AMELIORATED LOCATION AIDED ROUTING IN VANET

A Dissertation submitted

Ikjot Saini

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Under the guidance of

Er. Vikram Dhiman
(Assistant Professor)

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Name of the student	:Ikjot Saini		
Batch	:2013-2015	Registration No	:11304650
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Details of Supervisor:

Name	:Vikram Dhiman		
UID	:18360	Designation	: Assistant Professor
		Qualification	: M.Tech
		Research Exp.	:7 year

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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. Ameliorated Location Aided Routing (ALAR) has been proposed in order to improve the efficiency of LAR scheme by using multicasting. It is applicable for the dense traffic scenario that is of city where the density of vehicles is enough to provide efficient connectivity. The simulation results show the outperformance of ALAR.

CERTIFICATE

This is to certify that Ikjot Saini has completed M.Tech dissertation titled Ameliorated Location Aided Routing in VANET under my guidance and supervision. To the best of my knowledge, the present work is the result of her original investigation and study. No part of the dissertation has ever been submitted for any other degree or diploma.

The dissertation is fit for the submission and the partial fulfilment of the conditions for the award of M.Tech Computer Science & Engineering.

Date: Signature of Advisor

Name:

DECLARATION

I hereby declare that the dissertation entitled, Ameliorated Location Aided Routing in VANET submitted for the M.Tech Degree is entirely my original work and all ideas and references have been duly acknowledged. It does not contain any work for the award of any other degree or diploma.

Date: **Investigator**

Regn. No.

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CHAPTER 1
INTRODUCTION

VANET (Vehicular Adhoc Network) is a prime area out of all the communication research studies. Vehicular environment is highly dynamic network with vehicles and roadside units along fixed geographical layout of roads. This network is infrastructure less and no setup is done previously. The communication among all the vehicles and roadside units is completely in adhoc manner. The standard for this technology is IEEE 802.11p in which the wireless connections are provided for the communication [1, 2]. This is specially designed for the vehicular environment as the characteristics of this network are different from the mobile adhoc network.

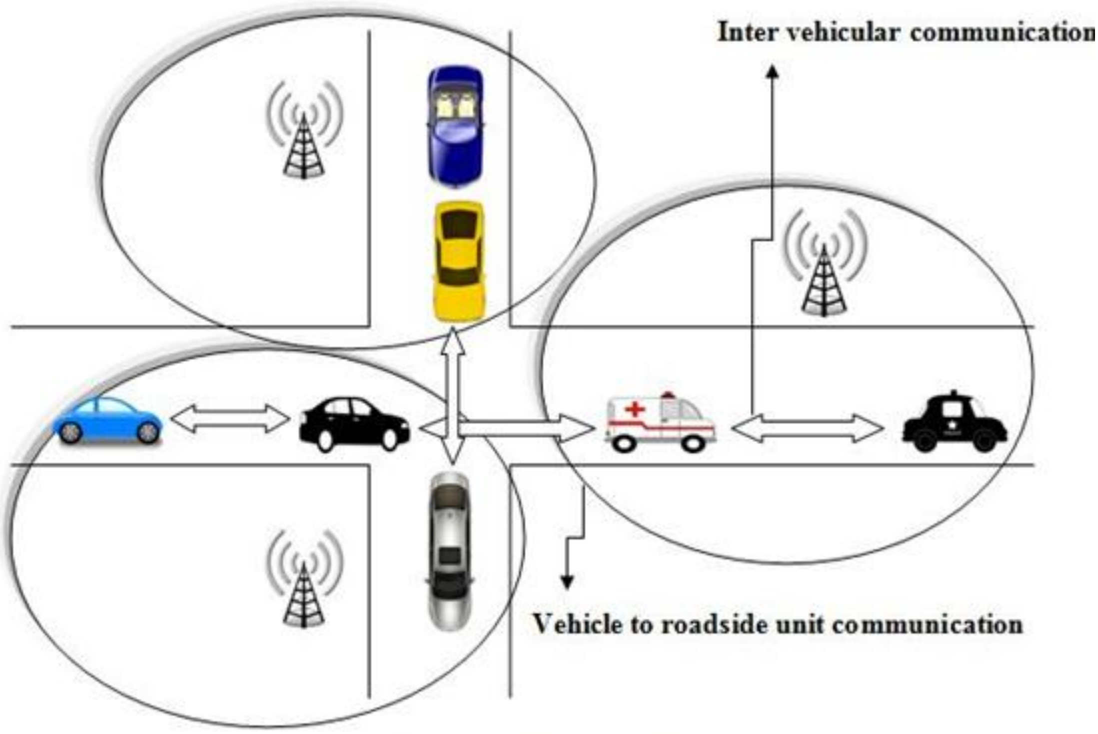

Fig.1.1 V2V and V2I communication

Communication scenarios: In the vehicular networks, potential communication scenarios: vehicle to vehicle communication and vehicle to infrastructure scenario. There are so many hotspots by the roadside such hot spots can operate with the help of internet service provider or integrated operated. Communication of the vehicles takes place clearly by using the short range factors where vehicles cooperate with each other and forwards the data in different approaches [2]. Combination is possible as well of all such scenarios. ITS is working over many projects and it is proposed that all the active nodes will collect and forward the critical information which can be used for the safety purposes. Various sensors are put in such a manner that may collect as well as process the information with exchanging such information along with the neighboring vehicles. The scenarios can be categorized into two types:

- Vehicle to vehicle communication: This type of communication can be used to exchange the information between different vehicles. This system mostly is used in modern vehicles which are presently working. There are mainly two application areas distinguished into two parts; first as in the vehicle network sensor, actuator or controller and second is high quality multi-media for comfort [8].

- Vehicle to road side communication: This can be established between a vehicle and a fixed infrastructure. This communication is in the two forms, namely, unidirectional or bidirectional fixed infrastructure [10]. The unidirectional transfer of information from broadcast station to the vehicle is supported by broadcast system. In this system, all the vehicles communicate point to another point with the base station or access point. Though, base station makes coordination in communication by using the physical synchronization with medium access. Base station balances excessive load and provides the access control in proper channel. Bidirectional technologies further divide into the cellular mobile phone system and small range system. Existing cellular infrastructure like GMS and UMTS which makes information required infrastructure always available.

1.1 Characteristics of the VANET:

- Immensely dynamic topology: The multiple paths and the intersections along the geographical patterns tend to have high speed vehicles to change topology frequently.

- Regular disconnected network: Dynamic topology changes leads to the frequent disconnections in the network unless it is provided with enough roadside units. These help in maintaining the connections. But the requirement is the frequent usage of roadside unit.

- Mobility model and relative prediction: The positioning of the vehicles as well as their movement is not easy to predict. Thus, for the sake of convenience, predefined roadmap modeling is followed which provide better prediction for the real time scenarios.

- Communicating environment: Mobility model can give an overview for the prediction but other features as the kind of environment also is essential factor. It can be any one of highways, urban or road architecture.

- Constraint of Hard delay: In emergencies, packet delivery becomes a major problem. Hence, only higher data rates can not be sufficient for this environment as it demands to be strict and accurate in terms of time.

- Battery consumption is unlimited: Vehicles provide ample amount of power to be provided to the sensor networks so that it cannot suffer from the problems of battery.

1.2 Applications of VANET

The classification of the applications of VANET is based on the kind of communication that can either be Vehicle to vehicle or Vehicle to roadside unit. Following are the applications:

- Safety oriented applications: These applications assist in monitoring the road surroundings and the vehicles that are approaching or the upcoming intersections and turns. These require real time traffic which can be stored at Roadside unit and can be fetched whenever needed. The cooperation of vehicles in order to exchange messages increases reliability and make possible the automated emergency messages. One of the most notable notifications is the broadcasting of the warning message in case any vehicle had accident. This message helps highway patrol and the surrounding vehicles about the accident position.

