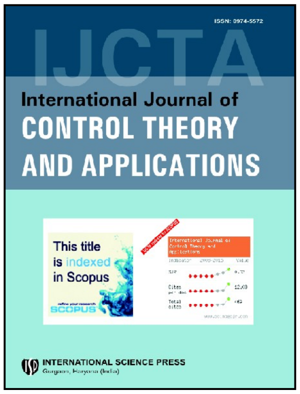

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An Improved Greedy Parameter Stateless Routing with Virtual Line in Vehicular Ad Hoc Network

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Abstract: Congestion problem and packet delivery related issues in the vehicular ad hoc network environment is a wide issue for research in recent years. The design of efficient network protocol is a major challenge in vehicular ad hoc network which utilizes the value of GPS and other parameters associated with the vehicles. In this paper, Greedy perimeter stateless routing protocol(GPSR) is improved by drawing a virtual line and by considering perpendicular distance of one hop neighboring node of source over that virtual line and comparing them to obtain next forwarding node. This algorithm is compared with the existing improvements in GPSR protocol for congestion and routing on the basis of various performance parameters like throughput of the network, end to end delay, routing overhead and packet loss ratio. The results also validate the performance of the proposed approach.

Keywords: Improved GPSR, VANET, GPSR, AODV

1. INTRODUCTION

VANET (Vehicular Ad hoc Networks) is a type of Mobile Ad hoc Network (MANET) in which each node acting as router to transfer information from one node to another node. In the VANET network, movement of node is based on the geographical area [1].VANET has given birth to many attractive applications."Collision Avoidance" is one of its applications. Most of the road accidents are resulting from vehicles parting the road or traveling rashly through intersections. Inter vehicular communications and infrastructure to vehicular communication as discussed above can save many road accidents and therefore can save many human lives. The worst traffic accident occurs when a number of vehicles strike each other after a single accident unexpectedly stops traffic. In collision avoidance technique whenever a single vehicle lower its speed because of any reason, it broadcasts its position and other related information to all other vehicles. Furthermore, long waiting hours in traffic increase time wastage for the drivers. An important decline in numbers may be attained during VANET [5]. In this approach, vehicles collect the desired information about the current traffic from surrounding environment and send it over network. Using this uploaded information traffic agencies helps in controlling congestion. In this approach, each vehicle calculates the number of its neighbor vehicles and their averages speeds and then sends this information to other vehicles in order to prevent them approaching the busy location. Moreover in some cases, the message may be communicated by those vehicles which are moving in another path thus it can be communicated earlier to the any automobile medium in the direction of the overcrowding site. Information like climate, road surface, manufacture zones, railways lines, and emergency vehicle signal is also collected by vehicles.

Greedy Perimeter Stateless Routing (GPSR) protocol

Greedy Perimeter Stateless Routing is a routing protocol that depends on the geological location of nodes which is also required for vehicular ad-hoc network (VANET) [2]. GPRS attains neighbor vehicle message by using GPS positioning apparatus instead of obtaining huge routing information to maintain the message in routing table. In this routing protocol, every node transmits its location information periodically to the neighboring nodes. The information received by neighboring nodes is stored in the form of tables stored at those nodes. In order to promote the desired packet effectively, GPSR utilizes the information of nearest neighbor of destination[3]. Every node in GPSR has information of its location and its neighbors. The information about location of node provides helps to obtain better routing. All the neighboring nodes facilitate in making the forwarding decision in a suitable way without snooping with the information related to topology. The benefit of GPSR is that it keeps the currently existing location of the forwarding node. This can help to send the packet in short time interval and also reduce the distance among destination nodes. Moreover, there are some demerits as well. In this GPSR protocol, few topologies result in making the packet to move out of specific range from the destination [4]. Also, this protocol will not work if there is no nearest neighbor present to destination. GPSR is not appropriate for those ad-hoc networks where nodes are moving highly as a node will be unable to maintain its one hop neighbor's information as the other node can move out of its coverage area or range because of the higher mobility of dynamic nodes. It can result in loss of data packets.

