Route Discovery in VANETs Using Routing Protocols with Reliable and Connective Metrics

Sachin Prabhu[1], Smitha Shekar B[2], Harish .G[3]

[1]M. Tech Student, Department of CSE, Dr. Ambedkar Institute of Technology, Bangalore, India

[2, 3]Associate Professor, Department of CSE, Dr. Ambedkar Institute of Technology, Bangalore, India

Abstract: ***Vehicular adhoc network is an emerging technology which gains lots of popularity in recent time. Data transmission in vehicular communication with preventing delay and error is a challenging problem due to dynamic topology of the ad hoc network. Here our approach is to make a reliable path in V2V(Vehicle-to-Vehicle) communication which transmit the data in less time without delay using reliability and connectivity matrix***

Keywords: V2V, Matrix, Reliability

1. Introduction

In recent time Vehicular Ad hoc Network(VANET) has gained lots of popularity and interest from the industrial sector [1-2]. A vast development has been done in this area as emergence of wireless network technologies [3-4]. Communication range of VANET across vehicle and road side unit (RSU) is 1000m. While considered relative speed is high as 200km/h [5].

VANET application is divided into two category one is safety application and other is non-safety related application. Safety application considers the transport efficiency, traffic management and other information related accident, collision avoidance, accident warning [6]. Formation of traffic management system make a great intelligence in transportation system.

Traffic management applications form part of a greater Intelligent Transportation System (ITS) and include toll collection, intersection management, cooperative adaptive cruise control and detour or delay warning.

The applications for VANETs vary significantly in their requirements. Safety messages require fast and guaranteed access and a short transmission delay, while messages are relatively short. The infotainment services could require a heavier data load, with less severe timing requirements. Owing to the wide variety of expected VANET applications, VANET networks need to support a broad range of requirements. For safety applications a high level of quality of service (QoS) needs to be ensured, while for the user infotainment services this may not be a stringent requirement.

The movement of nodes in a VANET is relatively predictable because it is restricted to the roads on which the vehicles travel. This has several advantages and disadvantages for applications and routing protocols. The predictability of the position of a vehicle allows an improvement in link selection, but the linear topology of VANETs reduces the possible path redundancy. The bandwidth issue also is aggravated due to intersections, traffic jams, and the presence of buildings beside the roads, especially in an urban environment. VANETs also have the potential to grow to a very large scale. For example, consider a section of a road with three lanes. In normal conditions, with an inter-vehicle distance of 70 m, we have around 70 vehicles within a radius of 1 km around a given car. During a traffic jam, with an inter-vehicle distance of 5 m, there can be more than 1000 vehicles within the same region.

VANETs comprise two main modes of communication, vehicle to infrastructure (V2I) and vehicle to vehicle (V2V).The former is for communication between the On-Board Units (OBUs) on vehicles and an infrastructure, through RSUs. The latter is between vehicles that connect through OBUs. OBUs are network nodes mounted on vehicles and therefore inherently mobile and wireless. RSUs are stationary network nodes and are usually mounted in an elevated position on existing transportation infrastructure, such as traffic lights, street lights and road signs [7]. RSUs provide a wireless link to vehicles and a wireless or wired link to the infrastructure. In this paper the focus is primarily on V2V, but relevant aspects of V2I are also covered where necessary. In Figure 1, V2V communication is represented.

