route breakage and lead to dropping the packet. If source does not receive any route reply within the timeout interval then initiates the transmission again.

- Packet Delivery Ratio: This is one of the significant factors for the measurement of the performance of the network when employed upon by a routing protocol. The performance not only depends on the factors which have been chosen for the simulation but also relies on the structure of the network. The prime parameters are packet size and the number of nodes. Additionally the transmission range also affects the overall performance.

$$PDR = \frac{\text{Sum of all received packets}}{\text{Sum of all packets sent}}$$

- Average Delay: The mean delay that all packet face while routing through the network across the source to destination is the average delay. Thus, this delay depends on the packet delivery ratio up to some extent. This average delay contains all kind of delay occurring in the network such as retransmission delays, discovery delays and route buffering, transmission and propagation delay.

The simulation results are carried out on the basis of the comparison between the existing LAR routing protocol that have broadcasting nature and ALAR routing protocol which emphasize on multicasting or rather selective forwarding. The simulation results involve the packet delivery ratio in proportional values as well as the overall delay in seconds associated in the communication. In first scenario, the existing protocol has been discussed.

Fig.6 shows the packet delivery ratio is about 87.8401 for the network size of 50 vehicles and it abruptly increases to 88.2943 for 75 vehicles due to lesser collision rate. For 100 vehicles in the network, it decreases swiftly to 87.6346 and then rises slowly up to 87.8312 and dramatically falls down to 86.4219 due to participation of more number of vehicles. As the network populates and the broadcasting of the packet causes the high rate of collision, thus, the delivery ratio faces such a fall down.

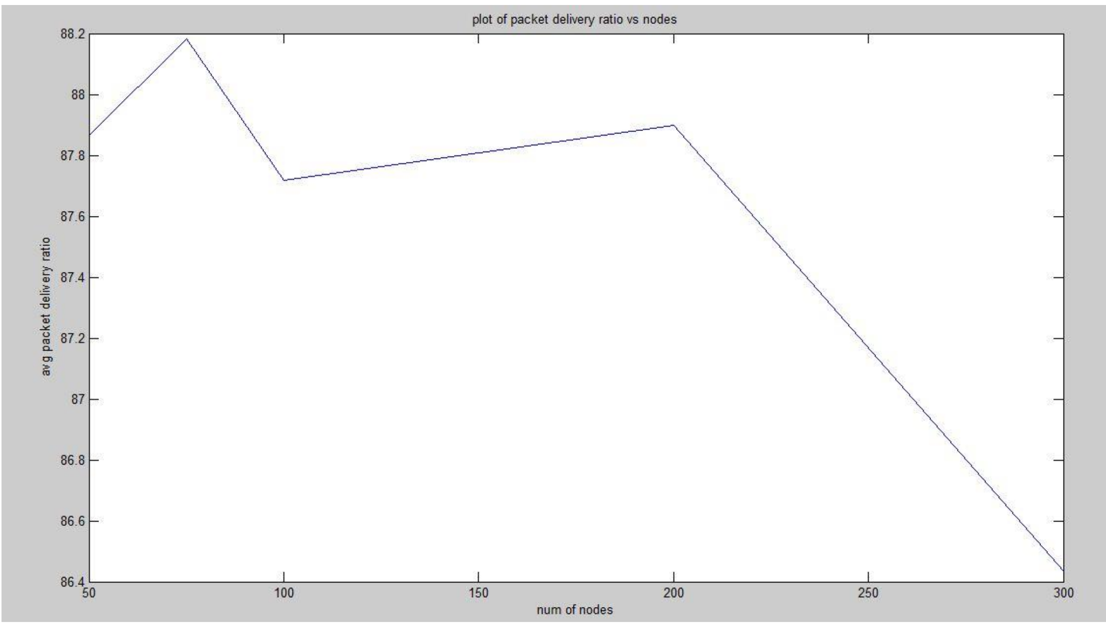

Fig.6 Average Packet delivery ratio in LAR

Fig.7 reveals average packet delivery ratio for the Ameliorated Location Aided Routing protocol. When there are 50 vehicles in the network, the packet delivery ratio is 88.1010 which drops down to 87.5543 when number of vehicles arise to 75. Further, an inclination can be seen when the number of vehicles reaches to 100, here, as the number of vehicles increases, the transmission of packet become faster relatively. At this point the packet delivery ratio is estimated as 88.1123 which reduce minutely to 87.9545 for 200 vehicles. This state of network is considered to be the optimized state where the transmission beholds the maximum number of vehicles with best ratio of delivery of packet as compared to LAR. After this extent, as the number of the vehicle arises, the decline in packet delivery ratio has seen with 87.6513 but this is not as much as in case of LAR that is 86.4219. Therefore, the overall packet delivery ratio of ALAR is more than that of LAR.

