Journal of Engineering Sciences

Vol 11, Issue 4 , April/2020
ISSN NO:0377-9254

DISTRIBUTED PATH PLANNING METHOD BASED ON OPTIMAL RSU ALLOCATION FOR VANET

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***Abstract*— Vehicular Ad hoc Networks (VANET) are emerging and trending in recent years for both research as well as industry communities. The main objective of VANET is to fulfill the user requirements on the road to make their drive safe, comfort and relaxed. Nowadays the vehicles are being equipped with embedded sensors, processing units and wireless communication capabilities for designing powerful and potential life changing applications on safety, efficiency, comfort, public collaboration and participation while they are on the road. It paves way to design and deploy different architectures for vehicular networks in highways, urban and rural environments to support many applications with required quality of service. Traffic congestion has become a major social problem in metros and cities due to rapid increase of vehicles usage. This situation can be handled effectively with Vehicular Ad hoc Network based path planning systems. Road Side Unit (RSU) play a vital role in controlling traffic flow for vehicle's secure driving by broadcasting locally analyzed data, forwarding some important messages and communicating with other Road Side Units and so on. Road Side Unit based architecture divide the city into different network areas and use a distributed path planning algorithm. The path planning is formulated by two layers, one is area path selection in upper layer and another intra area routing in bottom layer. To maximize the availability of Road Side Units in the Vehicular Ad hoc Network, it can be fully distributed over an entire area. It can be used to gather all traffic data from every intersection. An intersection priority based Road Side Unit placement method is used to find the optimal number and best position to place the Road Side Units. The greedy algorithm is used to provide the full distribution with a maximum network connectivity between Road Side Units while minimizing RSU deployment costs. The performance is evaluated in NS2 and system level simulations conducted to demonstrate the algorithms to work with traffic data and to find the optimal number of RSUs and its best position to place in the area.**

1. INTRODUCTION

The main aim of VANET is to provide a group of vehicles to create and maintain a communication between the vehicles without having any central base station. The major applications of VANET are concerned to avoid serious accidents, saving human lives and traffic congestion control. However, these important applications of VANET emerge new challenges and problems. The lack in infrastructure, VANET puts additional responsibilities on vehicles. Every vehicle becomes part of the network and also manages and controls the communication on this network along with its own communication capabilities. Vehicular ad-hoc networks plays vital role for the communication between moving vehicles with one another and RSU in an environment. A vehicle can communicate with another vehicle while on road directly is called Vehicle to Vehicle (V2V) communication or a vehicle can communicate to an infrastructure such as a Road Side Unit (RSU) known as Vehicle-to-Infrastructure (V2I). A detailed study of routing with different topologies and network path planning is presented in this paper[1]. A key design area in VANET in order to properly form a communication network is routing the packets in effective manner. The paper discusses different path planning algorithms for VANET and presents limitations of those algorithms.

1.2 ROUTING IN VANET

VANET routing can be classified by transmission strategies and its routing information. The various transmission strategies are unicast, broadcast and multicast. The Topology based position routing protocols allows the various direction finding information such as position which required preinstalled map or path direction information. The transmission broadcast strategies routing can be confidential under unicast, broadcast and multicast. Multicast can be divided into geocast and cluster based routing protocols. In unicast routing, one to one information / message transmission using multi hop method and the mid nodes are used for data forwarding. This is widely used class in ad hoc network. In VANET, many unicast routing protocols are proposed with topology based are AODV, DSR and GPSR etc.,

In broadcast routing, one to all communication occurs. This routing protocol mainly used in VANET to communicate the safety related message/information. Some of the broadcast protocols are as Flooding, BROADCOMM, DV-CAST etc., The simple broadcast is carried by flooding in which each node rebroadcast the message to other nodes. But the environment with large node density, it causes exponential increase in network bandwidth. In multicast routing, one too many communication take place. It can be further divided into geocast and cluster based. In cluster based routing, nodes are partitioned into cluster and single cluster head is selected for all outgoing and incoming communication. The COIN and CBDRP protocols are cluster based routing [2]. In geocast routing, the delivery of message / information to other nodes lie within a specific geographic area like area that an accident taken place. The position based protocols assume that GPS tool is equipped with vehicle in order to find its own geographic location and geographical position of closing stage vehicle. Without the use of location services it is very difficult to find the destination position. The numerous location services have been used in grid position service or in hierarchical location services to find the position and location.

Greedy Perimeter Stateless Routing scheme mainly use Greedy forwarding strategy that has no path calculation for routing from source node to destination node. The position of the destination node is inserted into packet header and that packet sends to the next hop closer to destination using greedy strategy. GPCR Rather applying greedy forwarding strategy at each forwarding node, GPCR uses restricted greedy strategy when nodes are in street and actual routing decision taken place at junction of streets [3]. Here the packet is forwarded to a node in the junction rather sending it across the junction. GPCR has higher delivery rate than that of GPSR with large average number of hops and slight increase in latency.

Geographic Source Routing (GSR) use Dijkstra’s shortest path algorithm to calculate the shortest path on each junction with greedy forwarding strategy to the next junction until to reach the destination node. The real time information is not used for path selection of next node, so it may stop at local and tries to select another vehicle node outside that road using greedy forwarding strategy. A-STAR (Anchor-based Street Traffic Aware Routing)calculate the complete path for packet forwarding. it also use dijkstra’s shortest path algorithm, but uses number of bus line on the road as weight parameter for path selection. It provides congestion information for better decision making towards the path selection by considering the number of bus line on the road as density of the vehicles lower the chances of local maximum. when the situation occurs, the road marked as out of service and path can be recalculated. GyTAR (Improved Greedy Traffic Aware Routing)use wireless router to boost the network connectivity at every junction. At each junction, the next best junction can be selected by taking account of vehicles density between them and move towards the destination.

