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Path Planning Based on Hybrid VANET Enhanced Transportation System

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Abstract— There is a fast growth in the field of Vehicular Ad-hoc Networks (VANET) as they are being used for many applications. One of the important applications of VANET is in Intelligent Transportation systems (ITS). It consists of vehicle-to-vehicle and vehicle-to-infrastructure communications based on wireless local area networks. Traffic accidents and congestion problems are becoming worse now days. Because of vast number of vehicles on road, transportation sector is significantly worried; this indications to additional accidents and fatalities, and adversarial environmental and economic impact. Many methods have been established in the field of vehicular ad hoc networks, but they are not that efficient and face a lot of problems at the time of execution. This paper gives an overview of the past few techniques in this field and presents a real–time intelligent transportation system based on VANET, which addresses the issues of earlier techniques. We propose a hybrid-VANET-enhanced ITS framework, manipulating both the VANETs and the public transportation system. Second, we design a real-time global path-planning algorithm by using Destination Sequenced Distance Vector (DSDV) protocol to not only develop network spatial utilization but also decrease average vehicle travel cost per trip. A low complexity algorithm is developed established on Lyapunov optimization to type real-time path planning decisions

Keywords— Vehicular Ad-hoc Networks (VANET), Road-side units, Vehicle – to - Vehicle, and Vehicle – road - side units communications and Destination Sequenced Distance Vector protocol.

I. INTRODUCTION

Every day, a most of people die, and many people are injured in traffic accidents about the world. The desire to progress road safety information between vehicles to prevent accidents and similarly improve road safety was the main incentive behind the development of vehicular ad hoc networks (VANETs) [1]. VANETs are a capable technology to enable Communication among vehicles on roads. They are a special method of mobile ad hoc networks (MANETs) that offer vehicle-to-vehicle communications. It is supposed that each vehicle is equipped with a wireless communication facility to provide ad hoc network connectivity. VANETs incline to run without an infrastructure, each and every vehicle in the network can send, receive messages to other vehicles in the network. Intelligent Transportation System (ITS) that will change our way to drive and help emergency services [2]. VANETs permit vehicles to easily communicate among them and also with fixed infrastructure. This will not only improve the whole road safety, but also raise new commercial prospects. Each vehicle is equipped with a short range communication device and controller nodes are located in the intersection by traffic lights [3]. Our proposal manages traffic information looking for to avoid accidents, although the information here is gathered from the vehicles themselves so no further infrastructure is needed.

The primary application of a VANET is to allow vehicles to send safety messages that contain various information like vehicle speed, turning direction of vehicle, traffic accident information etc. to other nearby vehicles [4]. It is denoted as vehicle-vehicle or V2V communications and it also send the information to RSU. It is denoted as vehicle-infrastructure or V2I communications. This information send on regular basis so that other vehicles may adjust their traveling routes and RSUs may inform the traffic control centre to adjust traffic lights for avoiding possible traffic congestion. The main benefits of VANETs are that they enhance road safety and vehicle security while protecting drivers' privacy from various attacks such as DoS, Sybil, Alteration etc. Security is one of the most critical issues related to VANETs since the information transmitted is distributed in an open access environment [5].

This way, vehicles can interchange real-time information, and drivers can be informed around road traffic conditions and extra travel-related information. The most challenging problem is potentially the high mobility and the frequent variations of the network topology. In VANETs, the network topology could vary when the vehicles change their velocities and/or lanes. These deviations depend on the drivers and road situations and are usually not scheduled in advance. Embedded wireless devices are the main components of growing cooperative active safety systems for vehicles [5]. These systems, which trust on communication between vehicles, bring warning messages to drivers and may even directly take control of the vehicle of such submissions, including communication and finding of vehicle information are tightly coupled with physical dynamics of vehicles and drivers performance.

The major challenge to overcome the inefficiency of the traditional intelligent transportation systems is in collecting the real-time traffic information [2]. One solution to this problem is the usage of vehicular ad hoc networks (VANETs) which can be provide an ITS system with better communication techniques in a cost effective way. It enables Vehicle-to-Vehicle (V2V) and vehicle-to-roadside-unit (V2R) communications [3] which enables the exchange of real-time traffic information between vehicles and between a vehicle and road side units (RSUs) [4]. This information can be used to identify real-time traffic congestion and thus it is possible to decide and alternate path for the vehicle.