2. LITERATURE REVIEW

Vasil et.al.[1] proposed a geo AODV routing protocol that is similar with location aided routing which deploys GPS coordinates to reduce the area of search which is utilized through the means of discovery process. GeoAODV is used to dynamically distribute the position data between the nodes in the network. Also, in this work, performance of proposed protocol is compared with other LAR, AODV routing protocol. The proposed approach in [2] is utilizing the position information in order to enhance the routing protocol performance for any kind of ad-hoc network. This protocol reduces the area of search by utilizing the position data. In this, the proposed protocol moves in the direction where the final node is supposed to be located. Also, location aided routing modifies the process of finding the route, so that only those nodes will rebroadcast the request message that belongs to the search area so that the number of routing message get reduced.

The Location Based Efficient routing protocol [3] divides the network field into separate zones and arbitrarily selects the node which may act as intermediate relay nodes and these nodes makes non traceable anonymous route. An analysis is presented in [6] that involve two types of MAC /PHY specifications that is IEEE 802.11g and the IEEE 802.11a. In the first experimental design, signal strength has been calculated which is produced by analyzed devices. The second design illustrates the quality of service of V2V communications of these devices.

Mitton et al. [7] analyzes the delay in the delivery the information only for the purpose of roadside unit (RSU) deployment in VANET network. Also in this paper, a model has been designed which helps to explain the relation among delay and deployment distance between roadside neighbor units. Furthermore, the designed model considers the speed of vehicle, its density and some other parameters. The correctness and accuracy of the proposed model is confirmed and the effects of several parameters on the average delay are investigated through simulation results. A scheme based on the prediction of velocity and selective forwarding is presented in [8]. The sender choices the best candidate which will rebroadcast the message to other vehicle. In this technique, low overhead has been generated. This work proposed a broadcasting algorithm for VANETs. The proposed algorithm depends on the kalman filtering. The simulations results indicate that the proposed technique may improve the delivery ratio and decrease the end to end delay.

Xu Li et. al. in [9] works on distance based broadcast protocol also called as efficient directional broadcast for vehicular ad hoc networks. The performance has been evaluated of EDB [9] method depends on the mobility model generated by GPS data of taxis in Shanghai city. The result shows that EDB is efficient for vehicular network. Geographic source routing Protocol has been proposed in [11] in which an approach has been studied which does not require any navigational system. Modeling mobility model for vehicular ad-hoc networks is implemented in [12] that depends on the movement of vehicles and used with the ns-2 network simulator. The proposed method is compared with other traditional method like Waypoint mobility model and it is found that the new proposed model is far better than waypoint model.

3. PROPOSED METHODOLOGY

In the proposed approach, the link between source and destination is computed by considering various assumptions. These assumptions are related to acceleration of the target vehicle, velocity of source and target vehicle, distance between the source and the target vehicle and the direction of the target vehicle.

$$y - y_1 = [(y_2 - y_1) / (x_2 - x_1)]\ (x - x_1) \tag{1}$$

Now, the distance of each neighbor of the source node is calculated from the destination node using equation 2 and compared the calculated distance with the source to destination distance. This step is performed so as to select the nodes which lay in between the source and the destination vehicles. If the vehicles satisfying the above parameters is behind the source node then the hops in the communication path unnecessarily increases.

In order to solve the above mentioned problem and handle the demerits of GPRS protocol, we put forward a routing strategy based on nodes satisfying the below mentioned criterion will only be considered for the path selection process (i) when the velocity of the source node is less than destination node (ii) acceleration of destination node is more than source node (iii) destination or target node lies within the range of source node (iv) direction of both source node and the target node are same.

After the initial selection of nodes, the perpendicular distance of the node with the virtual line is calculated using equation 3 and the node with the least distance is selected for route discovery and the source node is updated with the selected node and process continues until destination is reached. This is because the angle among the destination and source node is minimized in order to make the GPSR protocol to be angle aware.

$$dist = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \tag{2}$$

$$perpendicular\ distance = \frac{|Am + Bn + C|}{\sqrt{(A^2 + B^2)}} \tag{3}$$

from a line $Ax + By + C = 0$

and m and n are the x and y coordinates of the concerned node

Figure 1 show the path selection procedure based on the perpendicular distance of the nodes from the virtual line.