The average delay in case of LAR has shown in Fig.8. For 50 vehicles in network, average delay is 2.9401 which rise to 2.9680 when vehicles increase to 75. Further, this delay hikes to 2.9798 as the vehicle count goes to 100. When there are 200 vehicles, the delay is 2.9694. After this point a significant elevation of 2.9980 can be seen, it is due to the reason that as the number of vehicles increases the average delay also increases as collisions increase.

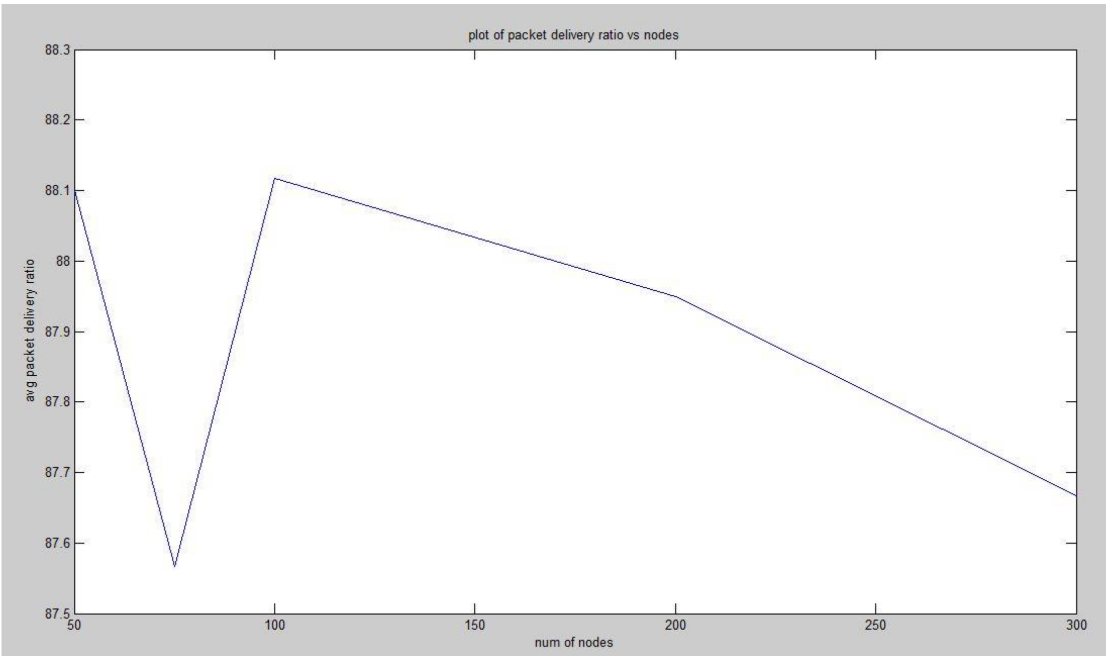

Fig.7 Average Packet delivery ratio in ALAR

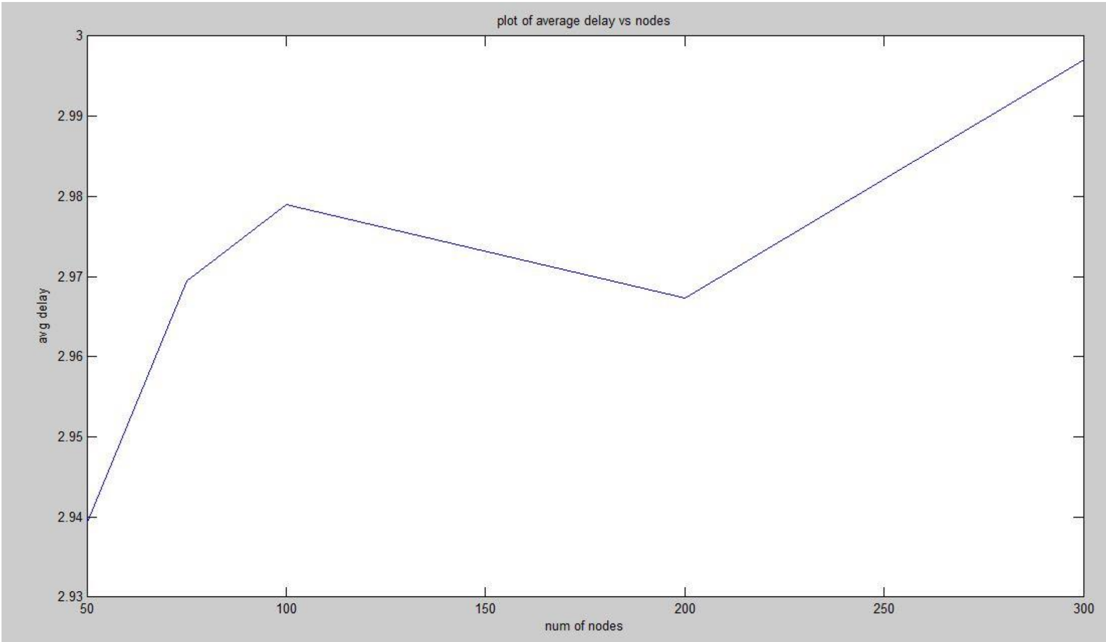

Fig.8 Average delay in LAR

ALAR reflects the lesser delay when compared to LAR. It can be shown by Fig.9. Here, delay is 3.1553 at initial pace, where the number of vehicles is 50 and as the network swells and contains 75 vehicles then it reflects drop down in delay of 2.9605. Further, as vehicle count goes to 100 then this delay reduces by 2.9701 and then for 200, it reaches to 2.9511 which considerably reduces. For 300 vehicles, the delay drops more to 2.9110, this is due to the more number of intermediate nodes for transmitting the packet which tend to reduce the searching time of further next vehicle.

Table.3 Comparison chart of LAR and ALAR

Parameter	Routing Protocol	Number of Vehicles				
		50	75	100	200	300
Average Packet Delivery Ratio (%)	LAR	87.8401	88.2943	87.6346	87.8312	86.4219
	ALAR	88.1010	87.5543	88.1123	87.9545	87.6513
Average Delay (sec)	LAR	2.9401	2.9680	2.9798	2.9694	2.9980
	ALAR	3.1553	2.9605	2.9701	2.9511	2.9110

Consequently, ALAR has shown the lesser average delay than LAR.