- Commercial Applications: These applications serve for the infotainment to the driver and the passengers including access to the web and getting local information. RSU allow such information providing it as a router. Downloading the maps of the region around for travelling purpose is an application for travelers. Other value added services are also provided by this application.

➢ Convenience Applications: Such applications are aim to enhance the efficiency of the traffic by hiking the level of driver's convenience. Route planning is proved to be optimized solution in case of road congestion. Collection of tolls electronically benefits the toll operators as well as the drivers. In case of parking, the availability can be checked previously. The fuel usage is another targeted benefit which involves the prediction of the upcoming topography on the route.

1.3 IEEE 802.11p STANDARD (WAVE)

Wireless Access in Vehicular Environment (WAVE) [1] is the technology evolved for the vehicular environment and it is the standard amendment of IEEE 802.11 that lead to the extension of IEEE 802.11p which is responsible for the exchange of the information among vehicles and roadside units.

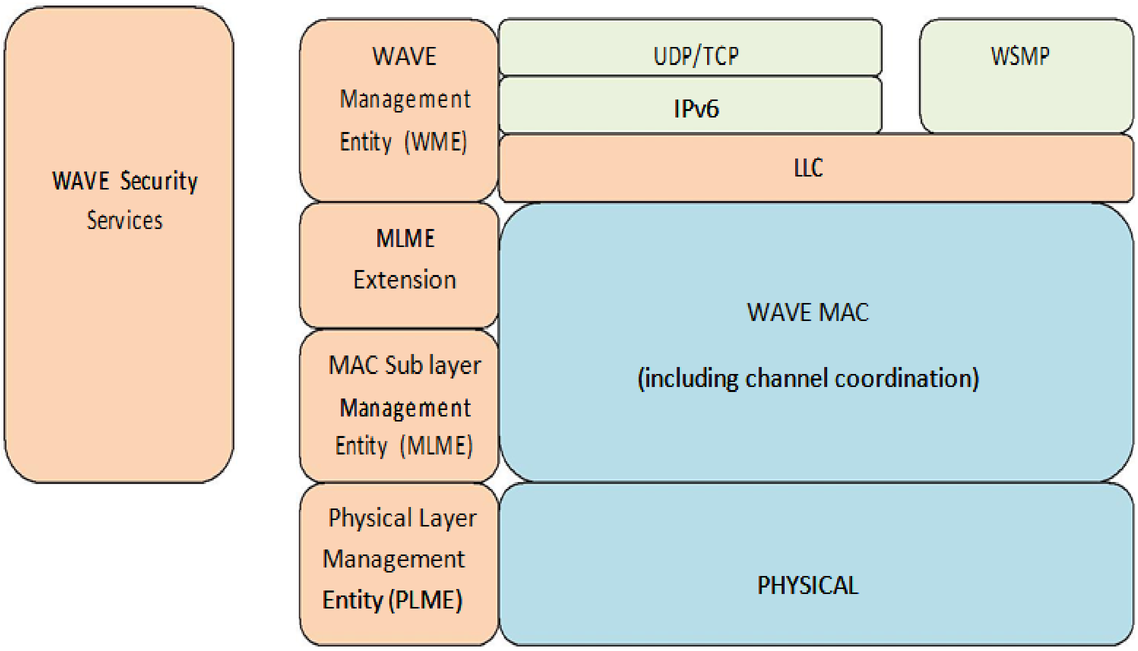

Fig.1.2 WAVE Protocol Stack

The channel frequency usage is distributed on the band as shown in Fig.1.3. The frequency band of 5.9GHz with channel spacing has three of the different ranges. DSRC (Dedicated Short Range Communication) is especially designed for the purpose of the vehicles as they have high topology changes. It provides the data exchange in two ways, either V2V or V2I. The range is defined for that is 1km for the transmission range. Transmission rate is also limits at 3 Mbps to 27 Mbps for the movement of vehicles at speed of 260 km per hour. The six channels are utilized for communication as bidirectional among different kinds of units. Physical layer (PHY) enables the exchange of frames. PLCP is Physical Layer Convergence Protocol, the first layer that helps in communication and process of converging Packet Data Unit (PDU) into frame of OFDM.

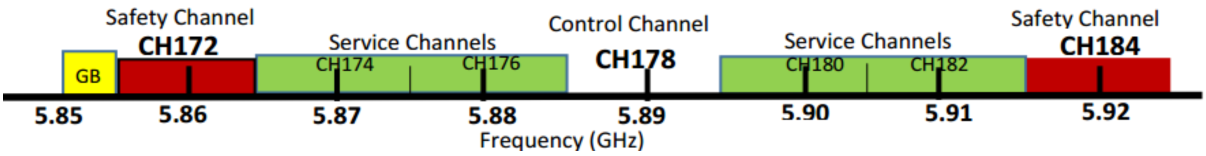

Fig.1.3 IEEE 802.11p Channel Frequency Band

1.4 Location Based Routing Protocol

Location based routing protocols have characteristics along with design architecture which makes vehicular communication more challenging. There are three broad categories of networks as cellular, adhoc and hybrid. Cellular network supports infotainment, for example, latest news, information of locality which is based on vehicle to infrastructure communication. Support to wide range of vehicular applications has been provided. There is a drawback of the requirement of infrastructure that is fixed and this problem is fixed by the adhoc networks in which no need of the infrastructure setup. This is more suitable for vehicle to vehicle communication. But it also faces problems due to network partitioning and routing link failures and rapid topology changes. The solution of this problem is the stationing of the access points by the roadside and in case there is no issue regarding energy consumption. In hybrid communication, cellular network collects information regarding the road and the vehicles through access point and these further processes the acquired information and make it available to drivers. Degradation in the performance based on the mobility and the dynamics of the vehicles. The mobile adhoc networks are completely differs from the scenario of the vehicular environment and the issues of mobile adhoc networks are only addressable to the traditional routing protocols. If the same is applied to the vehicular environment then it will face the problems of the high mobility and the dynamics in such nature. Position based routing has been found as the most suitable for this scenario. Following has classified as the forwarding strategies:

- Greedy forwarding- The scenario as shown in Figure 1.4, by using this forwarding strategy, the packet is forwarded to the node closest to the destination by the source. As per the figure, ‘S’ will send packet to ‘A’.

- Improved greedy forwarding- Improvement is done by predicting the neighbors of the source node by comparing the values in neighbor table and the direction and velocity of the neighbors. Here in the figure, ‘S’ calculates the latest predicted position of its neighbor and rather than sending data to ‘A’, it will send to ‘B’.

- Directional greedy forwarding- The nodes which are having same direction as the destination has. The closest node is chosen to forward the data. So, ‘B’ is selected as the next hop.

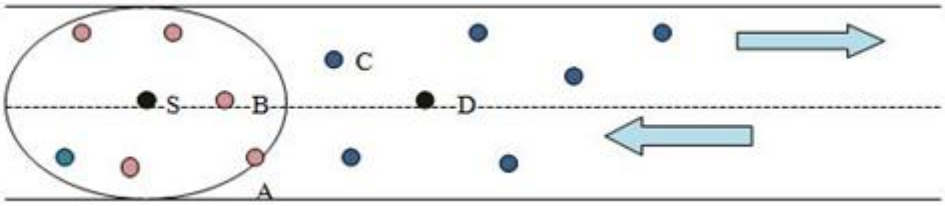

Fig.1.4 Forwarding schemes

- Predictive directional greedy forwarding- 2-hop neighbors of the forwarding node are maintained and prior sending the message forward to the next hop, it will consult the prediction of all the neighbors and selecting such a node which has same direction as the destination has. By selecting ‘A’ due to the reason of moving direction of its one-hop neighbor ‘C’ is same as of the destination.