Recent research on such cooperative vehicle safety (CVSS) systems has shown that significant performance development is likely by coupling the design of the components of the systems that are associated to vehicle dynamics with the cyber components that are responsible for tracking other cars and detecting threats. The types of likely actions and advices in vehicle security systems range from low-latency collision avoidance or warning systems to moderate-latency system that offer heads up information about likely dangers in the non-immediate path of the vehicle [6]. The main differences of these systems are the sources and means of information dissemination and acquisition. In active safety systems, vehicles are essential to be constantly aware of their neighborhood of few hundred meters and monitor probable emergency information. This task can be done by frequent real time communication between vehicles over dedicated short range communication (DSRC) channel. In adding to inter-vehicle communication[7]; roadside devices may also support vehicles in learning near their environment by delivering traffic signal or pedestrian related information at intersections.

Many algorithms are offered to identify an optimal path in answer to the real-time traffic information delivered by VANETs [5] [6]. But these algorithms can itself create congestions if not performed uncoordinatedly. One more inefficiency of these path planning algorithms is that most of them does not take driver's preference into consideration. In most cases the algorithms set its main objective as avoiding the congestion rather than finding an optimal path for individuals. Because of this, there might come an additional cost to those who are travelling because the path suggested might not be an optimal path.

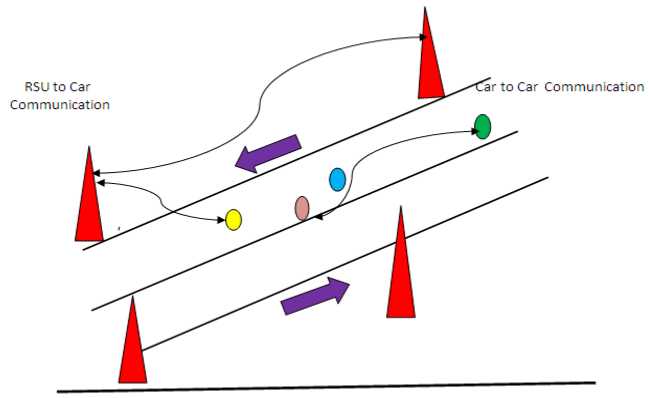

Fig .1 Structure of VANET

Therefore, algorithms should be designed to jointly consider the balance of the network traffic and the reduction of average vehicle travel cost [6]. To this end, propose a real-time global path planning algorithm which exploits VANET communication capabilities to avoid vehicles from congestion in an urban environment .Both the network spatial utilization and vehicle traffic cost are considered to optimally balance the overall network smoothness and the drivers preferences .Specifically, the contributions of this paper, which is given above in figure 1.

First, we propose a hybrid-VANET-enhanced ITS framework to simplify the application of real-time path planning. Secondly, we design a real-time path planning algorithm with by DSDV protocol to progress network spatial utilization and also to decrease average travel cost. Finally simulations validate the effectiveness and efficiency of the proposed path planning algorithm.

II. LITERATURE SURVEY

A number of works have been done on the area of ad hoc network security especially for identifying the real time path detection in vehicular ad hoc networks. This section mentions some of these works.

An accident or unexpected incident at the road and cause traffic congestion which often creates too much of problems for those who travel by road. People may fail to reach their destination on time, direct cost incurred by them (e.g. fuel wastage), indirect cost incurred by the driver (cost of not reaching the destination on time – is almost uncountable). This problem can be dealt or at least the cost can be reduced by route planning or path planning with congestion avoidance [5]. The traditional method which uses GPS, wireless internet or cellular networks is often inadequate to resolve this problem completely because of their incapability to notify a real time accident in a quick time [6]. Delays in transmitting this information are called as inefficient as not transmitting this information at all. One better technique to overcome most of the drawbacks of the traditional systems is by using a traffic management system with loop detectors for a continuous traffic measurement monitoring along arterials. There are certain drawbacks for cellular systems and loop detectors as well [7]-[8]. Cellular networks are highly expensive and as the amount of traffic data increases, other cellular networks my face congestion. For loop detectors also, deployment cost is usually very high. Another drawback is that in dense networks, performance of path planning is always less as the position measurement for short-distance transmissions becomes inaccurate.