Directional Greedy Routing (DGR) and Predicated Directional Greedy Routing (PDGR) are the forwarding strategies used to send the packet towards the destination [4].The routing scheme should handle to deliver the packet from the source to the destination with few hops and small possible delay. Reduction in number of hops during routing can be achieved in DGR by choosing the node moving toward the destination by using the greedy forwarding strategy. The enhanced DGR can achieve by predicting the vehicle mobility. Such information can be derived from the traffic pattern and street layout and it is used in PDGR while routing. The recovery strategy of both scheme use carry and forward approach.

2. REVIEW ON VEHICULAR PATH PLANNING

A VANET is a ad hoc network in that each node represents a vehicle equipped with wireless communication capabilities and transmitting/receiving signals while on the road. it improves road safety, traffic efficiency and

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ISSN NO:0377-9254

designing of traffic related applications, reducing the environmental impact and increasing the benefits of road users. A RSU is an access points which used together with the vehicles to allow information sharing in the roads. The key challenge is that to place these RSUs in a way that a maximum number of vehicles covered in the road [5]. Each vehicle can access RSUs in two ways. They are direct delivery it occurs when the vehicles within the transmission range and multi hop relaying it takes place when the vehicle is outside the transmission range. The main component of a VANET is RSUs other than the vehicles. The efficiency and performance are basically depends on the vehicle density and location of the RSUs positioned. During the VANET implementation, it is not possible to deploy a large number of RSUs either due to the less VANET enabled vehicles or due to the RSUs deployment cost. There is a huge need to deploy or position a less number of RSUs in a given location to get maximum coverage and performance.

Trullols et al [6] proposed an approach which covers maximum transmission range with less number of RSUs. It optimally deploys the RSUs as Dissemination Points (DPs) in urban area to increase the number of vehicles that communicate with the DP within the specified area. The Maximum Coverage Problem (MCP) is problem formulated by the coverage can be NP hard and use heuristic algorithms to handle the different levels of complexity and require different knowledge on the system. It also handle a large number of vehicles travel under one or more DPs coverage with adequate amount of time. A different formulation of the problem that is still NP hard use heuristic approach to solve.

Hartenstein et al [7]proposed a Cooperative Vehicle Infrastructure Systems which follow the CALM standards and mainly deals with development and testing of communication from vehicle to infrastructure. CVIS use the IEEE 802.11 WAVE related interface in the CALM frame work which represents as M5 interface (Microwave 5GHz). The objective of SAFESPOT (2006–10) is to design the systems for road safety based on vehicle to vehicle and vehicle to infrastructure communication.

Soyoung Park et al [8]present to provide reliable reputation scores in practical ways for vehicles in a VANET. Most of the vehicles are driven locally to accomplish their day to day activities and all the vehicles have predefined constant route paths. Based on this, roadside infrastructure could rely on frequent observations of the same vehicles passing the routes to build long term reputation scores for these local neighborhood vehicles, in the similar way as the reputation built up for people in a community or a society. These features is suitable for the initial deployment stage of vehicular network then the penetration rate of vehicles is very less or moderate and the vehicle based public key infrastructure is not established fully in this environment.

Wooseong Kim et al [9] proposed NAVOPT, a vehicular routing strategy assisted by the on board navigator and the navigation server. The on board navigator equipped with maps and GPS monitor to report its position or location to the server through wireless communication and it took shortest path from the server with current traffic information. In NAVOPT, the server use a flow deviation algorithm to calculate best optimal routes by load balancing vehicle traffic information with other route alternatives.

Baber Aslam et al [10] proposed two different optimization methods such as a Binary Integer Programming (BIP) and Balloon Expansion Heuristic (BEH) for the deployment of a restricted number of RSUs in an urban area. BIP method use branch and bound approach to find an optimal best solution and BEH method use balloon expansion analogy method to find an optimal or close to optimal solution.

Cavalcante et al [11] modeled the maximum coverage with threshold time and solve by using genetic algorithm. It focused on increasing the throughput and reducing the trip time by optimal deployment of limited number of RSUs and finding the optimal number and positions of RSUs that can cover up all the intersections which can obviously maximize the RSUs connectivity with one another.

Luigi Fratta et al [12] proposed an ARPANET which surpassed 40 nodes and is very fast growing like one node per month. Besides, the government and commercial P/S networks are emerging, designing an well-organized topology and flow assignment strategy could meet the requirements at lower costs is necessary to surpass the competition represent by circuit switch or private line networks. The major real time challenge is to solve a combined flow and capacity assignment problems. The key basic technique is to

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Vol 11, Issue 4 , April/2020
ISSN NO:0377-9254

‘‘deviate flows’’ on incrementally by improving the paths until it reaches optimal. In previous days, the FD algorithm was used to intend and advance the growing of ARPANET topology. After the topology became stable, the FD algorithm took its own as an perceptive, efficient method to solve different flow problems in network and different domains from ARPANET to WDM wavelengths, urban traffic cars and SDN tunnels.

In distributed path planning, there are different methods proposed to avoid traffic congestion. The challenges or problem faced in traffic congestion is no proper traffic information collection and not updating the information frequently. The deployment of large number of Road Side Units encounters a high installation cost. In order to reduce the installation cost, the Road Side Unit placement methods are designed and implemented to meet the requirements and maximum connectivity.

3. ROAD SIDE UNIT BASED PATH PLANNING

The traffic congestion can be reduced and avoided efficiently by the path planning methods. A hybrid intelligent transportation system (ITS) which uses both VANET and mobile network systems to enable communications among the vehicles, roadside units and a server. A path planning algorithm not only improves the utilization of a road side network but also reduces the average vehicle trip cost by avoiding jammed in traffic congestion. Lyapunov optimization technique is exploited to handle the optimal path planning problem. It is better than the distributed path planning in terms of balancing the utilization and vehicles trip timing and cost. The path planning and avoidance of traffic congestion uses the traffic information. VANET provides an ITS system which have efficient communication capabilities with less cost and excellent delivery of traffic information has been studied by Hoh et al [13]. It support both vehicle to vehicle and vehicle to roadside unit communications by collecting traffic updates in real time from vehicle and roadside units. The information must be absolutely error free and no delay in network to retransmit the information during emergency situation. It has to improve its transport layer protocols from current informal network transport technologies to design and develop protocol which fulfill the requirements.

