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# Early Alert Messaging Using Relative Positioning for Car Accident in Vehicular Ad-hoc Network

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**ABSTRACT**

In a vehicular Hoc Network (VANET), reaching a potentially dangerous zone on road, wireless Collision Avoidance(CA) system issues warnings to drivers. Global positioning system can be used to get the vehicle position and which can be shared with other vehicles in the network. In case of emergency not all the vehicle get affected so broadcasting of alert packet is not feasible rather it has to be multicast. Calculating the list of relative vehicles position is depending on the travelling direction, bearing angle and the distance. Recent studies have shown that sparse vehicle traffic leads to network fragmentation which poses crucial research challenge for safety application. Hence in this paper we propose a system which will find out the relative position between multiple vehicles by using Great Circle Algorithm. The improvement in VANET connectivity is made by road side unit which will manage all the vehicle information and detect the failure vehicle and calculate the detail of the vehicles that get affected by the failure vehicle and multicast alert packet to identified vehicles. This will avoid the broadcasting problem

**Keywords -** Vehicular ad-hoc network (VANET), Road side unit(RSU),Global Positioning System(GPS), Relative positioning, Safety application, Network connectivity, Multicasting

## I. INTRODUCTION

Vehicular Ad Hoc Network (VANET) is a technology that create a mobile network in a network by making use of moving vehicles as node. By turning every mobile vehicle into node or a wireless router VANET create a network with a wide range and allow moving vehicles to connect with each other forming a network. Vehicle communicate with each other or road side infrastructure in VANET. The most successful commercial application of mobile ad-hoc network is VANET. The vehicles which are in the immediate vicinity of other vehicle must know about the current moving status of the other vehicle and have information of its own kinematic status. Also must know the potential for hazardous condition in stretch of road that lies ahead upto 1 kilometer. Many interesting application is provided by VANET but the original purpose of VANET is provide transportation efficiency and safety oriented application as it reduce fatalities and economic losses caused by traffic accident. The goal of VANET is to provide road safety measures where information about vehicle current speed, location co-ordinates are exchanged with or without the deployment of road side infrastructure. Different VANET application have different region of interest (RoI). For safety application RoI is medium size effective application range that can be upto 1 to few kilometers. Congestion control applications requires a medium or large effective range this is important for vehicle drivers to know the congestion which is helpful for making decision and trip plan. Leading reason of accidents is behavior of driver. Expected number of car crashes as a function of driver reaction time. Safety application provides to anticipate about road accident and hazardous condition. Data exchange in VANET is a challenging task as the topology is highly changing and constantly moving. The nodes in VANET are highly dynamic and as a result network is frequently fragmented. When the emergency event occur i.e car accident or emergency breaking early alert message is given to the drivers which are behind it. The vehicle drivers who receive this message have enough time to react to the emergency situation because the wireless propagation delay is significantly smaller than the cumulative driver reaction. Vehicles which receive this early alert message have plenty of time to react to the situation and number of vehicle collision can be potentially reduce. In vehicle safety application vehicle disseminate traffic related information to all reachable nodes based on broadcast transmission. But in case of emergency not all the vehicles get affected in the network so broadcasting of alert packet is not feasible rather it should be multicast. Defining the list of node to be considered for multicast is challenging task as every vehicle cannot hold the location information of the entire Vehicle in the network. Calculating the list of relative vehicle position is depending on the travelling direction, bearing angle and the distance. Global positioning system can be used to get the vehicle position and which can be shared with other nodes in the network. The central requirement for VANET application like navigation, intelligent transportation, location based service (LBSs) and collision avoidance, is positioning information. For many applications, including collision avoidance and LBSs, Relative positioning is effective and central requirement for absolute or relative positioning. Global Navigation Satellite Systems (GNSSs) can be used the required level of accuracy does not meet for many applications. In a vehicular ad hoc network (VANET) performance of absolute or relative positioning can be improve by using Cooperative positioning (CP) techniques. Here data from different sources are fused to get the result. When vehicles are connected to VANET, the drivers can immediately receive emergency messages. In such cases, drivers have more time to react to hazards. It is essential to know vehicles located in the zone are well connected to VANET . But in contrast recent studies has shown that sparse vehicle traffic on highway during late night hours might lead to network fragmentation problem in VANET. Developing a reliable efficient routing protocol that can support safety applications in highly diverse VANET topologies is challenged by this disconnected network problem. The connectivity of VANET can be enhanced by deploying Road side Unit with a message advertising model which manage all vehicle information, find out the relative positioning between the two vehicles by using great circle algorithm and detect the emergency situation calculate the detail of the vehicles get affected by the failure vehicle using the Geo positioning and multicasting the safety alert message to the dedicated vehicle in enhanced VANET. The objective of this paper is to enhance VANET connectivity by deploying a Road side Unit. Find out relative positioning between two vehicles. Propose RSU-advertising model to improve the routing and disconnected problem in diverse network topologies by deploying RSUs. We aim at reducing the amount of broadcast traffic incurred for an event-based safety message delivery in a highway scenario by using dedicated multicasting. This is because the information that is contained in an event-based safety message is more time critical and has a longer lifetime than in a periodic safety message. However the periodic message delivery can also benefit from RSUs deployment, because RSU nodes enhance VANET connectivity. The routing performance of the safety application can be improved in these enhanced VANET connectivity.