VANETs are much more efficient than the traditional methods described above. VANETs enable real time communication when a sudden accident or incident occurs. V2V and V2R communications helps VANETs to achieve this with high accuracy [5]. The advantages of this communication when compared to the traditional techniques are that it is cheaper, quicker and more efficient. RSUs in VANETs are an important entity which improves the timeliness of data collection and distribution. This helps in performing a coordinated path planning for bunch of vehicles. In this method, to reduce the end-to-end transmission delays or buses are considered as super relays.

Miago Wang, Hao Liang et al [9] has investigates a special smart grid with enhanced communication capabilities, i.e., a VANET-enhanced smart grid. It exploits vehicular ad-hoc networks (VANETs) to support real time communications among road-side units (RSUs) and highly mobile EVs for collecting real-time vehicle mobility information or dispatching charging decisions. The real-time EV information can be exchanged among the on board units (OBUs) installed in vehicles, through multi-hop V2V relaying, based on dedicated-short-range-communication (DSRC) protocol , with a transmission range R. Besides, Global Position System (GPS) devices, which offer the service of shortest-path navigation, are also equipped in EVs and keep wired connection with the OBU.The globally optimal charging problem is formulated as a time-coupled MILP problem which is decoupled into a series of sub-MILPs through Lagrange duality. Each sub-MILP is further solved by the branch-and-cut based outer approximation algorithm.

S.Nagaraj, N. Nalini [10] had discussed about how the RSU will calculate the density of the vehicles on the road. If the density exceeds then broadcast the density message to the vehicles i.e. OBU, then vehicles check for the alternative path. Suppose when the density exceeds the maximum limit and if there is no alternate path found, then send the density information to the signal i.e. Base station (BS).The base station makes the decision and informs the vehicles i.e. the OBU.

The controlling of the vehicular traffic in road scenarios is the crucial problem. The main goal of VANETs is achieved by providing safety and comfort for passengers. Here they mainly discussed how the alternate path will be selected by the vehicles when congestion occurs. The proposed system reduces the congestion of vehicles thereby improving the effective travelling time. Hence, it can be concluded that the alternate path selection based on the density value holds a good potential for improving the traffic conditions at the intersection.

R.VijayaKarthika, P.R.Gomathi [11] says, Vehicular ad hoc networks (VANETs) enable vehicles to communicate with each other but require efficient and robust routing protocols for their success. In this proposed system, we exploit the infrastructure of Road Side units (RSUs) to efficiently and reliably route packets in VANETs. This system operates by using vehicles to carry and forward messages from a source vehicle to carry and forward messages from a source vehicle to a nearby RSU and, if needed, route these messages through the RSU network and, finally send them from an RSU to the destination vehicle. In that proposed system is mostly critical for users who are far apart and want to communicate using their vehicles' on board units. It accounts for both access patterns in our placement strategy and formulate this placement problem via an integer linear programming model such that the aggregate throughput in the network can be maximized.

Jing Zhao, Guohong Cao [12] says, Multi-hop data delivery through vehicular ad hoc networks is complicated by the fact that vehicular networks are highly mobile and frequently disconnected. To address this issue, we adopt the idea of carry and forward, where a moving vehicle carries the packet until a new vehicle moves into its vicinity and forwards the packet. Different from existing carry and forward solutions, we make use of the predicable vehicle mobility, which is limited by the traffic pattern and the road layout. Based on the existing traffic pattern, a vehicle can find the next road to forward the packet to reduce the delay. We propose several vehicle-assisted data delivery (VADD) protocols to forward the packet to the best road with the lowest data delivery delay.

Tom Schouwenaars, Bart De Moor [13] says, A new approach to fuel-optimal path planning of multiple vehicles using a combination of linear and integer programming. The basic problem formulation is to have the vehicles move from an initial dynamic state to a final state without colliding with each other, while at the same time avoiding other stationary and moving obstacles. It is shown that this problem can be rewritten as a linear program with mixed integer/linear constraints that account for the collision avoidance. A key benefit of this approach is that the path optimization can be readily solved using the CPLEX optimization software with an AMPL/Mat lab interface.

