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A STUDY ON POSITION BASED ROUTING FOR VEHICULAR NETWORKS

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ABSTRACT

VANET is a promising and emerging step towards the intelligent transportation system. Number of algorithms are available to disseminate the data between the vehicles. But position based algorithms have their own advantages in vehicular networks as it's routing mechanism is depend upon the position of source and destination and therefore there is no need to establish the route in advance between the source and destination. It also saves the bandwidth and overcome the route establishment overhead. But they require position based services like GPS.

Key words: VANET, Routing, Position based Algorithms.

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1. INTRODUCTION

Due to the increased traffic on the road, it becomes very essential to notify the drivers about the condition of the road, traffic and other types of the hazards. Vehicular ad-hoc networks is an innovative step that utilize the various upgraded technologies for deploying the smart transportation system. Dissemination of information or messages is key part of the VANET. Communication can be taken place between the vehicle to vehicles and vehicle to road side infrastructures. Different types of messages are disseminated like safety related messages, infotainment messages and mobility related messages that help to identify the routes. various heterogeneous emerging wireless technologies such as 3G cellular systems, long term evolution (LTE), LTE- Advance, IEEE 802.11, and IEEE 802.16e [1] [2] are integrated to provide the communication between inter vehicle network and outside network. The features of VANET is approximately similar to the MANET technology in form of self-organization, self-management and low bandwidth. But high speed of vehicles and frequently changed topology of network makes the VANET different from MANET. Therefore, it is not necessary the routing algorithms that perform better in MANET also give the same response

in VANET. As the topology of VANET changes very frequently and result in intermittent links so topology based routing schemes are less efficient as compare to the position based routing. In position based routing a better routing decision can take place with the help of appropriate location of the vehicles. Position based routing algorithms can be further categorized as: Delay tolerant algorithms, non-delay tolerant algorithms and hybrid. Delay tolerant routing algorithms. This paper contributes in surveying the various position based algorithms for VANET and comparing them with variety of different parameters.

2. RELATED WORKS

In past recent years a lot of study has been done on routing algorithms for vehicular ad-hoc networks. As a result of this study concluded that position based routing is more effective as compare to topology based routing in VANE. Today almost all vehicles are equipped with positioning system GPS and various sensors that enable the vehicles to know their own position and their neighbor's position. A variety of routing algorithms based on geographical strategies have been introduced to route the packet from source to destination [3][4][5][6]. In [7], author proposed a position based routing algorithm named as anchor based connectivity aware routing for vehicular ad-hoc networks that ensure the connectivity of the path to achieve the better packet delivery ratio and compare it with A-STAR using ns-2. In [8], Balasubramani introduced all the non-delay tolerant position based routing algorithms and presented a tabular comparison using various routing and other parameters. Idjmayyel *et.al* [9] proposed a position based routing with most forward within radius (PRMFR) which aims to minimize the total number of transmissions in the network and reduce the packet dropping ratio. Author implemented the proposed scheme on Manhattan grid model and also evaluate the effect of increased greedy nodes. Lahlah *et. al* [10] proposed a position based routing scheme which aims to work well in various obstacles like building, tree etc. Author used carry and forward strategy along with greedy approach. The detail on different types of position based routing protocols is discussed in the section III and in addition the tabular comparison is also given in the end of the section.

3. POSITION BASED ROUTING IN VANET

Routing in VANET is mainly divided into topology based routing and position based routing [11]. Topology based routing mechanism consider the network topology and take the routing decision accordingly. But the VANET comprises of dynamic topology and change very frequently that increase the routing overhead and result in poor routing performance. Position based routing mechanisms consider the position of vehicle to transfer the packet to the destination [12][6]. Position based routing can be categorized in three ways: non-delay tolerant, delay tolerant and hybrid.

3.1. Non-Delay Tolerant Networks protocols

Non-delay tolerant networks routing protocols are used to provide the realistic efficiency in VANET and these protocols transmits the data packets to their destination as soon as possible. The main purpose of using the greedy approach for these protocols is to send the packet to that next node which is closer to the destination as compare to other nodes. But greedy approach has its own deficiency when the packet attain itself to the local maxima at the node. Therefore, all the non-delay tolerant protocols have their own recover strategy to deal with local maxima problem.