Following are the routing protocols based on position:

- DGR (Directional Greedy Routing) Selection of the node moving towards the destination reduces hop count during routing. Further, Predictive DGR enhances DGR protocol by predicting the mobility of the vehicle and getting this mobility information from traffic pattern and street layout.

- GSR (Geographic Source Routing) uses Dijkastra's shortest path algorithm on a map from GPS system. It calculates shortest path on each junction and by using greedy forwarding strategy along the path to next junction until destination is reached. Although, in this case there is no use of the real time traffic for path selection of the next node may stop at local maximum and for recovery, some another vehicle is selected out of that road by making use of the greedy forwarding. GSR is combined position based and topology based routing and it is reactive location service. It has high overhead on network due to use of beacons but more scalable and suitable for sparse network.

- A- STAR is based on routing of positioning scheme. It uses bus routes in the city in order to identify an anchor path for packet delivery with connectivity at maximum. By considering number of bus line on road, it provides traffic awareness for better decision making towards selected path as more vehicle density lowers down the chances of local maximum situation. If local maximum occurs then road is marked as out of service and recalculation of path takes place.

- GyTAR (Greedy Traffic Aware Routing) proposes for city environments which is based on intersection and makes use of geographical routing protocol. It has following parts: selection of the junction and forwarding of data within two junctions. Position of junctions is used to identify the digital maps and the optimal path is selected by using Dijkastra's algorithm.

- EGySTAR is the modified version of GySTAR routing protocol. It selects junction dynamically as it is based on density of the vehicular environment in the direction of the destination and by considering the direction of the vehicles before selecting the next junction. Each junction gets a score and with its help highest score is selected as the destination junction with most of the traffic in destination direction.

1.5 Drawbacks of LAR Protocol

The use of positioning information has been widely used for location tracking and navigation. For example, GPS is commonly used in cars to assist drivers in navigating through foreign land. It is also used for military and defense operations. Despite unavailability of GPS at global level and positional information does come with deviation, i.e., errors. In addition, it is not necessarily true that all future mobile devices will be equipped with GPS receivers. Heterogeneous devices will exist and hence some devices will not have GPS receivers. In such situations, location based routing will suffer and fail to operate. Positional errors can also cause problems in routing. In addition, without considering signal strength, power life, and connectivity information, communication performance will suffer if data are routed based on location information alone. Lastly, prior and advance information about the positional information of the destination node may not be readily available at the source.

Chapter 2
REVIEW OF LITERATURE

Ko and Vaidya [5] propose LAR protocol which determine two of the zones, namely, request and expected. The rectangular area surrounds the sender as well as receiver. Expected zone covers the receiver where the possibility of it is high. The coverage is in the circular form as Fig. 2.1 demonstrates. The reduction in routing overheads is found by the decrease in the search area.

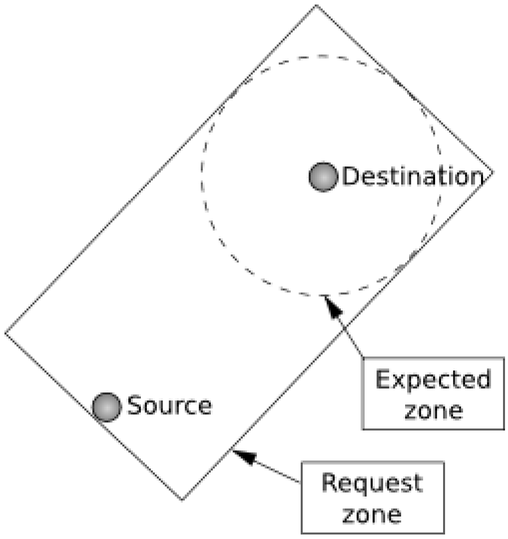

Fig. 2.1 Location Aided Routing

Zaruba, Chaluvadi and Suleman [14] address Location Area Based Ad-Hoc Routing Protocol (LABAR), Fig.2.2 shows the area distribution. GPS enabled nodes are G-nodes which are interlinked. The dedicated nodes are responsible for location mapping to IP address, provide reliable exchange of information. It is the collaboration of two kinds of protocols, namely, reactive and proactive. As the virtual backbone disseminates the location information among G-nodes and also updates them and the directional routing takes place towards the destination’s direction zone.

S. Basagi et al. [15] introduces Distance Routing Effect Algorithm for Mobility (DREAM) maintains the location routing tables of every node. Packet is forwarded on the basis of the knowledge of this location information. In order to have accurate location table, the periodic broadcast of control packet having the coordinates is carried out by each node. This concept introduces the accuracy and maintenance of the location information.

Karim El Defrawy and Gene TsudikIn [19] propose the issues regarding suspicion regarding anonymous designing of routing framework (ALARM). A MANET map is formed by current locations of the nodes. On basis of this map, every node decides to which node it wants to establish the communication. It authenticates and also offers data integrity as well as intractability with anonymity which results in resistance to any of the attacker inside the network.

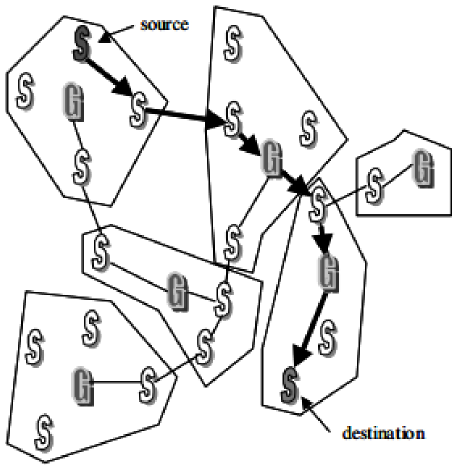

Fig. 2.2 Location Area Based Ad-Hoc Routing Protocol (LABAR)

Tzay and Hsu[17] propose Location Aware Routing Protocol with Dynamic Adaptation of Request Zone for Mobile Ad hoc Networks (LARDAR). There are three advancements in this protocol. First of all, rectangular or triangular request zone determine coordinate information. This zone, shown in Fig.2.3, is smaller and thus provides smaller space for the route discovery. Additionally, for the adaption of the estimated precision of request zone, it comprises dynamic adaption technique for the triggering of the nodes lying immediate to destination. This results in more precise request zone. At last, for having a redo discovery of the route, a progressive search is carried out that uses angle basis increasing search whenever route discovery fails.

Haiying Shen and Lianyu Zhao[20] address Anonymous Location-based Efficient Routing protocol (ALERT). This provides low cost protection with high anonymity. As it divides the network field in certain zones dynamically, it selects random relay node that is an intermediate node used for transmission. Additionally, the identity of the initiator as well as receiver remains hidden among all other nodes providing anonymity protection. When compared with other anonymous routing protocols, this provides lower cost with high efficiency to GPSR.

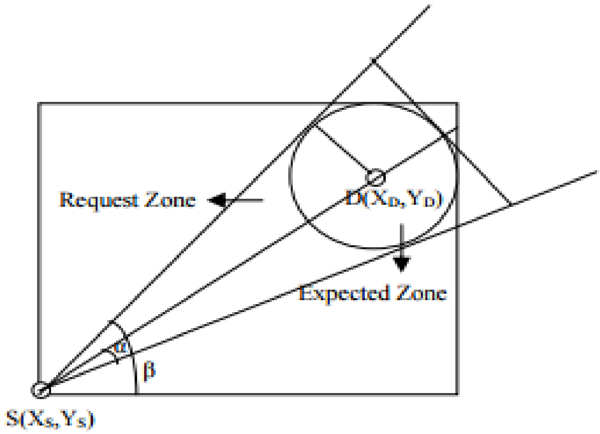

Fig.2.3 Location Aware Routing Protocol with Dynamic Adaptation of Request Zone for Mobile Ad hoc Networks (LARDAR)

Mohammad Al-Rabayah and Robert Malaney [21] present a protocol that collaborates two of the routing protocols. Reactive with the location based routing that gives efficient use of all available information regarding location. It makes spatial dependence of the various areas of the network at same epoch which can use different routing patterns. It enhances the scale at dramatic rate which can be calculated using routing control overhead.