VANET mainly rely on short range multihop communications where the end to end transmission time delay can occur. Many algorithms are designed to find out the optimal paths for each and every vehicles by using the collected traffic information. The Individual path planning algorithms of vehicles may lead to traffic congestion if coordination fails between then while executing. To smooth the flow of network to plan the optimal paths from a global point of view for a group of vehicles at same time. The optimal path planning algorithms mainly focus on the network side capacity improvement and ignore the drivers preferences. The decisions are made to avoid traffic congestion and balance the traffic rather than to find out optimal paths for individual vehicles, some vehicles may end with paying additional cost. Algorithms should be designed to accommodate the balance of the network traffic and the minimizing the average trip cost of the vehicles.

3.1 Hybrid Vanet Enhanced Transportation System

The hybrid VANET enhanced transportation system is composed of vehicles, RSUs, mobile network stations and a traffic server. Nowadays the vehicles are equipped with the individual onboard devices which enable wireless connection for a larger range and V2V communication is used to deliver the information such as its velocity, density and the location in a timely interval. The accident related information and traffic congestion warning message are send to and from the vehicles and then further shared to the nearest RSU via V2R communications. The VANETs and mobile network communications together to set up for the purposelike mobile tele monitoring and utilize in management systems for intercity public transportation has been pointed out by Schouwenaars [14] .

The vehicles can upload the received warning message information to the nearest mobile network base stations and then from the base stations to the traffic server. RSUs collect all the vehicle traffic related information like arrival, departure, congestion on each road where it is deployed. The vehicles are well connected to the cellular network system and RSUs are connected with each other with wired network. If the RSUs are implemented at every junction of the roads, the traffic information can be collected by the cameras and traffic flow meters directly. The traffic flow can be predicted by the closest RSUs based on the

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ISSN NO:0377-9254

traffic information collected from the VANETs has been studied by Chen et al [15]. The RSU can share the traffic information with each other and to the traffic server. If an accident or congestion happens on certain roads, the traffic server can able to execute path planning to provide optimal paths for the vehicles which are having different trip requirements based on the collected information in the server.

3.2 Traffic Flow Model

A traffic flow model is of inflow or outflow system. Every individual vehicle is likely to go behind a intended path from the starting point toward to its destination. The planned path can be referred to a path fixed in a GPS device as per the driver's favourite and based on the starting and ending locations. The driver will follow the predetermined path until the any message or information on congestion or accident received has noted by Chung et al [16]. The traffic server is responsible for finding an optimal alternative path or re routing the vehicles towards its destination when an accident or congestion occurs by using the path planning algorithm. The vehicle starting point and destination are located as s ($\in\Gamma$) and d ($\in\Gamma$) respectively in the road segments.

The time duration is represent as Δ and including a series of time slots as a time unit which is defined by theoretical to prevent loss of data in the compressive sensing for the estimation of traffic is indicated within the specific time duration T, based on the RSUs traffic flow rates in given time segment, the average road segment inflow rate of (i, j) of the time duration T is denoted as $\lambda_{ij}(T)$ and calculated using the belowequation no. 3.1. The road segment outflow rate (i , j) can be arrived from the average rate of vehicles passing to nearby road segment during the time duration T.

$$\lambda_{ij}(T)=1/\Delta\sum_{t=(T-1)\Delta}^{T\Delta}\lambda ij(t) \quad (3.1)$$

Routing is the roaming of vehicles from one to the another intersection. In every intersection, the RSU nearby to the intersection preserve a virtual queue of length Q_{di} (T), representing the number of the vehicles buffered in the intersection particularly intended to destination d ($\in\Gamma$) in given duration$T$. The total length of all virtual queues of intersection i for all destinations is calculated as $Qi(T)$ $=\sum_{d\in\Gamma}Qdi$ (T), where $Q_i^d(T)$ calculation is shown below in equation 3.2 has been arrived by Luan et al [17], with $\mu^d_{ij}(T-1)$ is the road segment (i, j) outflow rate with destination d in the $(T-1)$ given time duration, satisfying $\mu_{ij}(T-1)$ $=\sum_{d\in\Gamma}\mu^d_{ij}(T-1)$. Likewise for road segment (i, j) the leftover number of vehicles in given time duration T as follows,

$$Q_{ij}(T)=\max\{Q_{ij}(T-1)-\mu_{ij}(T-1), 0\}+\lambda_{ij}(T-1)$$

$$Q_i^d(T) = \max\{ Q_i^d(T-1)-\sum_{j\in Ji}\mu_{ij}^d(T-1),0\} +\sum_{u\in Ji}\lambda_{ui}^d(T-1) \quad (3.2)$$

The recurrent and non-recurrent congestion are two kinds of traffic congestion. The recurrent congestion occurs due to the tension between the present traffic flow condition and the road environment conditions which is non-incident based. $C_{ij}(T)$ represent the maximum number of vehicles outflow of a road segment (i ,j) within specific time duration T, which is determined by the road environment conditions, the number of streets, road length and the traffic congestion. The non-recurrent congestion occurs due to an accident or incident, which can decrease the road capacity. A warning message for the congestionδ(Iij) with (€[0, 1]) represent how the congestion type 'I' happening on the road segment (i, j) impact on the road capacity. if the valueδ(Iij) = 1, which means recurrent congestion occurs otherwise δ(Iij) € [0, 1) means non-recurrent congestion.