## II. RELATED WORK

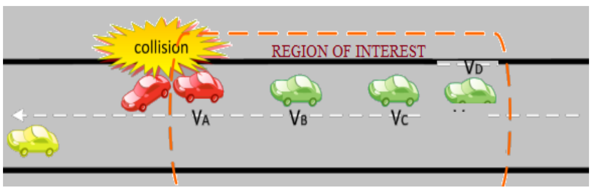
Over the last couple of years, there has been dramatically increase in the interest in VANETs research. The Vehicle Safety Communications (VSC) project brings Mercedes-Benz, Ford, Nissan, GM, Toyota, BMW and VW together to work cooperatively. Vehicle safety applications enabled by DSRC communication is identified by VSC project. The applications for vehicular safety application have widely been discussed by national highway traffic safety administration [NHTSA] [1][2]. One of the most important applications of vehicularnetworks is vehicle-to-vehicle communications for Cooperative Vehicle Safety (CVS) [3]. In these systems vehicles frequently broadcast their position and safety information to allow hazard prediction. The vehicle safety applications have been developed [4][5]. There are number of work proposed to study DSRC technology that improve safety on road in [6] an over view of vehicle co-operative collision avoidance application based on emerging DSRC device and improve the highway traffic safety along with demonstrating the need for data prioritization for safety critical application. Xue *et al.* proposed a communication protocol for collision avoidance and computed the MAC transmission delay [7]. In [8] Xu *et al.* showed that chain collisions can be severity lessened by reducing the delay between the time of an emergency event and the time at which the vehicles behind are informed about it. Safety applications rely on broadcasting. There is some previous research that addresses the broadcast messaging in VANETs. Several congestion avoidance mechanisms for broadcasting messages, especially for the periodic beacon messages, have also been proposed before. In [9] and [10], Tonguz *et al.* proposed a distributed vehicular broadcasting protocol (DV-CAST), based on a vehicle's connectivity the local routing decisions are made. [11] Proposed a distributed transmit power control method based on a strict fairness criterion to control the load of periodic messages on the channel and to avoid saturated channel conditions. Farnoud *et al.* In [12] used a positive orthogonal code to distribute a transmission pattern for broadcast messages performance in terms of the success probability and the average delay in message delivery was reported. In a Vehicular Ad Hoc Network (VANET),before reaching potential dangerous zone emergency messages are given to the drivers on the road by the wireless Collision Avoidance (CA) system. This paper proposes an analytical model for wireless CA system for evaluating the performance of emergency messaging [13]. The network fragmentation is a result of sparse vehicle traffic. Safety application faces a crucial research challenge because of these. Here they analyses and quantify the VANET connectivity improvement by deployment of limited number of roadside units (RSUs) and in this enhanced VANET environment author investigate the safety applications routing performance. [14] much of the literature assume radio ranging VANET CP systems, which is not viable. [15] here author suggested power saving model for RSUs.[16] Here the author Consider this and technologies emerging for vehicular communication and presented CP method that improve the relative positioning between two vehicles within a VANET, these is achieved by fusing the available low-level Global Positioning System (GPS) data . In [17] the authors investigated the problem of placing gateways in VANETs to minimize the power consumption and the average number of hops from access points to gateways. Lochert *et al.* studied in [18] how the infrastructure should be used to improve the travel time of data dissemination over large distances. In [19], the authors used stationary support units to improve the refreshing rate of the information dissemination in city scenarios Banerjee *et al.* showed in [20] that supporting infrastructure can improve the mobile network performance by adding, including relays, meshes, and base stations. In [21], the authors investigated delay-tolerant networks (DTNs), where an end-to-end route between mobile nodes does not exist. In such networks, traditional adhoc routing paradigms such as adhoc on-demand distance vector routing (AODV) or dynamic source routing (DSR) will not properly work. Instead, the asynchronous message forwarding paradigm based on the store–carry–forward concept is used to achieve interoperability among different networks. Naumov *et al.* studied in [22] VANET routing protocols by using mobility information that is obtained from a vehicular traffic simulator based on real road maps ratio. In [23], the authors focused on network fragmentation scenarios in VANETs with real-world vehicular mobility models and provided a store–carry–forward solution to routing in disconnected networks. The existing literature shows that, when the VANET is well-connected ,Car accidents can be significantly reduced when traffic-related data can be successfully collected. On the other hand, in sparse VANET, two vehicles are probably disconnected and the message delivery is taken by the store-carry forward scheme. In[24] some applications which inherently need multicast routing protocols are introduced. Then the author precisely look over the usefulness ofcurrent multicast routing protocols for VANETs. Based on literature, there are several multicast protocols such as Flooding, Tree-based, Mesh-based, Overlaybased, Backbone-based, and Stateless [25]. We want to challenge the features of mentioned protocols against VANETs' characteristics.