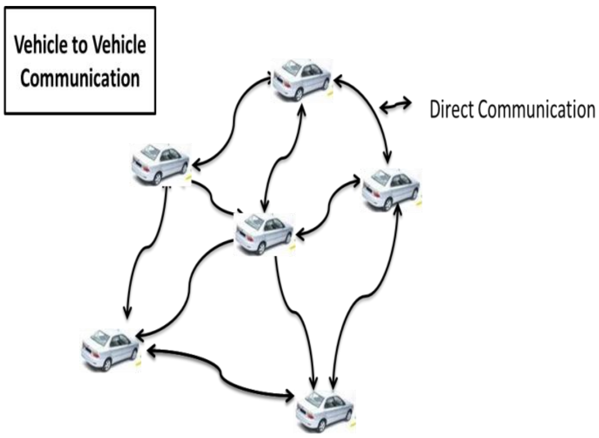

Figure 1: V2V Communication

Vehicles communicate either by one hop or multihop communication. In one hop communication, vehicle directly communicates with target node, whereas in multi-hop communication source node does not communicate directly, it will use relay node. Moreover, the multi-hop communication nature in VANETs has the need for a robust routing protocol, where more than one route exists between the source and target vehicle. Concerning the routing protocol, the selection of the best path among multi-paths depends on the routing metric [4].The path that obtains the best metric will be selected, and hence designing a routing metrics for VANETs technology is becoming an important issue, and has gained the focus of researches in this area. VANETs technology can be applied for an extensive variety of safety and comfort applications like Intersection lane changing, Collision warning, Road hazard notification, Overtaking vehicle warning, Traffic vigilance, Head on /Read end collision warning, Automatic fee payment, position based services such as searching the nearest restaurant or hotel, nearby fuel station and infotainment applications like getting access to the Internet. Continuous connectivity between the nodes, routing and security of data are major concern in VANETs because of dynamic topology of network, and it makes routing of packet from source to destination vehicle more challenging. However, the periodic updating of routing information increases the network overhead.

2. Related Work

In [8], a protocol is introduced known as Multipath Route Restoration Protocol (MRRP) wherein the case of link failure due to congestion is mainly not only focused in the change of route, but also on the route restoration of the link failure path from source to destination. By using Network Simulator2 (NS-2) in an urban scenario the proposed protocol is implemented on a lattice topology. To an existing protocols the result which is given by the simulation is been compared, in our proposed work the throughput and average end-to-end delay is much better.

However, to reduce the number of collisions and/or reduce the complexity an intuitive algorithm known as SNR-Guaranteed Optimal path selection algorithm (SNRG-Opt), Range-Aware Broadcasting (RAB), Low-complexity SNR-guaranteed path selection algorithm (Low-SNRG), the Collisions Minimized Optimal path selection algorithm (CM-Opt), and distributed algorithms have been proposed in [9].

For the process of organizing a Cluster Head Election (CHE) and cluster structure which is mainly suitable for VANETs a novel algorithm has been proposed in [10]. Additionally, robust clustering-based routing protocol, wherein a high communication efficiency can be achieved has been represented and also it is appropriate for the deserts which ensures that an information delivery is reliable and on each of the vehicle optimal exploitation of the equipment.

In determining the quality of the communication system in VANETs, Vehicles movement direction is quite important and has a great significance in restricting the routing protocols' capabilities and performance. Thus, many researchers have given considerable attention to the vehicle movement trends.

The effect of the driving behaviors and vehicle classification is considered by Zhang *et al.* [11], in this context and also in the movement direction and consequently incorporated these effects into the route-finding process. The vehicles are classified into several categories and then examined the effect of the vehicle movement trends to aid in making a routing decision by the energy-efficient routing protocol which existed in the proposed protocol. Using the current directions and the next directions, it predicts the movement direction only after going through the road intersections. In terms of energy consumption in urban scenarios it demonstrated reasonable results, but it greatly relies on the road intersection while performing the routing process.

Wang *et al.* to reflect the real-world vehicle movement while studying the performance of packet-routing protocols, proposed a vehicular mobility model in small-scale and large-scale VANETs. Furthermore, according to the environment, quantity and speed of the vehicles, the Connection-Based Restricted Forwarding (CBRF) and Connection-Less Geographic Forwarding (CLGF) algorithms were presented. To determine the shortest communication distance *r*, these algorithms were employed; subsequently, to determine the shortest route *r* was used [12].

Zhang *et al.* [13] to predict both up-link and down-link connectivity probabilities, proposed an analytical model along with deriving the urban environment route by means of roadside auxiliary facilities. By addressing both the broadcast storm and connected network problems in urban VANETs, others proposed a broadcasting routing protocol where both direct and indirect packet routing protocols were utilized [14].

3. Proposed Approach

There are two approaches which we considered for our reliable VANET communication. One is reliability matrix and other is connectivity matrix. This approach is basically helpful in finding the reliable path with less overhead. A best suitable path selected for the communication which does not get disconnected and overhead of network is also less.