3.3 Vehicle Categorization And Mobility Model

The vehicle types are categorized into three types as private cars, taxis and buses. The GPS devices are equipped on all vehicles and tuned to provide the shortest path service. The bus path are generally fixed in a planned manner when compared with private cars and taxis in which the paths are changeable every time according to their own preferences. Let wm $\in$ {0, 1} (m $\in$V), indicates the capability of turning flexibility for the vehicle m. when the vehicle get any information regarding the congestion or accident takes the value as 1. if m is a taxi or a private car and takes the values as 0, it can change their paths to alternate with possible turning flexibility whereas the buses have to wait until the traffic congestion is cleared. The warning messages can be delivered to the vehicle traffic server as well as to assist path planning is designed for message transmission.

The mobility of each vehicle can be differentiated by two random variables V and D. V represents the velocity of the vehicle that obtain two possible values. The velocity transition is of two state continuous time Markov chain with transition rate 1/D. A vehicle in the beginning chooses vL and after an exponential distributed time duration with the mean of D, the vehicle velocity changes to vH. The vehicles can move independently whether the density is low or medium..

3.4 Optimal Path Planning

The path planning algorithm is used to help the vehicles to prevent/avoid congestion and traffic balance uniformly in the entire network. Luan et el [18]has studied the optimization problem can be resolved by applying the drift plus penalty framework in the Lyapunov optimization process. At every time duration, the dynamic algorithm get vehicles turning decisions for maximize the lower bound of network throughput. The weight of an intersection is mainly associated to the differential queue backlog between intersection I and its nearby intersections and average intersection travel cost.

3.5 Path Planning Algorithm

The steps for performing the path planning algorithm are as follows,.

Step 1: Initialize the set of intersection is 0.

Step 2: For each intersection calculate the weight.

Step 3: For each non zero weight update the set of intersection.

Step 4: Vehicles at intersection with highest weight is re-planned.

Step 5: Vehicles with destination d stored at intersection should be dispatched to the queue.

Step 6: The number of vehicles with destination d is re-planned.

Step 7: Then queues at all the remaining intersections are updated automatically.

Step 8: The process continues until all intersections connected are processed.

The algorithm for path planning is executed for the fixed number of vehicles and used to find out the optimal path for the vehicles.

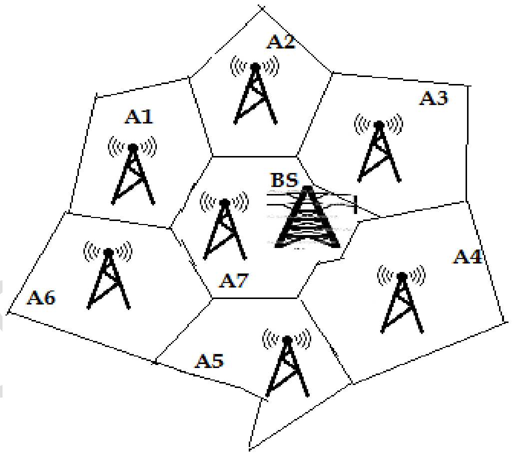
3.6 Distributed Path Planning

A distributed RSU based path planning system is used to overcome the new congestion problems rise in less infrastructure systems and reduce the complication of infrastructure based systems. In this path planning system, the entire network is separated into a sequence of area and each area is controlled by a central RSU. So that the path planning issues for the entire network is addressed in a distributed way, each RSU execute path planning for all vehicles in their boundary area. In order to reduce the the computational difficulty, it is divided into area path selection and intra area routing which are calculated by the collective routing request information of the local area and traffic information of other nearby areas. In the information collection process, V2V and V2R communications are taken efficiently and only the average travel time to move across each area is shared to cutthe communication overhead between the RSUs have been studied by Collins et al [19]. The optimization model aims to reduce the average travel time of the vehicles.

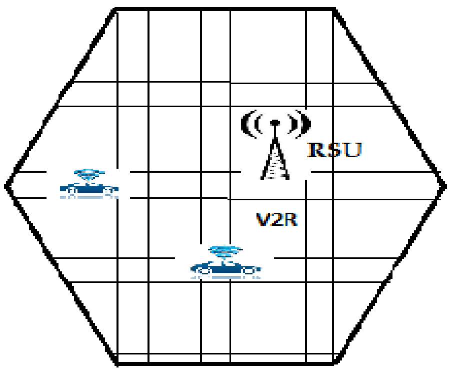
3.7 System Model

A new urban traffic network architecture and the related communication scheme. A multi commodity flow model is introduced to show the real time vehicle traffic conditions in an urban environment.

Figure 3.1: RSU based Network Architecture



(a) Area level



(b) Road level

The network architecture framework can be depicted both at area level and road level with vehicles, RSUs and BSs shown in above figure 3.1(a). The whole network area is separated into a series of areas with equal size represent as *{Au}Ku*=1. The RSU is installed in each area centrally so that it communicates with one another through mobile networks as shown in the above figure 3.1(b), every RSU has a communication range which is smaller than the size of an area. when a vehicle come inside the communication range of an RSU, automatically it can receive the information through V2R communications. Otherwise, the information is broadcasted through V2Vvand then finally V2R communications.

Every RSU carry out path planning for all the vehicles in its deployed area range. First, it gathers local and other area traffic information. When a vehicle arrives inside the RSU area range request the route for the destination by sending its present exact location. Based on the gathered information, each RSU can calculate approximately the area passage time and broadcast in timely interval to other RSUs through mobile networks. Wischhof et al [20] has defined the area crossing time is the average travel time to cross through the local area in different directions. Each RSU can collect all the vehicles route request within its area range and crossing time of other areas. Besides the traffic information inreal environment, every RSU wants to know the nature of each road in its area range including length of the road, speed limit and the capacity of the road. The road capacity is the maximum number of vehicles can be accommodated by the road per unit time.