## III. PROPOSED METHODOLOGY

Based on reported result in previous studies we find that design of early alert message advertising model with reliable routing protocol for multicast messaging that can cope with network fragmentation problem is crucial. To reduce the re-healing time for a sparse VANET and to reduce the number of re-healing hops for a dense VANET, we investigate the use of RSUs to assist the traffic safety messaging, which aims at delivering early alert safety messages to dedicate vehicles using relative positions by multicasting the alert message to only those vehicle which is going to get affected by the event with high reliability, few hop counts, and low delay. Our goal is to improve the VANET connectivity for safety message delivery between the vehicles and the RSUs
.

### 3.1. Multicasting of Alert Message

VANETs topology is highly dynamic and rapidly changing. There is temporary network fragmentation in VANET due to unique characteristics such as special mobility patterns. The transportation safety is enhanced by VANETs provide traveler information, develop comfort applications and traffic flow is improved. VANETs' routing protocol faces many new challenges based on realizing these applications. Popularity of multicast routing protocols has increased the cause is, the VANET routing protocol provides many to many and one to many communication for different application of VANET. Most of the existing multicast routing protocols are designed to satisfy safety applications. However there are some non-safety applications that also need multicast routing protocol. In recent years vehicles role is important in human life. Since human spend plenty of time driving their cars daily. The growing number of cars within the cities and along the highways requires a precise management to improve traffic flow and decrease the number of deaths and injuries in vehicular collisions, and eventually make travels more pleasant. In the highways, the most dangerous accidents are Rear-end and Chain Vehicle Collisions that occur because of sudden speed decrease. If any vehicle collision or anomaly event imposed a sudden speed decrease to front vehicle, all the vehicles in the risk area i.e Region of Interest should be announced to avoid Rear-end and Chain Collisions.