Dan Luo and Jipeng Jhou [22] address a routing protocol with improved hybrid location approach which merges topology based routing with that of geographic. This reduces overall delay, problem of reactive routing. Further, average delay and packet delay rate also outperformed than that of pure reactive routing.

Lee, Yoo and Kim [23] presents the improvement of the LAR protocol by considering node locations and the energy consumption. In order to have efficient routing, minimization of the unnecessary flooding of control messages is carried out. The prime focus is on the limited energy of mobile nodes and using it in optimized way. This proposal leads to the decrease the energy consumption with increase in average lifetime by 12 percent than that of LAR.

Karp and Kung [16] present Greedy Perimeter Stateless Routing (GPSR). It sends packet using the location information based on the distance. It utilizes the greedy forwarding strategy as shown in Fig.2.5. Sometimes there may be a case when the farther node from destination is best for the path. Such a scenario is applied upon by right hand rule for forwarding as soon as possible.

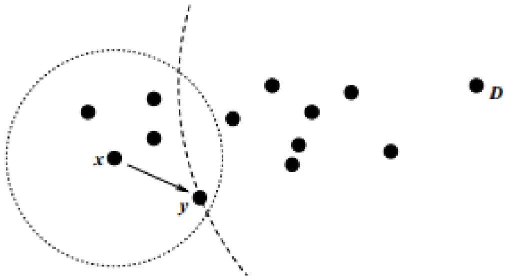

Fig. 2.4 Greedy Perimeter Stateless Routing (GPSR)

Shanshan, Yanling, Yonghe, Mohan [24] propose Location Based Routing Scheme for Opportunistic Networks (LOOP) which forwards the packet to certain location rather than sending it to target node. The mobility traces are learnt by the patterns on which the nodes move. It helps in evaluating the performance of the protocol. It enables the message delivery at a quite high rate which abruptly decreases the load of network and occupancy of buffer of the nodes.

Mohammad A. Mikki [18] presented Energy Efficient Location Aided Routing Protocol (EELAR), extension to the LAR protocol. It focuses on the energy consumption by the mobile nodes. It restricts discovering area discovery to quite smaller area. It eventually causes reduction in the control packet overhead. A wireless reference base station has used along with the circular area with centre at the base station which further divide it into six areas distributed equally as shown in Fig. 2.5. The control packets are flooded to certain sub areas rather than flooding it to entire network in the route discovery phase. The mobile nodes' locations are kept with the base station in a position table.

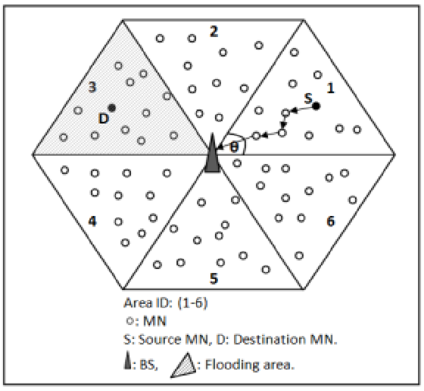

Fig.2.5 Energy Efficient Location Aided Routing Protocol (EELAR)

Prakash Raj, Selva Kumar, Lekha [25] reveals Location Based Routing Protocol (LBRP) as the scheme operating without loop. It extracts dynamically topology to send packet to destination in a faster manner.

Kim, Young-Song, Hwang [26] address the data transmission with lesser consumption of the energy in stable manner. In this case, base station need to be aware of the nodes' location. The energy is balanced by all the nodes for entire lifetime of the network. It utilizes the cluster formation for the wider possible distributed environment.

Haidar Safa, Hassan Artail and Diana Tabet [26] present cluster based trust-aware routing protocol (CBTRP). The protection against the intermediary malicious nodes is the concern of this protocol. The organization of the network is carried out in such a way that it elects the most trustworthy node among all as the cluster head which handles further routing activities. The trustworthiness is constantly ensured as soon as it is found to be malicious; dynamically updating is done for the packet path. It avoids malicious routes and makes the safer communication link setup.

Putthiphong Kirdpipat and Sakchai Thipchaksurat [27] proposes Location-based Routing with Adaptive Request Zone (LoRAReZ) which reveals mobility impact. The scheme gives the adaptive area for the two zones, namely, request and expected. It relies on the source and destination distance.

Juanfei Shi and Kai Liu [28] gives power efficient location-based cooperative routing algorithm (PLCR) The analysis of the cooperative relay gives the successful packet reception probability which hike the overall routing power. The location information is utilized for taking the next node for transmission as well as cooperative node which comprising minimum power.

J. J. Garcia-Luna-Aceves have presented multicasting routing protocol and it is named as core-assisted mesh protocol. Multicast meshes are used instead of multicast trees due to the fact that it provides connectivity among multicast groups despite of frequent changes in the location of the mobile nodes. It also provides packet forwarding over these multicast meshes which ensure that there will be no loops. In the multicast mesh, the source forwards the packets to destination by using the scheme of reverse shortest tracking towards the source which is same as multicast tree. However, CAMP assures that in a certain time period, every receiver of group has a reverse shortest path to every source in multicast group. Simulations have shown that protocols based on mesh exceed multicast protocol based on trees in dynamic networks.[29]

Neng-Chung Wang, Jong-Shin Chen, Yung-Fa Huang and Si-Ming Wang (2003) have proposed scheme over routing based on location and this scheme is greedy LAR. The design gives first of all a baseline that provides a differentiation line between the source and the destination node in the route discovery phase. Nodes which are the neighbouring nodes of the source having the shortest distance to the baseline is chosen in order to get the next broadcasting node. In this way a better route can be found by reducing the network overhead. Simulations also have shown the efficiency of GLAR scheme as better than that of LAR scheme [30].

Amiour med tahar, Bilami azeddine proposed relaying algorithm at multiple point in AODV protocol. This algorithm results significant reduction in broadcasted messages in period of the flooding. In the ns2 simulation conducted using parameters that approximate the reality such as freeway topology, changing location of mobile nodes with high speed and high traffic density. This simulation shows the extended AODV using MPR reduces the load and performance better than the standard in case of AODVM using MPR reduces the load and performs better than that of standard in case of traffic with low and high speeds [31].

Fiore, Politecnico di Torino, Harri, Filali, Bonnet have drawn attention towards the self organising networks of the moving vehicles and their peculiar characteristics as cars are not uniformly distributed so the velocity also varies with unique dynamics of connectivity. These characteristics are simulated at both macroscopic as well as microscopic levels by VanetMobiSim which is a generator for network simulators which creates realistic movement traces of vehicles. Further it validates showing the interaction between featured macro mobility which enables to reproduce phenomenon of traffic [32].

Karim Seada, Ahmed Helmy(2007) developed two of the protocols that attain low overhead and high delivery rate by making use of the local information of the locations of the nodes and the geographical routing mechanism with region flooding. One protocol is Geographic Forwarding Geocast which works in dense networks and has close to minimum overhead. Another protocol is Geographic Forwarding Perimeter Geocast that assures delivery with no flooding at global level. Results have shown the improvement in delivery rate and overhead reduction [33].