3.1.1. GPSR (Greedy Parameter Stateless Routing)

GPSR is one of the position based routing mechanism that use the neighbor's position and greedy forwarding strategy to disseminate the packet to the destination [10]. As the name

applies the GPSR operate in two modes. Firstly it forward the packet using greedy forwarding strategy in which the vehicle send the packet to that neighbor which is closest to the destination [13]. This is shown in figure 1, where the vehicle s send the message to destination closer vehicle p. But in greedy forwarding strategy suffer from the local maxima problem where the vehicle found no other neighbor vehicle closer to the designation as compare to itself. In figure 2 the sender vehicle s found no other neighbor vehicle closer to the destination vehicle d. Whenever this local maximum problem occurs, the vehicles switch to the perimeter mode that route the packet along the perimeters of local maximum in counter clockwise direction [11]. While going the perimeter routing, if the packet reaches at vehicle that is closer to the destination as compare to that vehicle at which the perimeter mode has activated then the routing again enters into the greedy forwarding mode. GPSR is not suitable for city environments due to the two main reasons. Firstly the greedy strategy fails due to lack of direct communication link. Secondly, frequent switching between the greedy and recovery modes and use extended path by recovery mode to reach at destination which wreak the more delay.

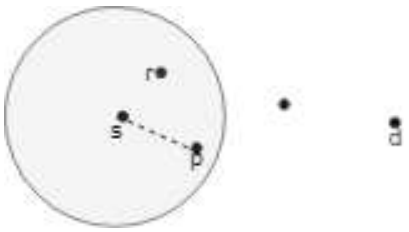

Figure 1: Greedy forwarding

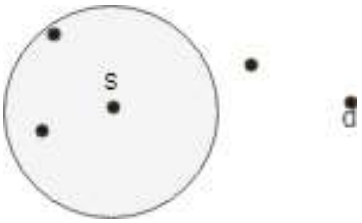

Figure 2: Local Maxima Problem

3.1.2. A-STAR (Anchor based street and traffic aware routing)

A-STAR [14] is position based routing approach that use the street map to compute the junction route and also consider the traffic awareness to transfer the packet to the destination. In city environment, some streets are wider and comprises of higher vehicle density as compare to others. The traffic is more regular and communication links becomes more reliable due to traffic. The less weight is assigned to the streets of higher vehicle density and more weight is assigned to streets with low density of vehicles and Dijkstra's least weight path algorithm is used to compute the anchor path. As a result if the packet is routed across the streets with less number of lower weight assigned then it increases the packet forwarding delay.

3.1.3. GSR (Geographical Source Routing)

GSR [15] is positional based protocol that route the packet on the basis of street map and position of vehicles. Difference between the GSR and A-STAR is that the A-STAR uses the traffic information but GSR not. Packet is disseminated to the next junction node and junction ID is used to compute the shortest path using the Dijkstra algorithm. This protocol is specially designed for dense network and it is compulsory to use the street map.

3.1.4. GpsrJ+

Author proposed non-delay tolerant protocol GpsrJ+ [16] which bypass the junction node to minimize the hop count. Node's beacon message contain the node id and road segment id. Therefore, all the nodes are able to know the junction nodes and its neighbors. When a node find no other node closer to destination as itself then recovery strategy is required. In GpsrJ+, forwarded node can bypass junction node safely as it know on which road segment the junction node will forward the packet.

3.1.5. CAR (Connectivity Aware Routing)

CAR [17] is another position based routing protocol which is designed for city or highway environment. It finds the destination along with a connected path from source to destination which is auto-adjusted. Nodes send the HELLO beaconing message of velocity vector which consist direction and speed of vehicle. On receiving the beaconing message, node enter the detail of sender in its neighbor table and compute its own and neighbor's velocity to set the expiration time of table entry. Periodic beaconing has their own disadvantage as it consumes bandwidth and increase the network overhead. Therefore, CAR enable the node to beacon the messages according to their neighbor's situation. If node has sufficient number of neighbors then interval of beaconing the message will be increased and will be decreased in dense area. CAR uses notation of guard which is geographical marker having the information like time to live count, radius and state data etc. Two types of guards can be presented by CAR named as standing guard and the traveling guard. To overcome the routing errors, CAR protocol represented two recovery strategies: the time out algorithm and walk around error recovery.

3.1.6. SAR (Spatially Aware Packet Routing)

Tian et al. proposed the SAR [18] protocol to address the disadvantages of the GPSR and GSR with a recovery procedure to avoid a local maximum. As mentioned, the greedy forwarding function in the GPSR fails to overcome impediments due to the lack of direct communication between nodes. In such a case, GSR ignores situations such as the sparse network with insufficient nodes for forwarding packets. Conversely, SAR suggests finding an alternative path from the current location where the local maximum occurs and then replaces the original route with the new one.