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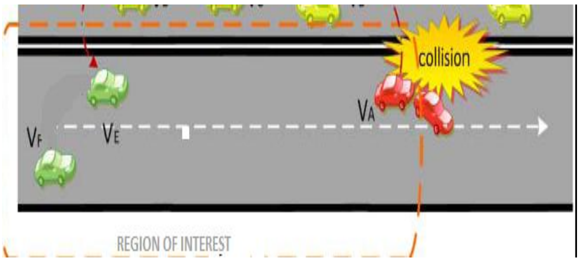


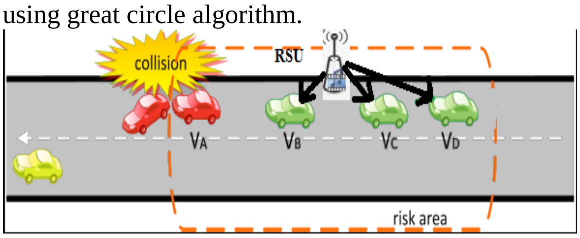

**(b)**

Figure 1.vehicle getting affected by the event.

For example, considering Figure 1(a), if any vehicle collision or anomaly event imposed a sudden speed decrease to VA, all the vehicles in the risk area i.e Region of Interest (VB,VC,VD ) should be announced to avoid Rear-end and Chain Collisions. In case of emergency not all the vehicles get affected in the network so broadcasting of alert packet is not feasible rather it should be multicast, but defining the list of node to be considered for multicast is challenging task as every vehicle cannot hold the location information of the entire vehicle in the network. However, the communication can be interrupted when the density of vehicles is not enough. In the other words, the communication suffers the Hole Problem figure 1(b) therefore RSU is employed to overcome this.

### 3.2. Enhancing Vanet Connectivity With Employing Road Side Unit (Rsu)

Road side unit will manage all the vehicle information and detect the failure vehicle and calculate the detail of the vehicles get affected by the failure vehicle using the relative positioning and multicast alert packet to identified vehicles. Calculating the list of relative vehicles position is depending on the travelling direction, bearing angle and the distance. The relative position can be find out to calculate to which vehicles the alert message should be multicast. Relative position is calculated using great circle algorithm.

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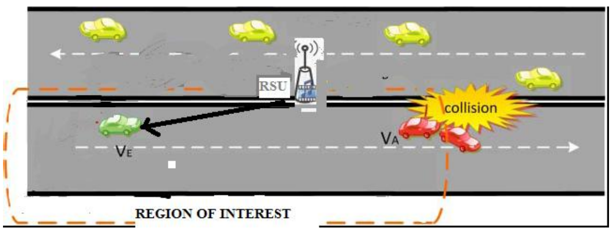


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Figure 2 Multicasting of alert message by using RSU

## IV. RESEARCH METHODOLOGY

### 4.1. Great Circle Algorithm

The shortest distance between any two points on the surface of a sphere which is measured along a path on the surface of that sphere (as opposed to going through the sphere's interior) is great-circle distance or orthotropic distance of the sphere. Geometry of spherical is not same as of ordinary Euclidean geometry, so the equations for distance also take a different form. In Euclidean space the distance between two points is nothing but length of a straight line from one point to the other point. no straight lines are present on the sphere. In spherical geometry i.e non-Euclidean geometry, geodesic replaces the straight lines. *Great circles* are the Geodesics on the sphere (circles on the sphere whose centers are coincident with the centre of the sphere). There exist unique Great circle between any two different points which are not directly opposite each other on a sphere. The great circle separate into two arc by these two points on the sphere. Great circle distance between the points is length of the shorter arc. Riemannian circle is a great circle associated with such a distance. Antipodal points are the points which are directly opposite each other between two points. There are infinitely many great circles between which are antipodal points i.e directly opposite to each other. But the length of all great circle arcs between antipodal points are of the same length which is half the circumference of the circle, or $\pi r$, where $r$ is the radius of the sphere. Because the Earth is nearly spherical (see Earth radius) equations for great-circle distance can be used to roughly calculate the shortest distance between points on the surface of the Earth (*as the crow flies*), and so have applications in navigation .To calculate the direction of movement enough to know coordinates of two consistently received landmarks. If you use the Cartesian coordinate system and adopt the longitude on the axis "X", latitude on the axis "Y" - then it is possible to calculate the vector of movement.