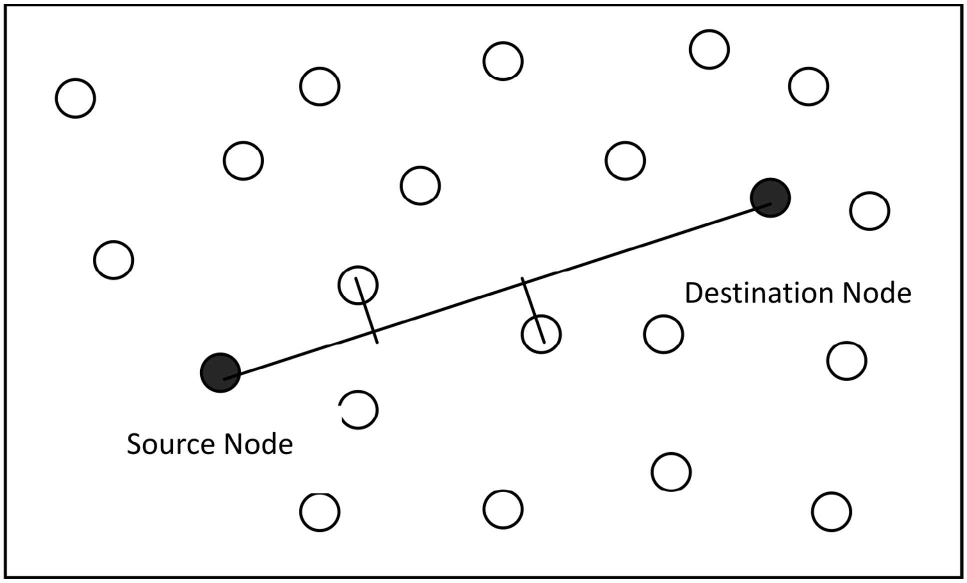

Figure 1: Path Calculation between Source and Destination Node

Algorithm

$\textbf{Start}$
$initialize\ n_i \leftarrow\ location, where\ n_i\ is\ the\ i^{th}\ node$
$d1 \leftarrow Dist(n_s, n_d),\ /Calculate\ the\ distance\ between\ n_s\ and\ n_d,$
$where\ n_s\ is\ the\ source\ node\ and\ n_d\ is\ the\ destination\ node$
$dir \leftarrow Dir(n_d),\ \ Direction\ of\ destination\ vehicle$
$S_s, S_d \leftarrow Speed(n_s\ , n_d),\ \ Speed\ of\ sourceand\ destination\ vehicle$
$A \leftarrow Acc(n_d),\ \ Acceleration\ of\ destination\ vehicle$
$l \leftarrow Line(n_s, n_d),/\ Line\ between\ source\ and\ destination$
$\textbf{for } \boldsymbol{i} \coloneqq \mathbf{0}: \boldsymbol{N}, where\ N\ is\ the\ total\ no.of\ neighbor\ nodes\ of\ source\ node$
$d2 \leftarrow Dist(n_i, n_d)$
$\textbf{if}\ (\ S_s < S_d \& A_s < A_d \&\ dir_s = dir_d\ )$
$\textbf{if}(d1 > d2)$
$dp \leftarrow\ PerpDist(n_i, l)$
$\textbf{if}\ (dp\ is\ minimum)$
$Update\ n_S \leftarrow n_i$
$\textbf{end if}$
$\textbf{end if}$
$Update\ Route(n_s, n_d)$
$\textbf{end if}$
$\textbf{end for}$
$\textbf{end}$

In the algorithm presented above, firstly all the nodes in the network are initialized with location and various wireless parameters. Then the distance between the source and the destination node is calculated using equation 2. Direction, speed and acceleration of each node are also stored in the variables for further reference. A virtual line between the source and the destination node is marked using equation 1. For each neighbor of source node, the distance between those nodes to the destination node is calculated and comparisons between speed, acceleration and direction are drawn. If the distance between the neighboring node and the destination node is smaller than distance between the source and destination nodes, perpendicular distance is computed between the virtual line drawn and the node using equation 3. If the distance is minimum, then it is updated to the route until the destination is reached.