Zhi Li, Yanmin Zhu, et.al [14] says, Traffic sensing is crucial to a number of tasks such as traffic management and city road network engineering. We build a traffic sensing system with probe vehicles for metropolitan scale traffic sensing. Each probe vehicle senses its instant speed and position periodically and sensory data of probe vehicles can be aggregated for traffic sensing. However, there is a critical issue that the sensory data contain spatiotemporal vacancies with no reports. This is a result of the naturally uneven distribution of probe vehicles in both spatial and temporal dimensions since they move at their own wills.

A lot of studies are still being conducted based on VANET, although VANETs consider multi-vehicle path planning; few of its disadvantages are that it does not consider average total cost or the driver’s preference. To overcome these challenges, we propose a global path planning algorithm to avoid traffic congestion in urban area. The new system ensures full utilization of network resources and the average total cost of the vehicles are considerably reduced.

III. EXISTING SYSTEM

In Real-time monitoring and control on signalized arterials, a traffic management system with loop detectors for continuous traffic measurement and monitoring along arterials is introduced. However, inevitable drawbacks cast a shadow on the application of cellular systems and loop detectors. For cellular systems, as they are not dedicated for traffic data collection, the collection services can be highly costly, and the high volume of traffic data may also cause congestion for other cellular services. For the loop detectors, the deployment expense can also be very high. Moreover, the inaccuracy of position measurement becomes a problem for short-distance transmissions particularly in dense networks, which will degrade the performance [15].

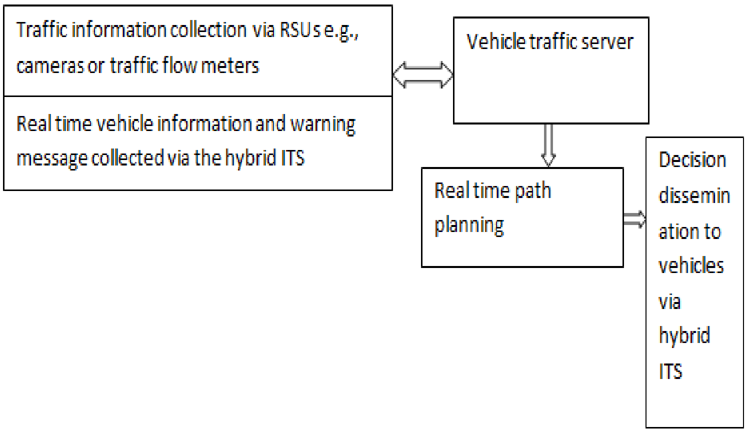

Fig .2 Existing System Architecture

The figure 2 is the architecture of Existing System Traffic Information collection via RSUs e.g. (cameras or flow meters) and Real time vehicle information and warning message collected via hybrid ITS have vehicle traffic server to give real time path for vehicle via hybrid ITS.

Issues in Existing System

- Cannot make quick response to an emergency or congestion due to a sudden accident
- Not dedicated for traffic data collection
- The collection services can be highly costly

IV. PROPOSED SYSTEM

In the proposed system, a globally optimal path-planning algorithm is proposed for vehicles to avoid traffic congestion (including those caused by accidents) in a suburban scenario. With the real-time traffic information collection and decision delivery enabled by a hybrid-VANET-enhanced network, the road network resources are fully utilized, and the average travel cost of vehicles is significantly reduced. In addition, the impacts of VANETs on the path-planning algorithm are further discussed. First, to facilitate the application of real-time path planning, we propose a hybrid-VANET-enhanced ITS framework, exploiting both the VANETs and the public transportation system. Second, we design a real-time global path-planning algorithm with using DSDV protocol to not only improve network spatial utilization but also reduce average vehicle travel cost per trip. A low complexity algorithm is developed based on Lyapunov optimization to make real-time path planning decisions.

DSDV is a proactive protocol that maintains route to all the destinations before requirement of the route. Each node maintains a routing table which contains next hop, cost metric towards each destination and a sequence number that is created by the destination itself. This table is exchanged by each node to update route information. A node transmits routing table periodically or when significant new information is available about some route. Whenever a node wants to send packet, it uses the routing table stored locally. For each destination, a node knows which of its neighbour leads to the shortest path to the destination. DSDV is an efficient protocol for route discovery process. Hence, latency for route discovery is very low. DSDV also guarantees loop-free paths.