A. Reliability Matrix

For evaluation of link quality or reliability between the nodes a matrix is created known as reliability matrix. Speed, distance, direction and connectivity matrix are the parameter which is represented in equation (1) and required for creating a reliable path. Required parameters are discovered from router discovery mechanism. Source node initiates the beacon 'HELLO' message to next node and generates a Sorted Route Table (SRT). As VANET devices are mobile in nature, maintaining the dynamic topology become a challenging job.

Let's assume source vehicle is represented as V_S and destination vehicle represented as V_D. Connectivity matrix represented as β_n and it is used for selection of next node based on threshold value. Node selected for next hop is based on threshold value above 0.5. Less threshold value nodes are not eligible for the next forwarded node. This approach is beneficial for reducing the bandwidth consumption and routing overhead. Reliability matrix represented as:

$$RelMex(V_S, V_D) = \{\beta_n\, v, d, r\}$$

Where v is the vehicle velocity, r is the vehicle radio range of communication and d is the vehicle density. In our approach three conditions are assumed for the vehicle movement and matrix value assigned according to the movement between 0 and 1. First is vehicle moving in the same direction and also present in the direct communication range in that case matrix value assigned 1. While if vehicle are moving in no range of communication in that case matrix value is 0. If vehicle are moving toward each other in range of communication then matrix value assigned as 0.5. If vehicle are moving in opposite direction 0.2 is assigned as matrix value.

B. Connectivity Matrix

Selection of next forwarding node creates extra network overhead. Connectivity matrix reduces the overhead during node selection. This approach enhanced the probability of success to the next node selection or selection of the target node. Behavior node is helped in determining the node probability. It also helped in initializing the request of route node.

$$\beta_n = (Successful\ attempt)/(no.of\ attempt)$$

In initial attempt connectivity matrix value is given 1 for each outgoing link and a 0.5 is fixed as threshold value. Connectivity matrix gets updated after each attempt. Node having less 0.5 threshold value get rejected due to the overhead issue. Another node is selected as a forward node for reaching the destination and reduce the overhead and delay.

Reliable VANET routing approach basically consists of three algorithms i.e. discovery of route, route reply and selection of next node. In route discovery phase RouteREQ and RouteREP functions are designed for selecting the optimal route. Next neighbor is selected based on the next neighbor history detail and packet details are sent. Based on threshold value node selection is done. This approach enhanced the network throughput and enhanced system channel utilization in data transmission.

C. Reliable Path Approach

In this approach, source node sends a RouteREQ packet to the destination node. Sender waits for the route reply message till the defined threshold time δ value. Next node for packet forwarding is not found within given threshold time then it stores the details and forwards it to the other node. If RouteREQ is received by the intermediate hop node then it generates the reliability matrix parameters and generates the path and at the same time routing table is also updated by the intermediate node. RouteREP message is sent back to the source node. Further data packets are transmitted through the route created based on the reliability matrix. As source node receives RouteREP from several node it creates a table for all route based on sorted distance between sender and receiver. If there is any problem with selected route like, link failure route broken due to speed of vehicle in that case it selects alternate path from created route table.

D. Route Reply

As RouteREQ data packet reaches the destination it initiates the RouteREP message and sends it back to the source node. From this approach it initiates the RouteREP message and transmits it to the source node. In this process it also contains all the possible paths when it sends back the details to the source node. And also reliability matrix get updated according to that.

E. Next node Selection

At the time of route discovery process connectivity matrix is used for selection of the next node which helps in reducing the network overhead and it also saves the bandwidth usage. Node will only be eligible to explore if it has greater threshold value or more than 0.5.

4. Result Analysis

Table 1: Simulation Parameter

Value	Parameter
Dynamic	Number of vehicles
1500m*1500m	Area
352288	Video Resolution
1124362 bytes	File Size
19sec	Video play time
V2V	Scenario
Proposed Approach	Computing Algorithm

In the V2V case, a source node and a destination node start communicating through intermediate node. Data packet transmitted from source to destination by reliable shortest distance calculation. If there is more load on a node in that case route may change for the transmission or in case of vehicle is moved in V2V case.