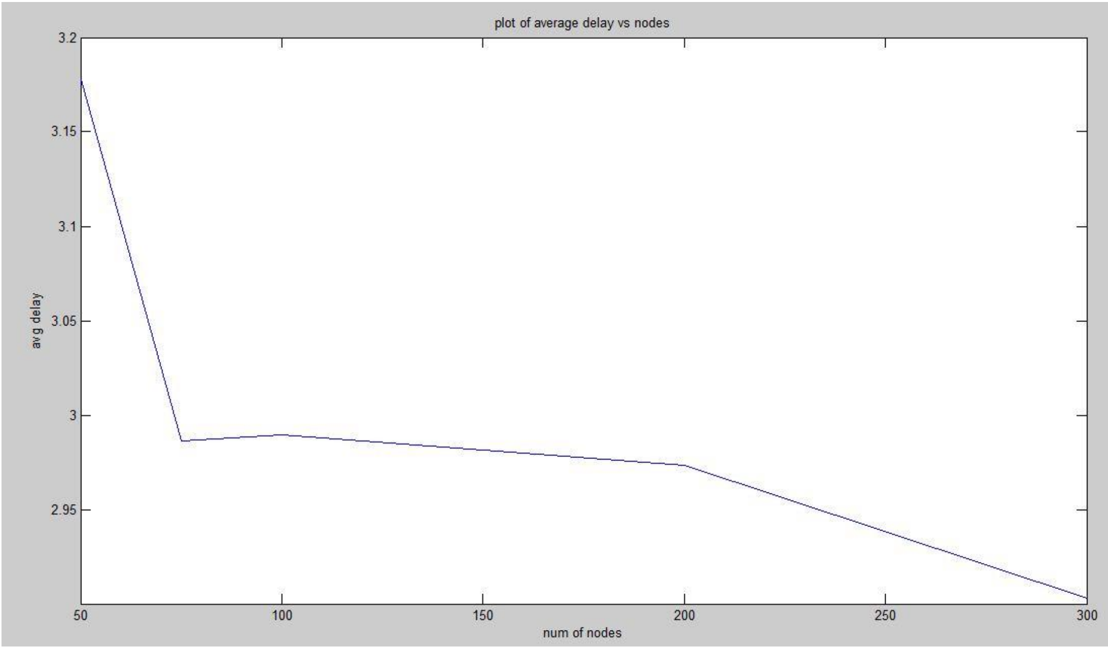

Fig.9 Average delay in ALAR

By drawing the comparison between both of the routing protocols, it has been observed that the simulation results of the average delay and packet delivery ratio of ALAR outperformed the same for LAR. The significant delay can be seen in case of LAR as the number of vehicles increases than 200 and goes up to 300. For the same number of vehicles the delay recorded for ALAR is lesser as this routing protocol copes up better in denser urban environment. On the other hand, the average packet delivery ratio is another aspect which shows a gradual rise in the delivery ratio with hike in number of vehicles which depicts that in a dense vehicular environment, the delivery ratio improves and significantly grows high until a threshold; here it is 200 of vehicle in total.

V. CONCLUSION

This paper presents an extended position based routing protocol, named as ALAR which collaborates predictive directional greedy routing with that of location aided routing in the urban scenario. The next hop selection is based on the least distance from the destination and the similar direction as of the destination. This is done by having baseline between source and destination and comparing it with the distance of the farthest node in the RSU range which is covering previous vehicle as well. It is applicable for the dense traffic scenario that is of city where the density of vehicles is enough to provide efficient connectivity.

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