4. SIMULATION ENVIRONMENT

Network Simulator NS-2.35 is used for the simulation of the proposed GPSR approach. The network range of the vehicle is set to be 215 m. Two cases are used for the calculation of results by tracing the trace file generated by NS 2 using the AWK Script. In the first case, the speed of the vehicles varies and the number of vehicles is fixed to 100. CBR data stream is used for the generation of the traffic which ensures constant flow of 512 bytes.

In the second case, the speed of the vehicles is kept constant at 10 m/s and the numbers of vehicles vary from 50 to 125. Channel of the simulation must be wireless with omni directional antenna mounted on vehicle. The MAC layer follows the IEEE 802.11standard. The data is collected by simulating 10 times and the average of the results is taken as the final results. The graphs are then plotted using the MS Excel tool.Table 1 shows the parameters set up for creating the simulation environment.

Table 1
Simulation Parameters used

Channel	*Wireless Channel*
Propagation Model	Two Ray Ground
Mac	IEEE 802.11
Antenna	Omni Directional Antenna
Number of Vehicles	50~ 125
Simulation Time	50 s
Grid Size	1000m x 1000m
Traffic Type	CBR
Mobility of Nodes	3~ 20 m/s
Packet Size	512 bytes
Network Bandwidth	2Mb/s

5. RESULTS AND DISCUSSIONS

The proposed methodology is implemented using the network simulator ns2.35. The Vehicular Ad hoc Network environment is created and performance of Improved GPSR is compared with the basic approaches. Figure 2 shows the end to end delay of GPSR [15], EGPSR [15] and improved GRSR. The end to end delay for the vehicles with less mobility is less and increases as the mobility increases. The reason for this is the number of retransmissions in the network reduces and the packets transfer accuracy increases. The packets are stored in the buffer of the vehicles and hence cause less congestion. Figure 3 shows the packet loss rate plotted against the mobility of the nodes. As the speed of the vehicles increases, the packet loss rate also increases as the packet congestion tends to increase. The decrease in number of retransmissions in the network in the proposed approach also decreases the packet loss ratio in the proposed approach.

Acceleration is the rate of change of speed and if the vehicle considered is accelerating then it will gain greater speed (in case of positive acceleration) and it will be out of reach of the source. Speed of the target vehicle must be higher than the source vehicle otherwise the source will overtake the selected target vehicle and the end to end delay of the packet to reach the destination is increased. The routing overhead is increased as the number of hops in the network increases. In this case if the source overtakes the target vehicle then the target again needs to further retransmit the packet which increases the overhead. Distance between the source and the target vehicle is also an important parameter of consideration as each vehicle has specific range in which it can transmit packets and if the considered target vehicle satisfies all the parameters but is out of range then the packets are lost and the packet lost ratio increases.

Direction of the target vehicle is another important parameter as if the vehicle satisfies all the other parameters and if its direction is opposite to that of the source vehicle then it carries and forwards the packet in opposite direction and the packet will be lost after time to live of packet is over.