A. ARCHITECTURE OF HYBRID-VANET ENHANCED TRANSPORTATION SYSTEM

The architecture of the considered hybrid-VANET enhanced transportation system, consisting of vehicles, RSUs, cellular base stations (BSs) and a vehicle-traffic server [1]. Figure 2 shows the architecture of the VANET system.

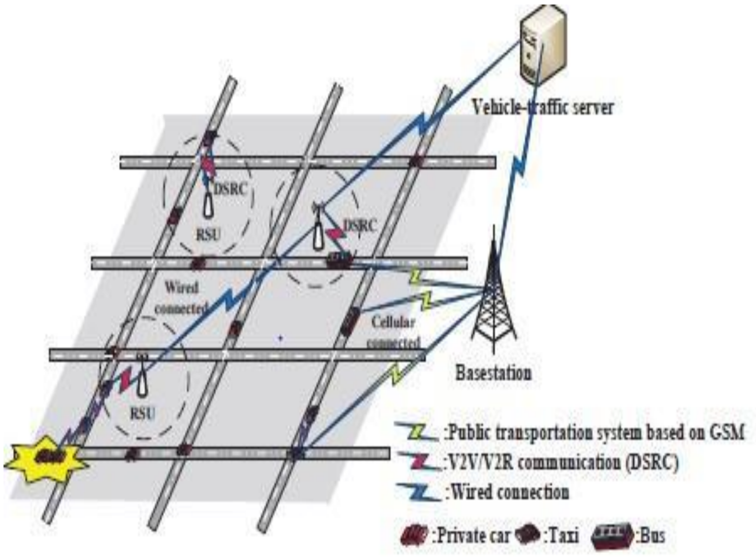

Fig .3 Hybrid VANET-enhanced network architecture

B. TYPES OF COMMUNICATIONS

Vehicles are equipped with on-board units (OBUs) that enable multi-hop V2V communications. That will helps to delivering periodic vehicle information (like location, density etc.). When vehicles generate alert about accident related congestion, this information will pass not only among vehicles but also with the nearest RSU through V2R communication. The taxis and buses will give priority for directly upload the warning message to nearest cellular BS and the BS will pass this information to vehicle-traffic server.

C. ROAD SIDE UNITS (RSUS)

RSUs are deployed along the roads for obtaining vehicle traffic statistical information. One RSU can communicate with nearby RSU through wireline communication. If RSUs are placed at intersections then traffic information are detected by cameras or flow meter connected to RSUs directly. Else traffic flow can be detected by nearest RSUs based on the collected information from the VANETs. An RSU can share its own collected information with other RSUs and vehicle-traffic server. When an accident occurs, the vehicle-traffic server using all the collected information for finding global optimal path. Figure 3 shows the path planning structure of enhanced ITS.

- **Traffic Flow Model**

Each vehicle is expected to follow a planned path from its starting point towards its destination. In the proposed system the driver can select his preferred path from a list of paths that connect source and destination. The driver will follow the same path until he receives any accident/congestion notification. When an accident/congestion occurs the vehicle-traffic server will take the responsibility for finding an alternate path by running path planning algorithm.

- **Path Planning algorithm Design**

For designing path planning algorithm comprises of main functions such GET ROUTE and SEND ALERT. GET ROUTE function find out all path from source to destination once the driver sets the source and destination. From this list driver can select a route for his journey. So it will keep driver's preferences. When any of the vehicles in the road come across with an accident/ incident/congestion, an alert will be sent to RSUs by using SEND ALERT.

Because of rapid growth of the car ownership, traffic congestion problems have become a very crucial problem, causing great inconvenience in people's daily life and to their work and also bring environmental pollution, waste of energy, and traffic jams. This greatly affects the improvement of people's living standard as well as the social and economic development. Path planning for the urban traffic can solve the problems of road congestion, travel inconvenience to a certain extent.

4.1 ADVANTAGE OF PROPOSED SYSTEM

- Average vehicle travel cost
- Reduce the delay
- Make a quick response
- Minimum energy consumption

4.2 SYSTEM MODULES

The proposed system contains three modules.

1. Creation of nodes
2. Communication from RSU to nodes
3. Best path selection

4.2.1 CREATION OF NODES

An undirected graph G (V, E) where the set of vertices V represent the mobile nodes in the network and E represents set of edges in the graph which represents the physical or logical links between the mobile nodes. Sensor nodes are placed at a same level. Two nodes that can communicate directly with each other are connected by an edge in the graph shows in fig 4.