3.1.7. GPCR (Greedy Perimeter Coordinator Routing)

GPCR [19] is one of the position based routing algorithm in which planar graph is formed using the streets and various junctions without using any external or global information. This protocol basically consist of two strategies such as restricted greedy approach and topological routing based recovery strategy that use street and junction information. In restricted greedy forwarding forward the packet to the next junction node rather than forwarding across the junction node that is closer to the destination. When the node a received a packet and lies in a street rather than junction then all the neighbors of that node a are determined and if any node among them found as coordinator node will be the next forwarding node. Coordinator nodes are those nodes which are near the junction. Repair strategy mode is active when the local maxima is arrived means the node does not find any node closer to destination as compare to itself. In this situation a right hand rule is applied. The packet send along the street and reach at junction node then junction node follows the right hand rule to forward the packet to the next forwarding node. So the protocol use the topology based street and junction information that reduce the maintenance of the planar graph

3.1.8. GyTAR (improved Greedy Traffic Aware Routing protocol)

GyTAR [20] is one of the non-delay tolerant position based routing algorithm which is suitable for city environments. GyTAR consists of two processes: firstly, junctions are selected dynamically through which a packet must pass to reach its destination, and secondly packets are forwarded between two junctions using an improved greedy approach. Junctions are selected dynamically to send the packet to the destination on the basis of their traffic density and the distance from the destination. Junction with high traffic density and closest to destination assigns the highest score and select as the next forwarding junction.

3.1.9. CBF (Contention based Routing)

CBF [21] is position based protocol that use the greedy forwarding approach without using beacon messages. The greedy forwarding approach used in CBF works in different way as

compare to the traditional greedy forwarding approach because the next hope node is selected by all the participating neighbors rather than the forwarding node itself. The packet is initially send to all direct neighbors. All the receiving nodes set the contention timer that is based on the distance of that node to destination node. Whose timer will expire first will be the next forwarding node and it suppresses the timers of the all other nodes. Author [22] discussed the three suppression schemes: a basic scheme, area based suppression scheme and active selection.

3.2. Delay Tolerant Protocols

Delay tolerant networks routing protocols deal with the various technical issues in heterogeneous networks that have problem of continuous network connectivity. Due to the frequent connection loss these type of protocols use carry and forward strategy to ensure the transmission of the packets to their respective destinations. Node store the packet with itself when it found no neighbor and carry along with packet for distance until a suitable neighbor node is not found. Some well-known delay tolerant protocols are discussed as bellow:

3.2.1. SKVR (Scalable Knowledge-based Vehicular Routing)

SKVR [23] is a hierarchical knowledge-based DTN routing approach that works for public transport networks with providing efficient communication. Ahmed and Kanere presented the network in two ways such as inter-domain and intra-domain. In inter-domain routing, different routes are considered for source and destination, whereas in intra-domain routing, same route is considered for source and destination. In the inter-domain routing approach, the packet is forwarded to a vehicle traveling in the destination domain. Once the packet is reached in the destination domain, the intra-domain packet transmission procedure is started. In intra-domain routing, the packets are sent in both directions on the basis of entries in the contact list. If the forwarding vehicle's contact list does not consist any vehicle belongs to the destination domain, then the messages are forwarded to any other vehicles in the contact list. When vehicles running across the same route meet one another, a node that carries a packet must take decision whether to continue the buffering of the data packet or to forward it based on the direction of the vehicle.

3.2.2. VADD (Vehicle-assisted Data Delivery)

VADD [24] is delay tolerant routing protocol that use carry and forward strategy to overcome the shortcoming of geographical based greedy routing protocols in sparse network. Due to the lack of network connectivity, vehicle have to carry the packet unless the establishing the connection and the speed of moving vehicle is lesser than the wireless communication. So the VADD utilizes the wireless communication. Vehicle can chose the path at the intersection. To enable the vehicle to select the best path, VADD consist three different packet modes: Intersection made, straight way mode and destination mode.

3.2.3. GeOpps (Geographical Opportunistic)

GeOpps [25] utilize the vehicle's navigation system and estimate the distance from the destination to that respective vehicle. It computes the arrival time taken by the packet to its destination from the current nearest point of vehicle. For example vehicle v has two neighbors' n1 and n2 and it chooses only n1 neighbor by computing the short nearest point if neighbor n1 is closer to the destination as compare to neighbor n2. This process is continued until the packet reach at the destination.