Michael Slavik and Imad Mahgoub(2008) have proposed a protocol for the multi-hop routing and it is names as Distribution-Adaptive Distance with Channel Quality. This protocol selects forwarding nodes by distance method. The factor because of which its performance gets affected is the decision threshold value which becomes very difficult to opt for each scenario to be considered. As there is variations in the node density and distribution patterns in the VANET scenario along with the varying quality of channel, adaptiveness of this protocol to such scenarios. This utilizes the method of quadrant of spatial analysis to feature the distribution pattern for every node [34].

Sanjoy Das and D.K Lobiyal have analyzed LAR protocol in different city scenarios using Manhattan model. This model of mobility is used in order evaluate the motion pattern of nodes. Simulation work is carried out using Glomosim 2.03 simulator. Results show that the maximum average end-to-end delay and average maximum packet delivery ratio in case network is sparsely populated while the densely populated network achieves lesser packet delivery ratio and average end-to-end delay [35].

Yan-Bo Wang, Tin-Yu Wu, Wei-Tsong Lee and Chih-Heng Ke have investigated GPSR that used GPS to have the locations of the vehicles and eases to decide the data delivery for the protocol to give improved adaptability in high speed network topology. In this paper, the scheme is proposed in order the Greedy Perimeter Stateless Routing protocol in the city scenarios. GPSR enhances routing accuracy along with the predictive mode in order to predict the dynamics the vehicular nodes which thus improves efficiency and performance of the data delivery [36].

Marwa Altayeb and Imad Mahgoub have focussed on the comparisons of different routing protocols and analyzed these routing protocols to get the strengths and limitations of them. From this comparison study, current trends and challenges are figured out in VANETs and the factors which are analyzed are dynamic, huge and variable network scale and constrained mobility. There are different VANET scenarios as urban city environment and highway environment which gives dense and sparse population of the vehicular nodes. Comparison study is classified in two ways: one is on the basis of topology and position based routing and another is based on the transmission strategies [37].

Y. K. Dalal and R. M. Metcalfe accomplished the algorithms for the delivery through store and forward packet switching and it works on the network in such a manner that it uses transmission of separately addressing the packets with multi destination addressing and spanning tree forwarding along with the source based forwarding. It makes use of broadcast routing in store and forward packet switching and it becomes practical because of the less complexity in existing networks [38].

Chapter 3
PRESENT WORK

3.1 RELATED WORK

➢ 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.

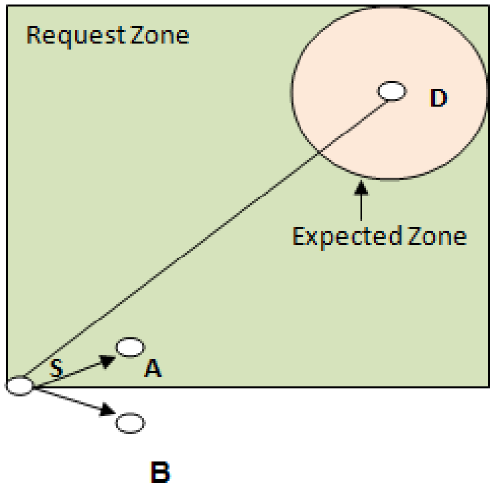

Fig.3.1: Location Aided Routing

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 hop 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 neighbors 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.

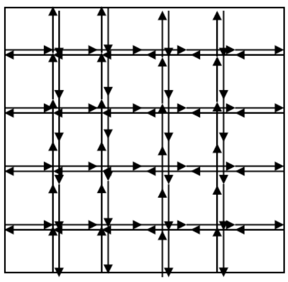

Fig.3.2: Manhattan Mobility Model

➢ 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.

3.2 PROBLEM FORMULATION

VANET works upon the basis of real time system where all the vehicles are moving nodes and travel with high speed on the road in the urban areas. Due to broadcast nature, network resources are wasted and network becomes inefficient. This network decreases the performance and throughput of the network as the packet delay increases and more number of vehicles is involved in transmission than the requirement of the communication. Thus, rather than using flooding of the message in the request zone, it should preferably be directed to the suitable intermediate vehicle that is reliable for the transmission. This involvement of the selected vehicles improves the resource utilization as well as assures the faster communication. In urban scenario, there is a large number of vehicles which communicate with each other, the roadside units helps in this communication in order to improve the efficiency of the network. The proposed LAR which reduces network overhead and packet delay, hence, enhancing the performance is named as Ameliorated Location Aided Routing protocol (ALAR). The Route discovery for the proposed scheme uses a baseline between source and destination vehicles. The packet is forwarded 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. 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.

3.3 OBJECTIVES

In the study of Vehicular Adhoc Networks, the routing of the vehicular nodes are analyzed and after evaluating the different forwarding schemes in various environments by making use of Global Positioning System in the Location Aided Routing, the establishment of the reliable path between the source and destination is to be carried out by eliminating the problems faced in the existing routing protocols. Robustness of the network can be enhanced by integrating the mesh and tree approaches along with the geographical positioning of the vehicles. This will improve the performance by having the knowledge of the direction and position of the vehicle and decreasing the packet delay of the transmission of the data. Therefore, the following are objectives of the study:

- To study the various routing protocols for the VANET routing.
- To analysis the shortcoming of the LAR protocol.
- To propose novel technique to overcome the problem of broadcast and enhancing the performance in LAR protocol.
- To implement the proposed novel technique.
- To compare the novel technique with the existing LAR protocol graphically.
- Performance investigation of the proposed routing protocol.

3.4 PROPOSED MODEL

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 neighbor of it which is moving towards the destination node is selected as the next hop. The position and the movement of the neighbors 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 case of position based routing protocols. The 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.

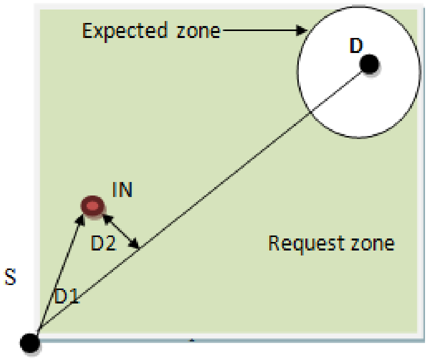

Fig.3.3: ALAR

In ALAR, the RSU plays important role for packet forwarding [14]. The source vehicle sends the packet 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.

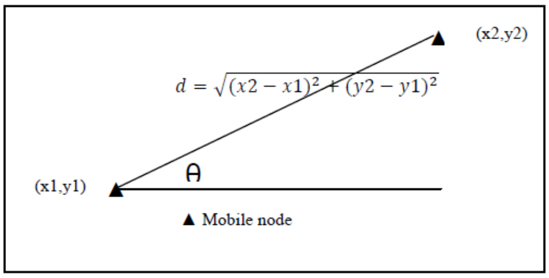

Fig.3.4: determining RSU to farthest vehicle distance

This is checked by considering a baseline from source to destination and also the distance from destination is checked for all the neighbors 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 neighbor 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.

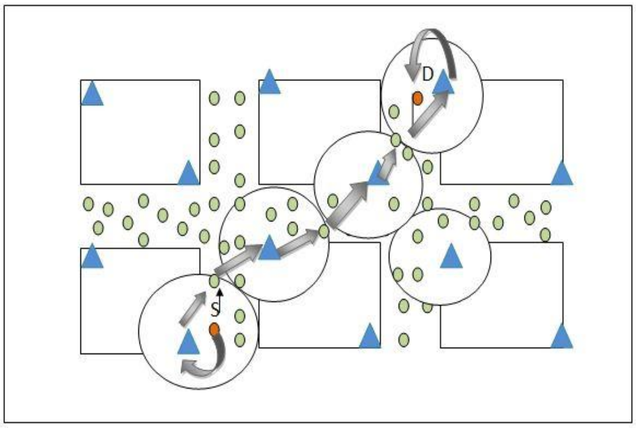

Fig.3.5: Route of Packet transmission from source to destination in ALAR

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 end to end delay.