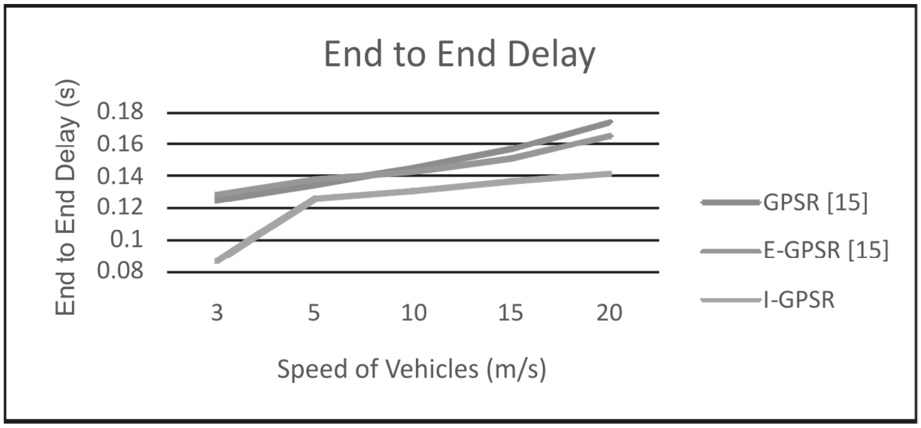

Figure 2: Shows variation in End to End Delay of GPSR [15],E-GPSR[15] and I-GPSR by varying speed of vehicles from 3m/s to 20m/s. Delay in case of I-GPSR is less than GPSR and I-GPSR

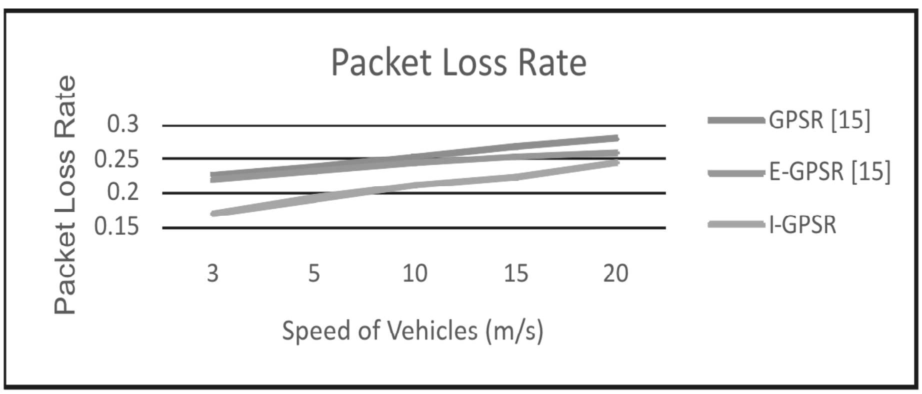

Figure 3: Shows variation in Packet Loss Rate of GPSR [15], E-GPSR[15] and I-GPSR by varying speed of vehicles from 3m/s to 20m/s. Packet Loss Rate in case of I-GPSR is less than GPSR and E-GPSR

For the comparison with the GPSR [20] and O-GPSR [20], two different scenarios are created. First is the urban scenario in which the roads without lanes are considered and the aped of the vehicles is 10 m/s. The two side traffic on the road is considered and the average speed of the vehicles is restricted. While in the second scenario, the average speed of the vehicles is double as of urban scenario and the two side roads with lanes are considered. Figure 4 and 7 shows the throughput of the network with respect to the number of vehicles. Figure 4 shows the urban scenario while figure 7 shows the highway scenario. The throughput of the network varies as the number of packets received varied with respect to the delay. This is due to the fact that the packets generated increased as the number of vehicles in the network increases.