In Multi Commodity Flow Model, all the vehicles route requests over the whole network is classified to a flow from an intersection to another as per its current location and the destination. Particularly the source and the destination intersection of the subsequent flow are defined as the nearest intersections to the current and destination location of a vehicle. The initial starting point location and the destination location of a vehicle may situate at different places in a city, the urban traffic can be depicted as a multi commodity flow model. The arrival rate flow equals to the number of route requests per unit time, so it can vary with time. The arrival rate of each flow is assumed to remain steady during a time interval with a short duration studied as per the route request information gathered by RSU, the arrival rate λf (n) of flow f during the nth period can be calculated by the particular RSU.

3.8. HIERARCHICAL PATH PLANNING

Based on the above RSU network architecture, a hierarchical path planning method is proposed in this section. In the top layer, the RSU present in the local area pick a path for each flow whose destination is in other area is called area path selection. In the bottom layer, the local area RSU is responsible for all flows path planning within the local area is called intra area routing. The problem formulated below is for a period and all parameters are assumed constant over time with unnoticed effect of time.

In Area Decoupling, to execute the path planning for all vehicles of the entire network in a distributed way. Each RSU provide guidance for the route to all vehicles in its local area range whereas the areas should be decoupled. Let Fu represent the set of flows within area range Au have two types of flows, They are native flow which created within the local area and other transferring flow which transferred from the neighbour areas has been pointed by Lochert et al [21]. If a native flow $f \in Fu$ has a destination in other areas, any vehicle belong to the local area should guided first to a neighbour area An u∈An u, in that An u is the set of neighbor areas of Au. In general, there can be more than one exit at the border between the local area and a particular neighbor area. The exit of a native flow in an area is unfixed before the path planning.

The area decoupling of all exits to a particular area are assumed to be connected by virtual intersection Ou ∈Ou. Here $O_u$is the set of virtual intersections of area range Au and equals to the number of neighboring areas. There is at least one destination for any type of flow f within area range Au has been studied by Hartenstein et al [22]. In area path selection, the main objective of the RSU is to select an area path with the minimum travel time for each flow having destination in other area. The problem for a particular flow f in area rangeAu. For notation simplicity, Af (0) represents the original area of flow f. Df (Pj) represents the area crossing or passage time of the jth area on the area path which is calculated by the average of the minimum travel time from the $ej-1$ inlets of the jth area to enter the (j + 1) has been studied. It is significant that the average travel time in the destination area is defined as the average of minimum travel time from all inlets of the area to the specified destination. Those information can be required from the RSU in the destination area and called crossing time of destination area.

After the area path selection, each RSU executes intra area routing for all flows within its area range and it aim to minimize the average intra area travel time for all vehicles. In order to keep system stability, the flow conservation and limited road capacity should be fulfilled. The average intra area travel time is defined as the ratio of total intra area travel time of an specified area to the total arrival rate of flows in that area.

3.9 Distributed Implementation

In the hierarchical strategy, each RSU has to carry out path planning within its managing area range independently after the area path selection for each vehicle has been chosen by the local RSU. The implementation of distributed path planning (DP) is shown in below algorithm,

Algorithm: Framework of distributed path planning

Step 1: Each RSU gathers all route requests within its managing area range.

For Node 103: Source address :
set X_132.70
set Y_4050.0
Destination address:
set X_ 6373.83
set Y_ 1425.55

Step 2: In each area, the RSU carry out area path selection for each flow.

RSU 8 calculate the distance:
Dist= sqrt[((x2-x1)*(x2-x1))+((y2-y1)*(y2-y1))] Distance of node 103=6771.192

Step 3: The RSU executes intra area routing design for each intra area flow. node 103 path :
at 1.5 setdest 3701.77 4050.83 150.0
at 23.5 setdest 3846.83 3837.06 150.0
at 25.5 setdest 6350.94 3852.33 150.0
at 43.5 setdest 6373.83 1425.55 150.0

Step 4: Once the request received, the RSU can classify the requests into a flow and replies with the related area path and intra area routing results.

Step 5: Repeat 1 to 4 in a new period

The distributed system executes path planning for all the vehicles in a timely manner within the entire network. Once the route request is received, the local RSU respond with the best routing results estimated at the start of the corresponding time. Kevin et al [23]. has been studied that the RSU responds with the corresponding intra area routing method when the destination location is within the local area. Otherwise, the area path method respond as well. After a vehicle gone from its original location area, then the RSUs next to the area path will guide by giving the intra area routing consecutively until the vehicle reaches its destination area location.

Table 3.1: Configurations of the Simulations

NETWORK PARAMETERS	VALUES
No Of Nodes	100
No Of RSU	9
Simulation Area	8500m*8500m
Routing Protocol	ADOV
Simulation Time	250 Sec.
Network Simulator	NS2-2.34
Connection Type	TCP
Packet size	2000

The algorithm for path planning is carried out by taking static number of vehicles. This algorithm experiments are performed above distributed path planning algorithm to find out the best optimal path for the vehicles.

4. INTERSECTION PRIORITY BASED RSU ALLOCATION

4.1 INTRODUCTION

RSU is a crucial unit in a VANET for gathering and analyzing traffic information sending by the smart vehicles. The main objective of the RSUs is to control traffic flow for vehicle's safe driving by broadcasting locally analyzed data, forwarding important information and exchanging the messages between other RSUs. To facilitate the availability and make best use of RSUs in the VANET, RSUs should be fully distributed over an whole area. Thus, RSUs can use and analyze all traffic data gathered from every intersection. So the intersection priority based RSU deployment methods are used to find out the optimal number of RSUs and its positions for the full distribution with maximum connectivity between RSUs while minimizing the RSU setup costs.