Chapter 4

RESULTS AND DISCUSSIONS

For the 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.

4.1 Simulation Model

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.

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.

Table.4.1 Simulation Parameters with specification

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.4.2 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

- 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.

$$\text{Packet Delivery Ratio} = \frac{\text{Sum of all received packets by destination}}{\text{Sum of all packets sent by source}}$$

- 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.

4.2 Implementation Code

```
%ikjot vanet multicasting project
%path creation
clc %clears all input and output from the Command Window display
clear all %clear all objects and reset assumptions
close all  %deletes all figures whose handles are not hidden

cn=1;
nodenum=[300 200 100 75 50];
for gggg=nodenum
nod=300;

for i=1:500 %number of transmissions assumed/initialized
    temp1=randi(100);
    while 1
        temp2=randi(100);
        if temp2~=temp1
            break
        end
    end
    comm(i).pair=[temp1 temp2];
end

for i=1:nod %vehicles initially
choice=randi(4);
if choice==1 || choice==2
    node(i).xd=-6+12*rand;
    node(i).yd=randi([-6 6])+0.05;
    if choice==1
        node(i).dir='e';
    else
        node(i).dir='w';
    end
else
    node(i).xd=-randi([-6 6])+0.05;
    node(i).yd=-6+12*rand;
    if choice==3
        node(i).dir='n';
    else
        node(i).dir='s';
    end
end
% plot(node(i).xd,node(i).yd,'rd')
% hold on
end


for k=1:100 %epoch


    for i=1:60 %communication pairs
    temp1=randi(100);
    while 1
        temp2=randi(100);
        if temp2~=temp1
            break
        end
    end
    comm(i).pair=[temp1 temp2];
    end

```

```
%for k=1:100
for i=-6:6 %plotting path along x axis
    x=[-6 6];
    y=i*ones(1,2);
    plot(x,y,'--')
    axis([-7 7 -7 7])
    hold on
end

for i=-6:6 %next line along x axis
    x=[-6 6];
    y=(i+0.1)*ones(1,2);
    plot(x,y,'--')
    hold on
end

for i=-6:6 % along y axis
    y=[-6 6];
    x=i*ones(1,2);
    plot(x,y,'--')
    hold on
end

for i=-6:6 %along y axis next line
    y=[-6 6];
    x=(i+0.1)*ones(1,2);
    plot(x,y,'--')
    hold on
end

for i=1:3 %Root nodes
    for j =1:3
        Root(i,j).xd=-8+4*i;
        Root(i,j).yd=-8+4*j;
        plot(Root(i,j).xd,Root(i,j).yd,'black*')
        hold on
    end
end

for i=1:3 %Range of root nodes
     for j=1:3
         Root(i,j).rangex=[-8+4*i-2 -8+4*i+2];
         Root(i,j).rangey=[-8+4*j-2 -8+4*j+2];
     end
end


for i=1:3 %for showing the range of Root nodes
     for j=1:3
         circles(Root(i,j).xd,Root(i,j).yd,2.5,'edgecolor','g','facecolor','none')
         hold on
     end
end

for i=1:nod %for every vehicle present in scenario
    if node(i).dir=='e'

        node(i).xd=node(i).xd+0.1; %0.1 is step size
        if (abs(node(i).xd)-floor(abs(node(i).xd)))<=0.1 %meeting the edge or intersections
            temp=rand; % generate real number between 0 to 1 that is probability
```

```
                if temp<0.05  %for opposite direction
                    node(i).dir='w';
                elseif temp>=0.05 && temp<=0.5 % 0.45 for same direction
                    node(i).dir='e';
                elseif temp>0.5 && temp<=0.75
                    node(i).dir='n';
                else
                    node(i).dir='s';
                end
            end
        elseif node(i).dir=='w'
            node(i).xd=node(i).xd-0.1;
            if (abs(node(i).xd)-floor(abs(node(i).xd)))<=0.1
                temp=rand;
                if temp<0.05
                    node(i).dir='e';
                elseif temp>=0.05 && temp<=0.5
                    node(i).dir='w';
                elseif temp>0.5 && temp<=0.75
                    node(i).dir='s';
                else
                    node(i).dir='n';
                end
            end
        elseif node(i).dir=='n'
            node(i).yd=node(i).yd+0.1;
            if (abs(node(i).yd)-floor(abs(node(i).yd)))<=0.1
                temp=rand;
                if temp<0.05
                    node(i).dir='s';
                elseif temp>=0.05 && temp<=0.5
                    node(i).dir='n';
                elseif temp>0.5 && temp<=0.75
                    node(i).dir='e';
                else
                    node(i).dir='w';
                end
            end
        elseif node(i).dir=='s'
            node(i).yd=node(i).yd-0.1;
            if (abs(node(i).yd)-floor(abs(node(i).yd)))<=0.1
                temp=rand;
                if temp<0.05
                    node(i).dir='n';
                elseif temp>=0.05 && temp<=0.5
                    node(i).dir='s';
                elseif temp>0.5 && temp<=0.75
                    node(i).dir='w';
                else
                    node(i).dir='e';
                end
            end
        end

        if node(i).xd>6 || node(i).xd<-6||node(i).yd>6 || node(i).yd<-6
            if node(i).dir=='e'
                node(i).dir='w';
            elseif node(i).dir=='w'
                node(i).dir='e';
            elseif node(i).dir=='n'
```

```
            node(i).dir='s';
        elseif node(i).dir=='s'
            node(i).dir='n';
        end
    end

    plot(node(i).xd,node(i).yd,'rd')%plot vehicles for red delta
    hold on  %holding a vehicle untill it show all at once
end

for i=1:60  %plotting communication path by green dotted lines
    plot([node(comm(i).pair(1)).xd node(comm(i).pair(2)).xd],[node(comm(i).pair(1)).yd node(comm(i).pair(2)).yd],'g--')
    hold on
end

chc=randi([1 nod],1,1);
for m=1:3 %generating root nodes
    for n=1:3
        count=1;
        Root(m,n).table=zeros(1,300);
        for i=1:nod %calculating the distance between root nodes and vehicle in its range
            tempdist=sqrt((node(i).xd-Root(m,n).xd)^2+(node(i).yd-Root(m,n).yd)^2);
            if tempdist<=2.5
                Root(m,n).table(count)=i;
                count=count+1;
            end
        end
        count=1;
        for j=1:nod
            if Root(m,n).table(j)==0
                break
            end
            count=count+1;
        end
        Root(m,n).vehicle_count=count;
    end
end

for i=1:60 % defining the roots to the vehicles
    dist=100;
    for m=1:3
        for n=1:3
            tempdist=sqrt((node(comm(i).pair(1)).xd-Root(m,n).xd)^2-(node(comm(i).pair(1)).yd-Root(m,n).yd)^2);
            if tempdist<=2.5
                Source(i).information=[m n];
                %Source(i).yd=Root(m,n).yd;
            end
        end
    end

    for m=1:3
        for n=1:3
            tempdist=sqrt((node(comm(i).pair(2)).xd-Root(m,n).xd)^2-(node(comm(i).pair(2)).yd-Root(m,n).yd)^2);
            if tempdist<=2.5
                Dest(i).information=[m n];
                %Dest(i).yd=Root(m,n).yd;
            end
        end
    end
end
```

```
 packet_delay=0;

    packets_recieved=0;

for i=1:60 %actual communication
    ms=Source(i).information(1); %source coordinate 1
    ns=Source(i).information(2); %source coordinate 2
    md=Dest(i).information(1); %destination coordinate 1
    nd=Dest(i).information(2);%destination coordinate 2
    Source(i).slope=(Root(md,nd).yd-Root(ms,ns).yd)-(Root(md,nd).xd-Root(ms,ns).xd);%baseline from source root to dest root
    Source(i).list=[];%defining a blank list which contains the intermediate transmitting nodes during communication
    for j=Root(ms,ns).table(1:(Root(ms,ns).vehicle_count-1))     %for the total communicating vehicles
        tempdist=sqrt((Root(ms,ns).xd-node(j).xd)^2+(Root(ms,ns).yd-node(j).yd)^2);%source to its root distance/slope
        if tempdist<2 %condition 1 for distance
            Source(i).list=cat(2,Source(i).list,j);%adding on the transmitting nodes if they lie in range 2
       end
    end
    %minimization algorithm
    temp=50; %it is taken as max. for difference of slope of root and node
    Source(i).hop=[];
    for ff=Source(i).list
        tempslope=(Root(ms,ns).yd-node(ff).yd)-(Root(ms,ns).xd-node(ff).xd);
        if abs(tempslope-Source(i).slope)<temp%condition 2 for direction where diff of both slope is calculated
            %when the minimum diff of slopes(here its temp) is obtained the next node is
            %selected to forward from root
            temp=abs(tempslope-Source(i).slope);%update the diff of slope in order to compare and get the minimum diff of slopes
            Source(i).hop=ff; %lastly, the hop is updated by the next vehicle with minimum slope
        end
    end
   flag=1;
    count_packets=0; %packet transmission
 while 1
     node(Source(i).hop).table=[];
     Source(i).hop=randi([1 nod], 1 ,1);
     for ff=1:nod  %for total vehicles in the scenario those can act as transmitting nodes
         tempdist=sqrt((node(Source(i).hop).xd-node(ff).xd)^2+(node(Source(i).hop).yd-node(ff).yd)^2);
         if tempdist<1
             node(Source(i).hop).table=cat(2,node(Source(i).hop).table,ff);
         end
     end
     tempdist
     condn_node=nod*(0.8-nod*0.001);

     count_packets=count_packets+1;
     node(Source(i).hop).list=[]; %list for vehicle used for transmitting
       for j=node(Source(i).hop).table
           tempdist=sqrt((node(j).xd-node(Source(i).hop).xd)^2+(node(j).xd-node(Source(i).hop).xd)^2);
           if tempdist<1
               node(Source(i).hop).list=cat(2,node(Source(i).hop).list,j);
           end
       end
       temp=Inf;
       %node.hop=[];
      for ff=node(Source(i).hop).list
          tempslope=(node(Source(i).hop).yd-node(ff).yd)-(node(Source(i).hop).xd-node(ff).xd);
          if abs(tempslope-Source(i).slope)<temp
              temp=abs(tempslope-Source(i).slope);
              tempsourcehop=ff;
          end
      end
```

```

    for ff=Root(Dest(i).information(1),Dest(i).information(2)).table
        if Source(i).hop>=condn_node
            flag=0; % to check whether its in destination root range or not

            break
            %it will only break when its within dest root range and comes out of all loops
        end
    end
    display('ikjot')
    if flag==0
        break
    end
    display('fef')
    packet_delay=packet_delay+1; %untill in while loop
end
if count_packets<4
     packets_recieved=packets_recieved+1;
end

delay(i)=packet_delay;

end
packets_sent=i;
pckt_del_ratio(k)=100*packets_recieved/packets_sent;

delay_time(k)=0.1*mean(delay);

hold off  %deleting previous vehicles untill it plot new ones
pause(0.00000001)

end
avg_PDR(cn)=mean(pckt_del_ratio);

avgdelay(cn)=mean(delay_time);
cn=cn+1;
end
figure
plot([50 75 100 200 300],avgdelay)
title('plot of average delay vs nodes')
xlabel('num of nodes')
ylabel('avg delay')

figure
plot(nodenum,avg_PDR)
title('plot of packet delivery ratio vs nodes')
xlabel('num of nodes')
ylabel('avg packet delivery ratio')
```