3.3. Hybrid

Hybrid position based protocols are the combinations of non-delay tolerant protocols and delay tolerant protocols. Position based algorithms use greedy approach to forward the data

packet means the node forward the data packet to that node which is closer to the destination but there can be a situation due to obstacles the packet reach at local maxima where the vehicle does not have any neighbor closer to the destination accept itself then recovery strategy is applied to get rid from this local maxima situation. But network connectivity must be high to assure the packet transmission but it is not guaranteed that the network is always connected so that these type of approaches can be failed. Therefore, the combination of greedy and carry and forward techniques provides the better results.

3.3.1. GeoDTN+Nav

GeoDTN+Nav [26] is position based hybrid protocol that utilize the both features of delay tolerant and non-delay tolerant. Hybrid protocols consist of three modes such as greedy mode, perimeter mode and DTN mode. This protocol switches from one mode to other depending on various parameters like number of nodes in the network, transmission quality of packet, transmission delay etc. firstly it works in greedy mode and if the packet stuck in local maxima situation then it apply recovery technique by switching in perimeter mode. After that if the perimeter mode also fails then it finally follows the DTN mode with mobility of the vehicles.

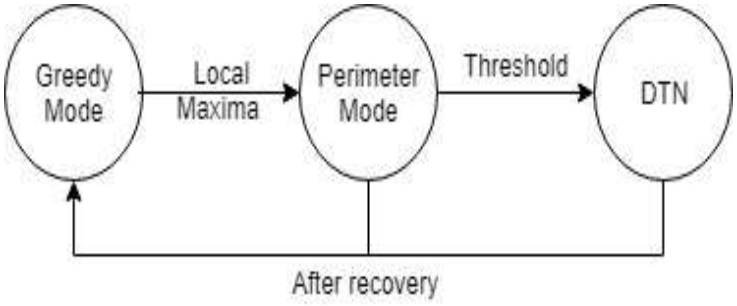

Figure 3. Transition between modes

In this protocol it is required that every vehicle is embedded with Virtual navigation interface (VNI) that provides two types of information: route information and confidence value. Route information provides the vehicle's route information and confidence value provide the information whether the vehicle moves randomly or how strictly it follows its route. This protocol is able to identify the network partitions and enhance the partition reachability by using the store-carry and forward technique when required.

4. CONCLUSIONS

This paper present the different types of position based routing protocols for vehicular network that can be a promising technique for deploying the intelligent transportation system. Vehicles for intelligent transportation systems are having a GPS (Global positioning system) and various sensors. These facilities enables the vehicles to analyze their own position and neighbor's position also. Therefore it is more suitable to use the position based routing protocols. In addition the tabular comparison of delay tolerant, non-delay tolerant and hybrid position based protocols with respect to different parameters is also given in the end of section 3. The VANET comprises of various challenges like dynamic topology, frequent disconnections of routes, driver behavior etc. Most of the routing protocols are

Table 1 Comparison among various VANET routing protocols

Routing Algorithm	Type	Greedy Forwarding Strategy	Carry & forward strategy(Buffering)	Traffic Awareness	Communication Environment	Map Requirement
GPSR	Non-DTN	Yes	No	No	Highway	No
GSR	Non-DTN	Yes	No	No	City	Yes
SAR	Non-DTN	Yes	No	No	City	Yes
A-STAR	Non-DTN	Yes	No	Yes	City	Yes
GpsrJ++	Non-DTN	Yes	No	No	City	No
GPCR	Non-DTN	Yes	No	No	City	Yes
CAR	Non-DTN	Yes	No	Yes	City	Yes
GYTAR	Non-DTN	Yes	No	Yes	City	Yes
CBF	Non-DTN	Yes	No	No	City	No
SKVR	DTN	Yes	Yes	No	City	No
VADD	DTN	Yes	Yes	Yes	City	Yes
GeOpps	DTN	Yes	Yes	No	City	Yes
GeoDTN+Nav	Hybrid	Yes	Yes	No	City	Yes

Suitable for the city environment and not for highway as shown in table 1. All the position based routing protocols follow the greedy forwarding approach and this approach has own its limitation like local maxima. In future, work on more suitable position based routing protocol which consider all such challenges and limitations and provide better solution is sensible.

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