VANETs are sub form of mobile ad hoc network to provide vehicle to vehicle and vehicle to infrastructure communication. Since vehicles can able to exchange traffic information with one another, it can carry out a smooth traffic as well as an enhanced road safety by allowing advance warning information about accidents and specific threats to safety. In smart vehicles, RSU plays a vital and essential infrastructural unit in VANET for collecting and analyzing traffic data information. Leontiadis (2009). pointed out

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ISSN NO:0377-9254

basically the RSUs can be installed at each intersections for maximizing data collection, sharing information and mainly broadcast traffic data given by smart vehicles. The researches on the RSU deployment and placement in VANET are mainly focused for optimal placement with a limited number of RSUs due to the high set up costs has been pointed out by Tutschku et al [24]. An approach of optimally allocating RSUs in order to maximize the availability and minimizing the setup cost of RSUs in the VANET.

The RSUs is capable of collecting and make use of traffic data gathered from every intersection, analyses, broadcast to VANET elements and especially to exchange traffic situations or messages with neighboring RSUs. Therefore, RSUs should be deployed in a way that is well connected with each other and all intersections covered. A solution to accomplish this goal is to place RSUs at every intersection but it is too expensive. Therefore need to discover the optimal ways for the full distribution of RSUs while minimizing the cost.

Greedy approach proposed three optimal ways to figure out the RSU deployment problem. The major principles prefer to place RSUs at important intersections, allocating RSUs until every intersection is covered and distributing RSUs as even as possible has been pointed. In order to evaluate the significance of each intersection, it introduces a concept of intersection priority. The intersection priority is computed by some traffic factors including vehicle density, intersection popularity and intersection individuality. Then finally the approach allocates RSUs at intersections according to the above principles. The greedy algorithm basically place RSUs at intersections in descending order of intersection priority. This approach can distribute RSUs in an even manner by the order of intersection priorities.

4.2 RSU Connectivity and Coverage

An RSU is a fixed unit installed in each intersection and it has the transmitter for wireless communications, storage for gathering traffic data and a computational device for generating traffic messages and analyzing traffic data. It is assumed to be equipped with a 75MHz of DSRC spectrum at 5.9GHz is implemented for the wireless communication has been studied by Raya et al [25]. RSUs are usually to broadcast traffic data given from smart vehicles. In addition, RSUs keep gathering and analyzing the local traffic situations then broadcast the analyzed data in a periodic manner and spread abnormal actions rarely. when two RSUs are connected if messages from one RSU can be send to the other without data loss. There could be two situations as shown in Figure 4.1. In the first case, the two RSUs are directly connected by locating each other within their transmission range. The RSU A and B at (b) mentioned in the Figure 4.1 shows that are out of transmission range of both but A can still get data from B with a high probability by vehicles passed through B since there is only one route between A and B and vice versa.

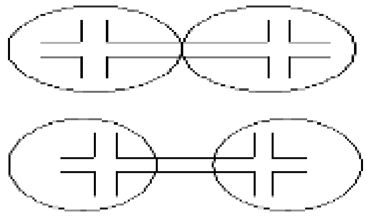


Figure 4.1 RSU Connectivity

(a) Directly connected: Both A and B are within transmission range of each other.

(b) Indirectly connected: Even though A is out of B’s transmission range, A can get data transferred from B by vehicles p (a &b) h B and vice versa. Bailey et al [22]p... out an intersection is covered by an RSU if the intersection is located within the transmission range of the RSU. The individual coverage of a single RSU comprise of all the intersections inside its transmission range.

4.3 Intersection Priority

The RSU deployment locations can be decided by the intersection priority value and every intersection is a candidate for RSU placement. Among the entire intersections, RSUs are placed at every intersections in descending order of the intersection priority until all the intersections are covered. The priority can be calculated by some traffic factor such as vehicle density. Let $P_i$be an intersection priority of the i_{th} intersection for $1 \leq i \leq n$. The value of intersection priority, $P_i$is determined as in below equation (4.1):

$$P_i = w_1 * f_{i1} + w_2 * f_{i2} + \ldots + w_m * f_{im} \qquad (4.1)$$

In that $f_{ij}$is a normalized value attained by the jth traffic factor for the ith intersection and $w_j$is a weight for each traffic factor for $1 \leq j \leq m$. Wright et al [26] studied the values are obtained by the factors that can have different units of measurement and the priority may be severely affected by the factor with a large scale of values.

Table 4.1 Notations

Notation	Description
A	A set of all intersections
A_i	The ith intersection in A where i = {1,….,n}
I_i	The intersection priority of A_i
N_i	A set of intersections within the transmission range of an RSU installed at A_i
PSET	A set of intersections where RSUs are placed

4.4 OPTIMAL RSU PLACEMENT

This method provides solid design to place and deploy the RSUs at intersections optimally.

Greedy Approach

The greedy approach only consider the intersection priority to place RSU.

RSU= {1,2,3,4,5,6,7,8,9}

Priority can be calculated by taking the number of vehicle in each RSU.

Priority 1= RSU 8(21)

Priority 2= RSU 5(15)

It basically starts to depoy an RSU at the intersection with the highest priority.

RSU 8 placed at 0.2

RSU 5 placed at 0.4

Then all the intersections within the transmission range of the RSU are excluded from a candidate set of intersections for RSU placement.

RSU= {1,2,3,4,6,7,9}

Next RSU can be deployed at the intersection with the highest intersection priority in the updated candidate set.

RSU 7 at 0.52

RSU 1 at 0.64

In this way, selecting the next location for RSU can be continued until all the intersections are covered.

This method can be used to deploy or place the RSU at the optimal location to cut the installation setup cost. It can be achieved with the intersection priority of the road.