Let N denote a network of m mobile nodes, $N_1, N_2, \dots\dots, N_m$and let D denote a collection of n data items $D_1, D_2, \dots\dots, D_n$ distributed in the network. For each pair of mobile nodes N_i and N_j, let t_{ij} denote the delay of transmitting a data item of unit-size between these two nodes. The nodes are created from 0 to 34 in the specified location and the source and destination nodes are marked are shown in figure 4. To provide hello signal signal with respective to acknowledgment and design infrastructure for deploying vehicles and RSU units. To create the node for communication in simulation, where starting node colour will be black. To communicate with each node first we need to send the hello message for all nodes. Then the node colour is changes to blue when the information is successfully send to all the node. Then the node to be adding green colour.

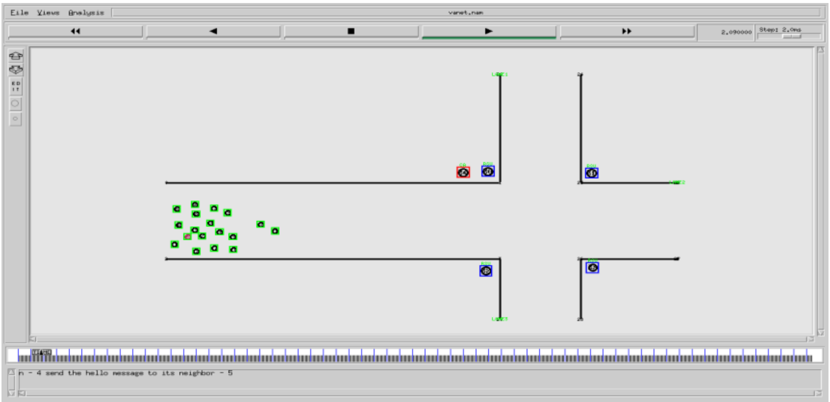

Fig .4 Creation of Nodes

4.2.2 COMMUNICATION FROM RSU TO NODES

Each vehicle inter-changes hello messages (HM) with its neighbours and this way it knows the amount of vehicles on its transmission range. Then, the vehicle sends a hello messages with the number of neighbours to the nearest RSU. For example, C1 counts with three neighbours (C2, C3, and C4). Notice that although C7 is inside its range they cannot establish any communication because of the buildings that represent obstacles. The car C5 does not see any neighbour around so it sends a SM to the nearest RSU with a zero on it. The messages sent by each vehicle to an RSU include the type of message (a new message called Statistic Message, SM), the identification of the vehicle sending the message, the current value of the number of neighbours in bits coverage range at that moment, the moment in which the message was sent and the IP address of the RSU destination. This message is sent by the vehicles each 2 sec. It is represented in the fig .5 This way, a car (v=40 km/h) sends 5 messages while it crosses a 100 m. street. The RSU will update the traffic statistics upon the reception of each new message.

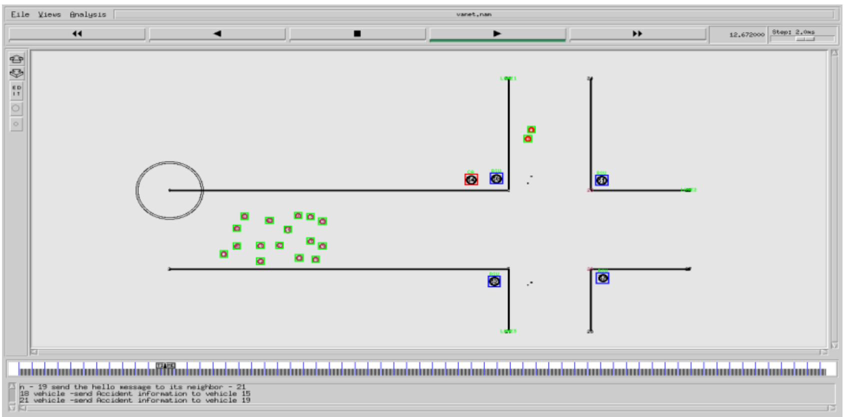

Fig.5 Hello messages to RSU units

4.2.3 BEST PATH SELECTION

Once the source and the destination is chosen list of available paths would be shown. Desired path can be chosen from this list for each vehicle. While moving along the road, system simulates the alert sent by a vehicle to RSU when it comes across any accident/congestion. System also simulates RSUs redirecting the other vehicle through alternate paths thus avoiding congestion.