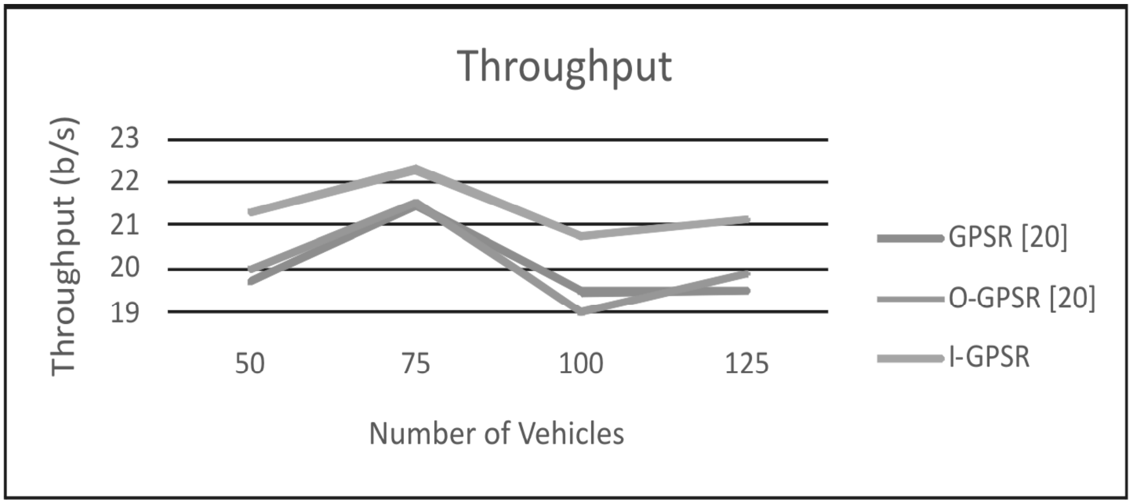

Figure 4: Shows influence of number of vehicles on Throughput of the Network in GPSR [20],O-GPSR[20] and I-GPSR protocols in Urban Scenario. Throughput of I-GPSR is better than GPSR and O-GPSR as number of vehicles are increased

Figure 5 and 8 shows the end to end delay in the network plotted against the number of vehicles. As the number of vehicles in the networks, packet generation in the network also increases. Thus end to end delay in the network increases and less in case of proposed approach. In proposed approach the route is selected which is the least angular route and thus is more likely to be connected during the communication cycle. Thus number of retransmissions in the network decreases and hence the end to end delay decreases.

Figure 6 and 9 shows the routing overhead plotted against the number of vehicles in the network. The routing overhead is directly dependent on the route selected. If the route selected remains for a communication cycle, then the packets loss in the network decreases and the routing overhead which mainly consists of the addresses of the hops also decreases.

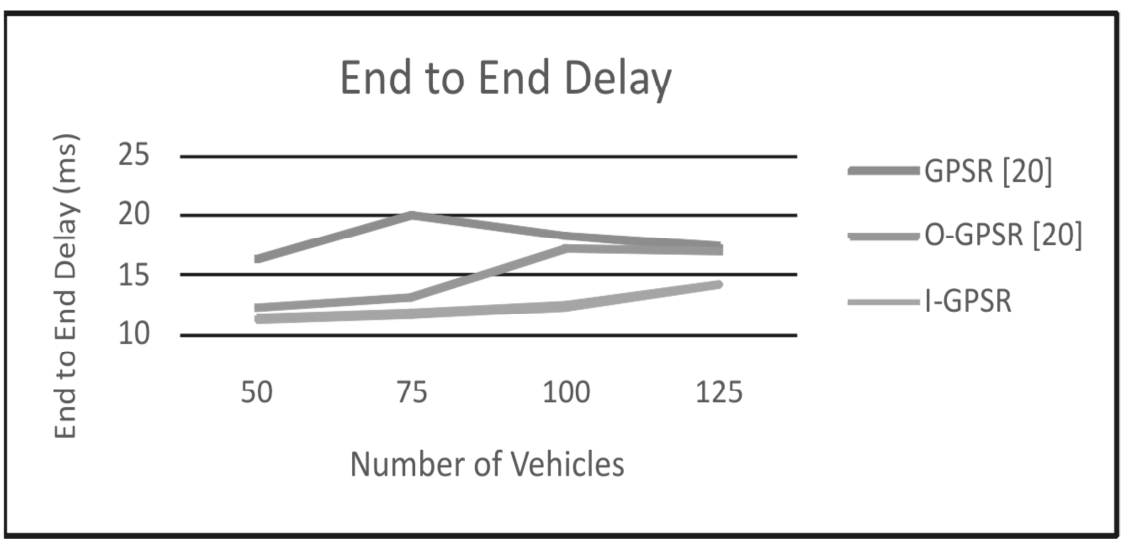

Figure 5: Shows influence of number of vehicles on End to End Delay in GPSR [20],O-GPSR[20] and I-GPSR protocols in Urban Scenario. Delay of I-GPSR is less than GPSR and O-GPSR as number of vehicles is increased in Urban Scenario