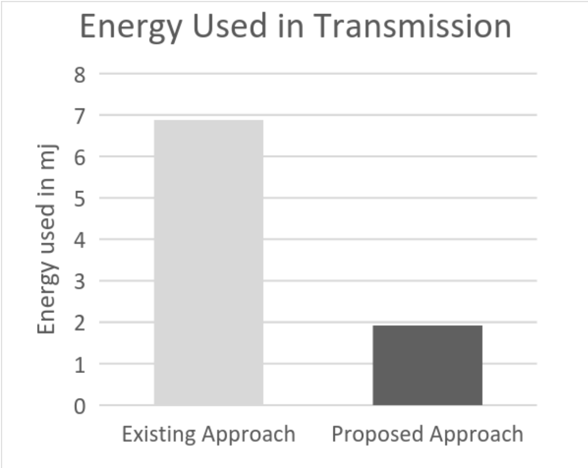

Figure 2: Energy Used in transmission

Energy utilized in transmission of video packet from source to destination for both the approaches is shown in above Figure 2 which shows that our proposed approach utilized less energy when compare with existing approach for the number of vehicle 25. Proposed reliable path selection approach has utilized 38% less energy as compare with existing. In below figure 3 packet drop is considered which is very important for the quality of video transmission and real time transmission, if packet is lost video transmission is not up to the mark. Here packet drop is considered for 25,20 and 15 vehicles which shows that our proposed EMSVS system performs better and less packet drop is observed. In all three scenarios packet drop rate is almost 50 % less for the proposed system. So quality of video is improved. In below figure 4 time delay observed for both the existing and proposed system, proposed EMSVS performs better because delay is observed less as compared with the existing system.

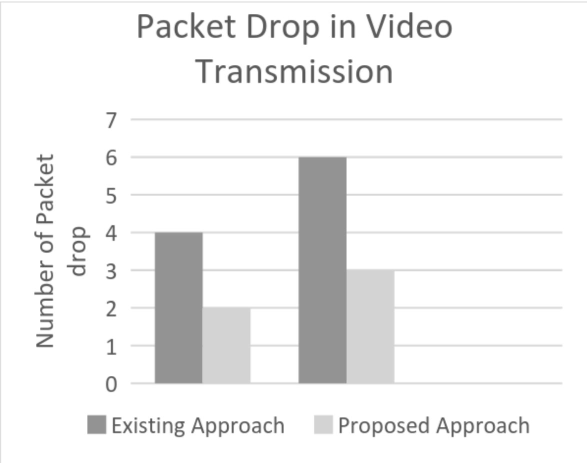

Figure 3: packet drop for the both existing and proposed Approach

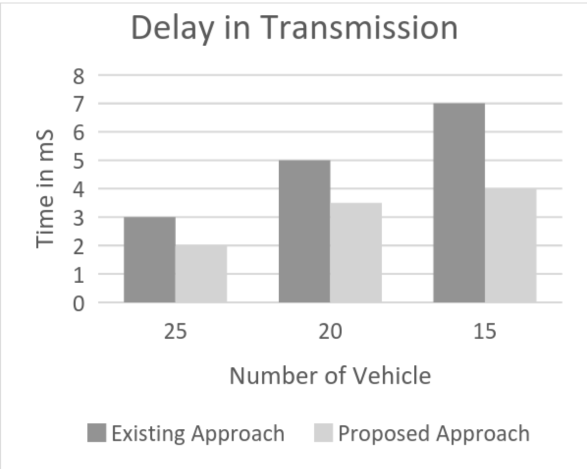

Figure 4: Delay in video transmission

5. Conclusion

This paper is considering the implementation of reliability matrix and connectivity matrix as a routing metrics for reliable path selection protocol. The advantage of the proposed method is it provides reliable path with less overhead. This is done by choosing the less overhead node. The reliable route can be calculated by considering the design parameters like node overhead, vehicles direction, speed and distance. The best path is selected to forward the packet between source and destination node by using the SRT table. This also increases the transmission throughput in the VANETs. During the design process some assumption has been made regarding distance, speed, direction and threshold value. Here we analyzed our system performance by transmission of a video in terms of energy consumption and delay. In future, delay constraint can be estimated in VANETs analytically by considering the above-discussed parameter and routing protocols and compare with other routing protocol.

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