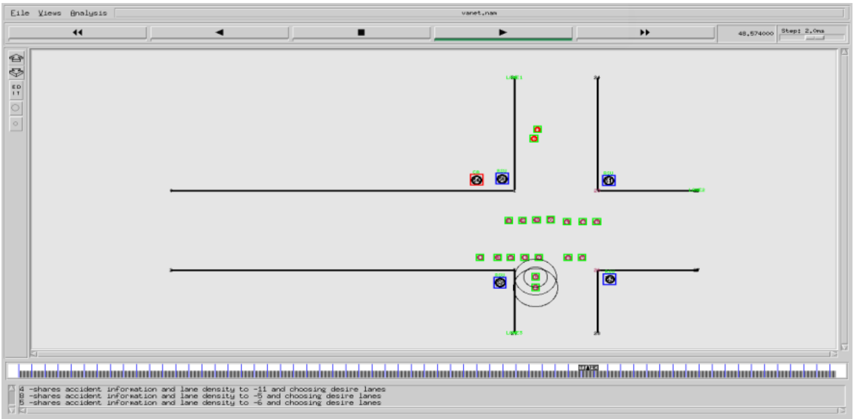

Fig .6 Best Path Selections

V. PERFORMANCE ANALYSIS

The NS2 tool is used to study the performance of our path planning based on hybrid VANET enhanced transportation system. We employ the IEEE 802.11 [17] MAC with a channel data rate of 11 Mb/s. We comparative the normal existing architecture with proposed architecture in order to prove that proposed simulation results are better in energy consumption as well as provide best path for source to destination.

5.1 PERFORMANCE METRICS

The metrics used to evaluate performance of proposed approach:

a) Throughput: It is defined as the total number of packets received by the destination node and total number of packets originated by source node with respectively time period.

b) Delay: This is defined as the average time taken for a packet to be transmitted from the source to the destination.

c) Average energy consumption: It is defined as the average energy required to send the packet and to receive the packet.

d) Packet Delivery Ratio (PDR): It is defined as the total number of packets received by the destination node and total number of packets originated by source node

A graph is plotted between time and packet size to study the delay in the proposed system and is shown in Fig. 7, Average energy consumption. Fig. 8, Throughput, Fig. 9, packet delivery ratio and in fig .10 , packet delay The result shows that path planning based on hybrid VANET performances is better than enhanced transportation system for the providing the best real path for source to destination.

Parameter	Value
Application Traffic	10 CBR
Transmission rate	4 packets/s
Packet Size	512 bytes
Channel data rate	11 Mbps
Area	700m*700m
Simulation time	800

Table I. Stimulation parameters

5.2 SIMULATION RESULTS

We used the performance metrics to validate the proposed algorithm with results obtained in this papers are shown in Figure 7-10.