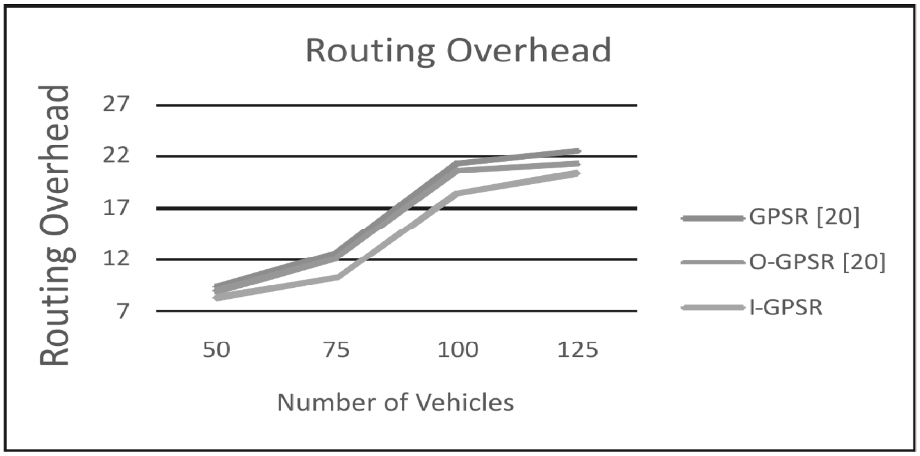

Figure 6: Routing Overhead of the Network in Urban Scenario with increase in scalability is less in I-GPSR than O-GPSR [20] and GPSR[20]

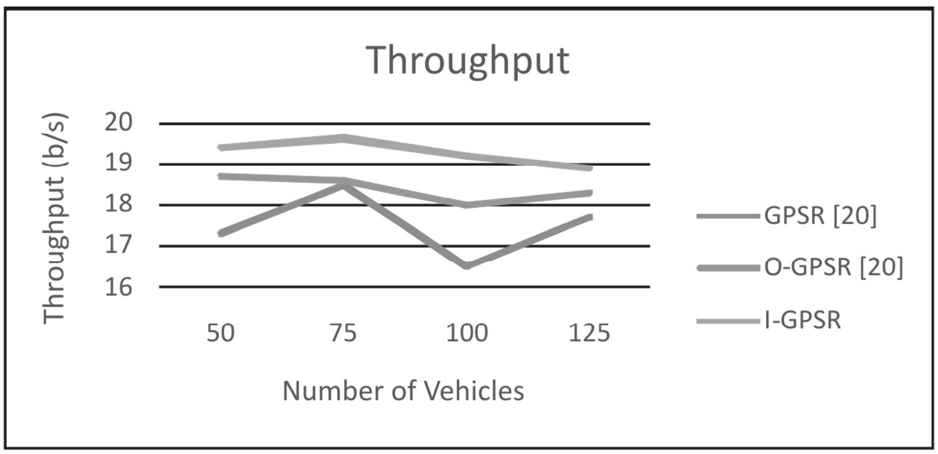

Figure 7: Throughput of the Network in Highway Scenario increases with increase in number of vehicles in I-GPSR than O-GPSR [20] and GPSR[20]