4.3 Simulation Results

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.4.1 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.

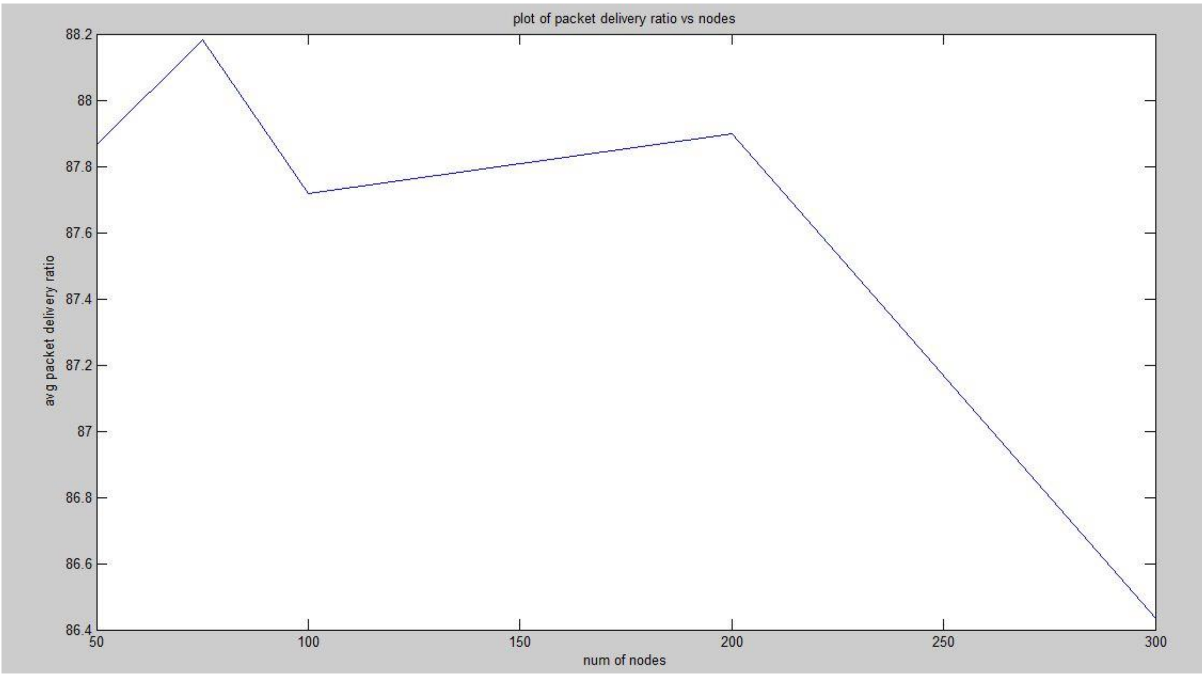

Fig.4.1 Average Packet delivery ratio in LAR

Fig.4.2 shows the 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.4.3. 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.