5. RESULT AND DISCUSSION

The distributed path planning method is evaluated with VANETs in smart vehicles communicate with each other through wireless communication. This system can exchange information using Vehicle to Vehicle and Vehicle to RSU in a active network through simulation. There are three approaches used to place the RSU at a optimal location to reduce the installation and setup cost. The performance metrics of the method and results are illustrated through NS2 simulator.

The general process of a simulation can be divided into following steps:

1. Topology definition: Defining their interrelationships and to ease the creation of basic facilities.
2. Model development: Models are developed and added to simulation.
3. Node and link configuration: Models set their default values and link configurations.
4. Execution: Simulation facilities create events and the data is requested by the user logged.
5. Performance analysis: After the simulation is completed, the data is available as a time-stamped event trace. This data can be statistically analysed by the tools like R to draw and arrive conclusions.
6. Graphical Visualization: The processed or raw data collected in a simulation can be used to draw graph with tools like Gnuplot, matplotlib or XGRAPH.

5.1 RESULT

The information about the road block is shared with other vehicle through RSU using wireless communication is shown in below figure 5.1.

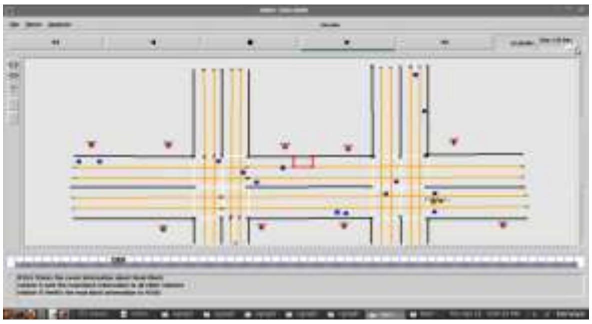
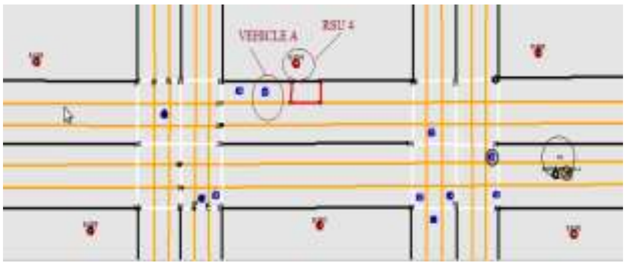


Figure 5.1 Vehicle Movement with information exchange

The RSU exchanging the message with other RSU and vehicles is shown in the below figure 5.2



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ISSN NO:0377-9254

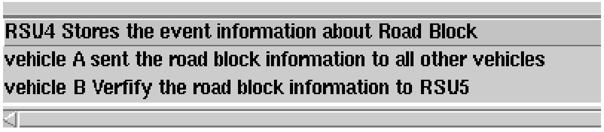

Figure 5.2 RSU distributing messages

The greedy approach is used for the optimal placement of RSU to reduce the intialization setup cost of the RSU in distributed path planning. It is shown in the belowfigure 5.3.

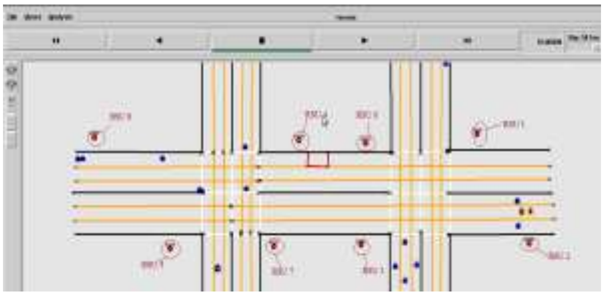

Figure 5.3 RSU placement using greedy approach

The comparision between therandom RSU placement method and Greedy RSU placement method is shown in the below figure 5.4

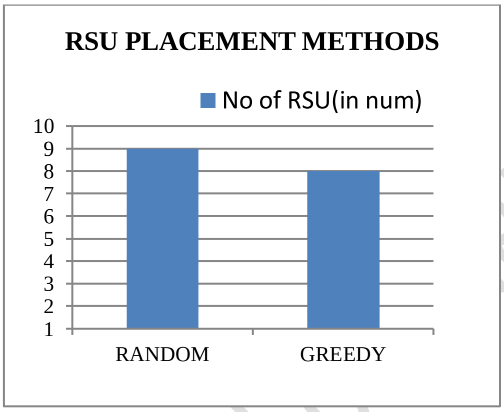

Figure 5.4: Comparision of RSU Placement Methods

TABLE 5.1 RSU Placement Methods

RSU Placement Methods	No of RSU(In Num)
Random	9
Greedy	8

The number of RSU placed in each RSU placement methods are shown in the above Table 5.1.

TABLE 5.2 Complexity of Two Path Planning Methods

Path Planning Methods	Complexity
Centralised Path Planning	High
Distributed Path Planning	Less

The complexity of the path planning methods are compared and it is shown in the above Table 5.2.

The different approaches and path planning for placement of RSU is simulated over a fixed number of nodes and the results are obtained from the method are agreeable and efficient than the traditional methods to reduce the installation and setup cost of RSU.

6. CONCLUSION AND FUTURE ENHANCEMENT

A decentralized path planning method with hierarchical routing is used to reduce the complexity and the path planning problem has further decayed to sub problems through area decoupling. In area path selection, the areas of congested condition can be avoided efficiently by reducing the average area crossing time. In intra area path planning scheme, the optimization model is established with the object to reduce the average intra area travel time and thus the congestion can be avoided through flow deviation appropriately.

An intersection priority based RSU deployment approach is used for allocating the RSUs to have the maximum coverage in all intersections with a good connectivity between RSUs while reducing the RSU installation and setup costs. In this paper, a practical approach called greedy method has been discussed clearly to find the optimal number and better positions for the placement of RSUs. The simulation results show that the output results are very similar for a given area with evenly distributed intersections but the approach works efficiently for very complex areas having uneven distributed intersections.