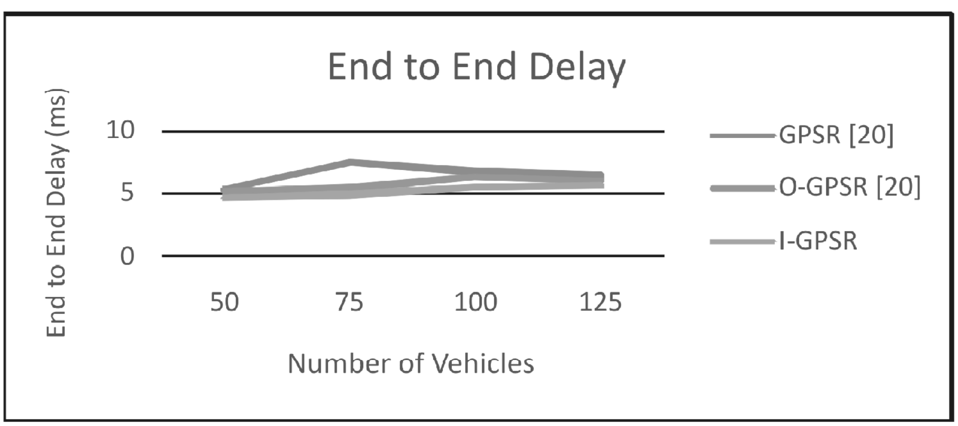

Figure 8: Shows the End to End Delay of the Network in Highway Scenario with varying number of vehicles from 50 to 125 vehicles. End to End delay of I-GPSR is less as compared to GPSR [20] and O-GPSR[20] as number of nodes are increased

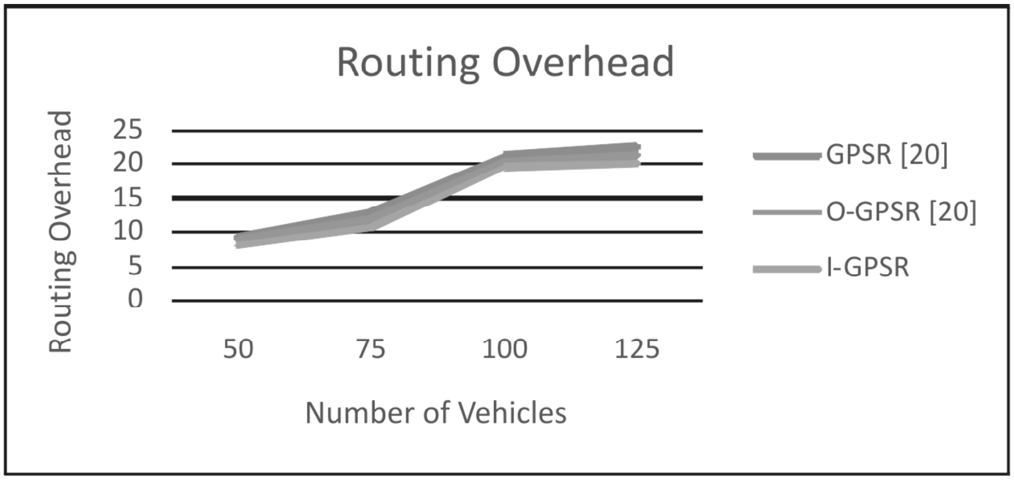

Figure 9: Shows influence of increase in scalability on Routing Overhead of the Network in Highway Scenario. I-GPSR outperforms O-GPSR [20] and GPSR[20] as routing overhead is less in case of I-GPSR with variation in number of nodes

6. CONCLUSION AND FUTURE WORK

This paper presents an improved GPSR with virtual line and this proposed algorithm shows best results to control congestion and packet loss with increase in number and speed of vehicles in vehicular ad hoc network. The proposed I-GPSR is compared with E-GPSR[15] and GPSR[15]in terms of end-to-end delay and packet loss rate with variation in speed by considering same simulation environment and in another scenario, I-GPSR is compared with O-GPSR[20] and GPSR[20] in terms of throughput, network delay and routing overhead by variation in number of vehicles. The results show that I-GPSR protocol outperforms the other two protocols in terms of throughput, network delay, packet loss ratio and routing overhead. A VANET environment was created and vehicular movement was simulated using ns2. The above discussed protocols were used for communication and the performance of the system was analyzed for a similar environment. Our proposed reduces end to end delay and network overloads by reducing the congestion problem and enhance throughput by drawing virtual line and reducing slope of neighboring nodes. This encourages us to further explore the proposed I-GPSR protocol in other environment. In future, hybrid protocols can be developed by exploiting the better features of I-GPSR and the traditional algorithms.

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