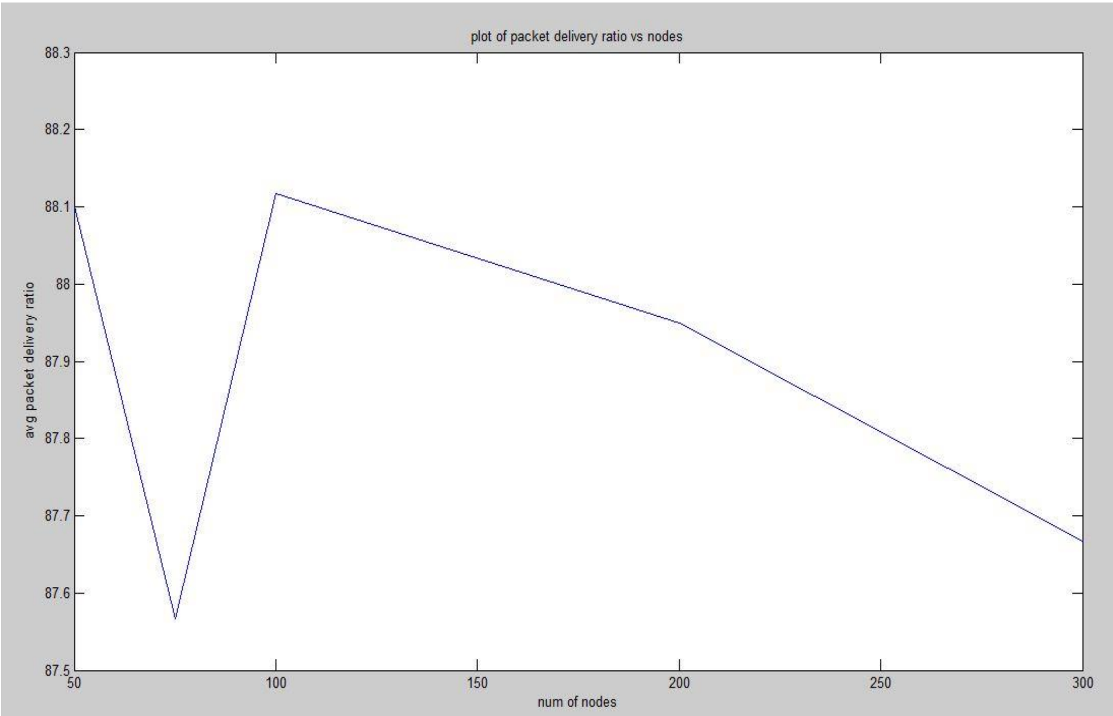

Fig.4.2 Average Packet delivery ratio in ALAR

ALAR reflects the lesser delay when compared to LAR. It can be shown by Fig 4.4. 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. Futher, as vehicle count goes to 100 then this delay reduces by 2.9701 and then for 200, it reaches to 2.9511 which is considerably reduecs. 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. Consequently, ALAR has shown the lesser average delay than LAR.

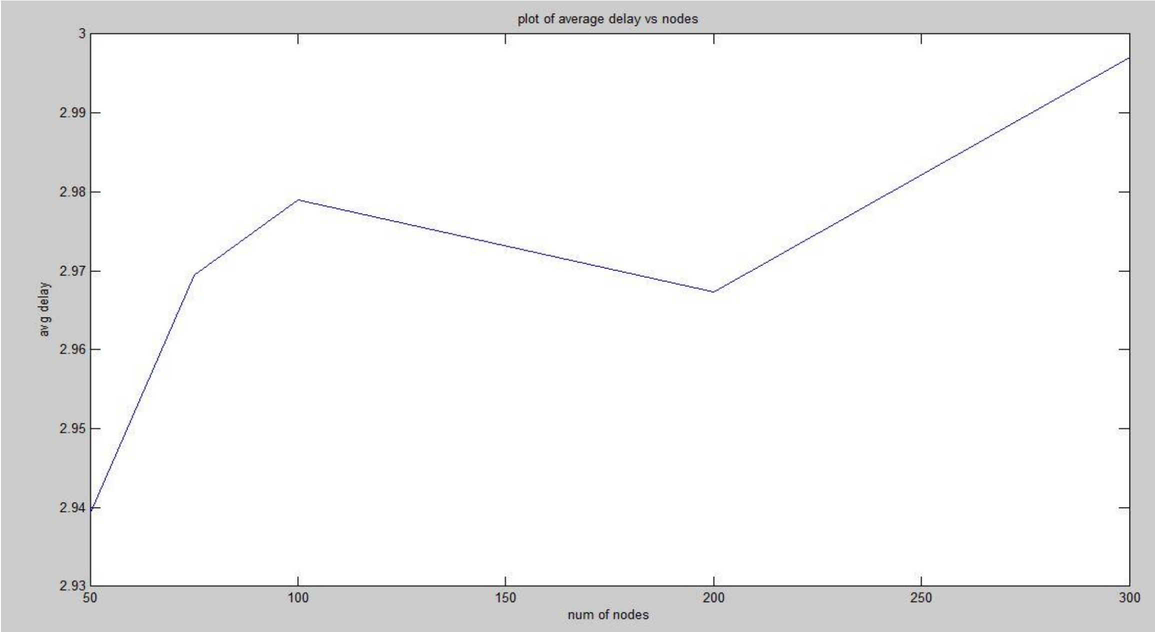

Fig.4.3 Average delay in LAR

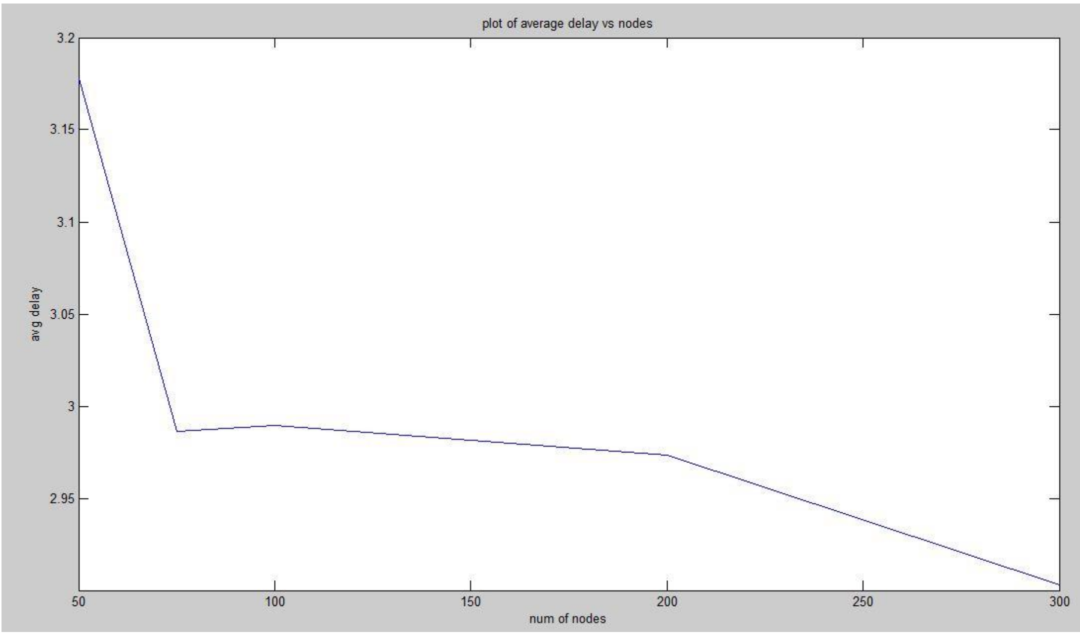

Fig.4.4 Average delay in ALAR

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.

Table 4.3 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

Chapter 5
CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

The proposed scheme presents an extended position based routing protocol, named as ALAR (Ameliorated Location Aided Routing protocol) which collaborates predictive directional greedy routing with that of location aided routing in the urban scenario. 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. The next hop selection is based on the least distance from the destination and the similar direction as that 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. The advantage of position based routing is that it makes use of the local information rather than keeping record of topology at global level. 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. It is applicable for dense traffic scenario that is of city where the density of vehicles is enough to provide efficient connectivity.

5.2 FUTURE SCOPE

The location aided routing in the vehicular networks proves to be more efficient than other routing protocols of VANET as it make use of the local information of the locations of the vehicles and the roadside units. The delay in the communication can be reduced to increase the performance of the network by restricting the search space in the request zone along the baseline. However, the intermediate vehicles which stop in between where roadside units have no transmission range, here arises the chance of packet loss. This packet loss is comparatively very low but still this can also be eliminated in order to have more effective communication.

Chapter 6
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