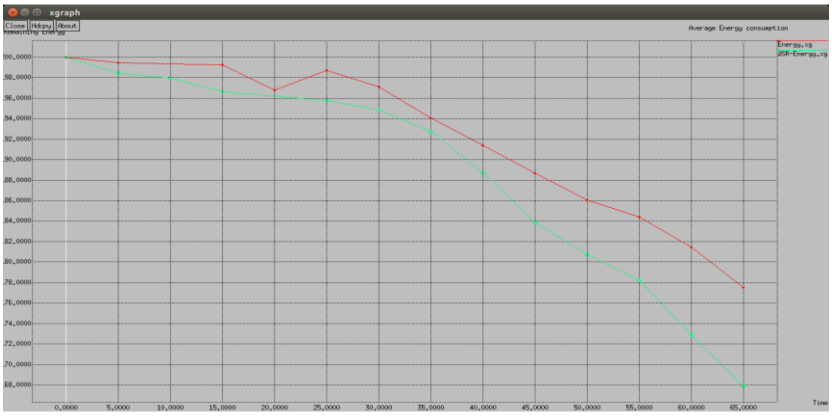

Fig .7 Average energy Consumption

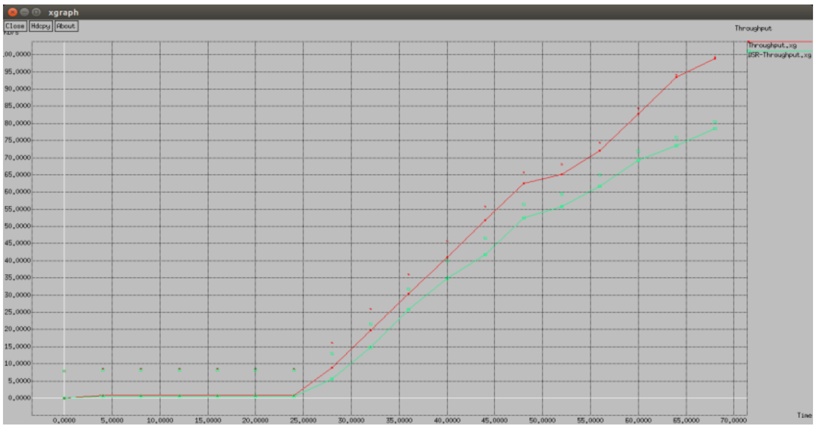

Fig .8 Throughput

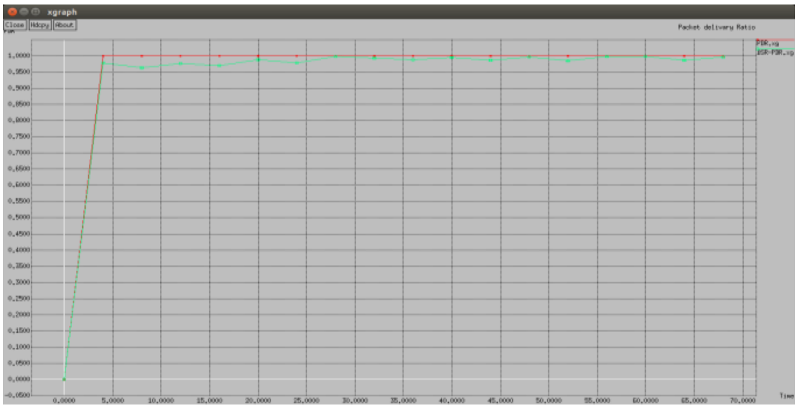

Fig .9 Packet delivery ratio

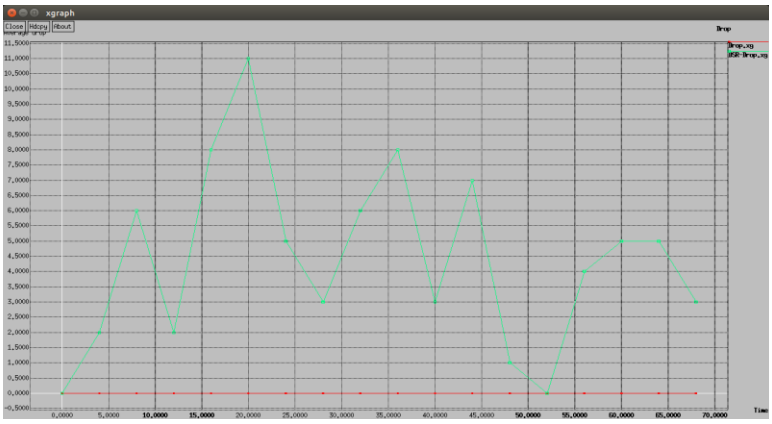

Fig .10 Packet Delay

Thus the proposed scheme is very significant and effective when comparing with existing methods.

VI. CONCLUSION

In this paper, we propose hybrid-VANET-enhanced real-time path planning for vehicles to avoid congestion in an ITS by using DSDV protocol. The existing system contain a hybrid-VANET enhanced ITS framework with functionalities of real time traffic information collection, including both V2V and V2R communications in VANETs and cellular communications in public transportation system. Then, a globally optimal real-time path planning algorithm is designed to improve overall spatial utilization and reduce average vehicle travel cost. In the existing system provide the new path when there is any congestion in their route .The new route assigning vehicles according to emergency of vehicle(like Ambulance) .In addition the proposed system provide route based on vehicle type(i.e. four wheeler, two wheeler and so on). In future work, we are planning to provide the secure communication protocol for the V2I/I2V in VANET.

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