In the future, we plan to implement a real test bed in order to confirm the performance of the approach in a real environment. In addition, we consider that our proposed approach can contemplate the feasible reach capability between the intersections and mainly it needs to be improved in future as enhancement. It develops a probabilistic model that can estimate the possibility of connectivity between two intersections without increasing the RSU set up cost and it can be applied to RSU deployment in real time scenario.

REFERENCES

1. Abdrabou A. and Zhuang W. (2011), 'Probabilistic delay control and road side unit placement for vehicular ad hoc networks with disrupted connectivity', IEEE Journal Selection Areas Communication, vol. 29, no. 1, pp. 129–139.

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ISSN NO:0377-9254

2. Chen J. et al (2010), 'Utility-based asynchronous flow control algorithm for wireless sensor networks', IEEE Journal Selection. Areas Communication, vol. 28, no. 7, pp. 1116–1126.
3. Claudia Campolo, Antonella Molinaro and Riccardo Scopigno (june 1 2015), ' Vehicular adhoc networks: standards,solution and research ', Springer.
4. Herring R., Abbeel P. and Bayen A. (2009), 'Path and travel time inference from GPS probe vehicle data', in Proceedings. Neural Information Processing System Foundation, Vancouver, BC, Canada, pp. 1–8.
5. Jariyasunant J. et al (2010), 'Mobile transit trip planning with real-time data', in Proceedings. 89th Annual Meeting Transportation Res. Board, Washington, DC, USA, pp. 1–17.
6. Trullols, Fiore M. and Casetti C. (2010), 'Planning roadside infrastructure for information dissemination in intelligent transportation systems', Computer Communications, 33 (4), pp. 432– 442.
7. Hartenstein H. and Laberteaux K. (2010), 'VANET Vehicular Applications and Inter-Networking Technologies', Wiley.
8. Park S., Aslam B. and Zhou C. (2011), 'Long-term Reputation System for Vehicular Networking based on Vehicle's Daily Commute Route', IEEE CCNC 2011, pp. 457-462.
9. Kim W. and Gerla M. (2011), 'NAVOPT: Navigator assisted vehicular route Optimizer', in Proc. IEEE conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), Seoul, Korea, July, pp. 450-455
10. Aslam B., Amjad F. and Cliff C. Zou. (2012), 'Optimal Roadside Units Placement in Urban Areas for Vehicular Networks', ICSS 2012, pp.423-429.
11. Cavalcante E., Aquino A., Pappa G. and Loureiro L. (2012), 'Roadside unit deployment for information dissemination in a VANET: an evolutionary approach', GECCO (Companion), pp. 27-34.
12. Fratta L., Gerla M. and Kleinrock L. (2014), 'Flow deviation: 40 years of incremental flows for packets, waves, cars and tunnels', International Journal of Computer Networks, vol. 66, pp. 18-31.
13. Hoh B., Gruteser M. and Herring R. (2008), 'Virtual trip lines for distributed privacy-preserving traffic monitoring', in Proceedings. 6th Annual International Conference Mobile System, Application Service, Breckenridge, CO, USA, pp. 15–28.
14. Schouwenaars T., Moor B., Feron E. and How J. (2001), 'Mixed integer programming for multi-vehicle path planning', in Proceedings Europe Control Conference, Porto, Portugal, pp. 2603–2608.
15. Guha R. and Chen W. (2009), 'A distributed traffic navigation system using vehicular communication', in Proceedings. IEEE Vehicle Network Conference, Tokyo, Japan, pp. 1–8.
16. Chung Y. (2010), 'Development of an accident duration prediction model on the Korean Freeway Systems', Accident Analysis Preview., vol. 42, no. 1, pp. 282–289.
17. Luan T H., Ling X. and Shen X. (2012), 'Provisioning QoS controlled media access in vehicular to infrastructure communications', Ad Hoc Networks, vol. 10, no. 2, pp. 231–242.
18. Collins L. and Muntean G.M. (2008), 'A vehicle route management solution enabled by wireless vehicular networks', in Proceedings IEEE INFOCOM, Phoenix, AZ, Apr, pp. 1-6.
19. Wischhof L., Ebner A., Rohling H., Lott M. and Halfmann R. (2003), 'SoTISA self-organizing traffic information system', in Proceedings IEEE Vehicular Technology Conference (VTC), Jeju, Korea, Apr, pp. 1171-1177.
20. Lochert C., Scheuermann B., Wewetzer C. (2008), Andreas Luebke and Martin Mauve, 'Data Aggregation and Roadside Unit Placement for a Vanet Traffic Information System', ACM VANET.
21. Kenneth Laberteaux and Hannes Hartenstein (January 1, 2009), 'VANET Vehicular Applications and Internetworking Technologies', ISBN: 978-0-470-74056-9, John Wiley & sons.
22. Kevin Collins and Muntean G.M. (2008), 'A vehicle route management solution enabled by wireless vehicular networks', in Proceedings IEEE INFOCOM, Phoenix, AZ, Apr, pp. 1-6.
23. Leontiadis I., Marfia G., Mack D., Pau G., Mascolo C. and Gerla M. (2007), 'On the effectiveness of an opportunistic traffic management system for vehicular networks', IEEE Transaction on Intelligence

Vol 11, Issue 4 , April/2020
ISSN NO:0377-9254

Transportation System, vol. 12, no. 4, pp. 1537-1548, Dec.

24. Tutschku K. (1998), 'Demand-based radio network planning of cellular mobile communication systems', IEEE INFOCOM.
25. Bailey C.A., McLain T.W. and Beard R.W. (2001), 'Fuel-saving strategies for dual spacecraft interferometry missions', J. Asrm. Sci., vol. 49, no. 3, pp. 469-488.
26. Wright M. (1998), 'Optimization methods for base station placement in wireless applications', IEEE VTC.