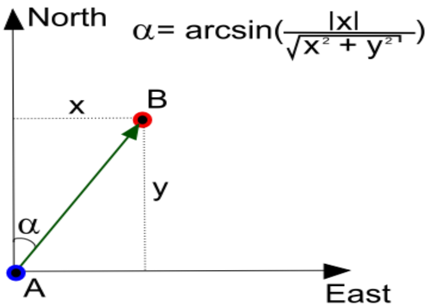



**Figure 3. Finding angle of movement**

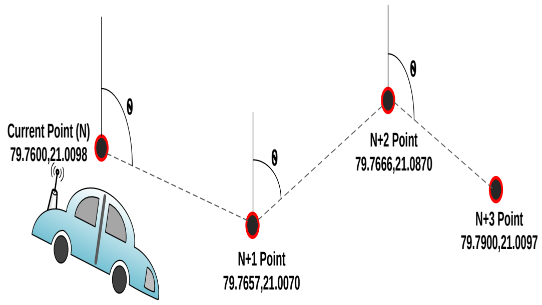



**Figure 4. Finding the bearing angle**

The figure 3 and 4 demonstrates how to calculate vector of the movement and the angle of the vector. Depending on the direction, you must perform correction of bearing angle. The following code snippet demonstrates how to calculate the angle of the movements (relative to north), received two landmarks. Current bearing, e.g. North, South, East, West is advertised by all recreational GPS units also tell all the points in between. electronic compass is advertise by some GPS unit. But why the other unit don't do this. It's creating confusion but great price difference is also given. Great circle algorithm is an alternative way to take a bearing. If the vehicle is moving and wants to know its current position then GPS is the perfect solution. The GPS periodically records your position as you move through the roads. GPS indicates which direction you are moving by comparing where you were to where you are now. The great circle uses this to indicate the current bearing and distance. Which is used to find the relative position between multiple vehicles?

### 4.2. Relative Position Dentification

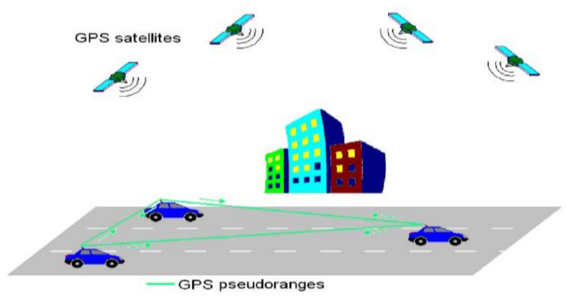
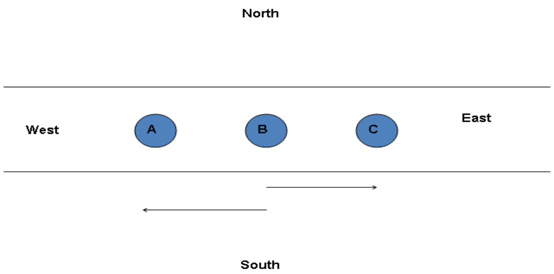



**Figure 5. locations Relation Identification**

Figure 5 describes the inter vehicular information sharing in VANET where every vehicle having location information of all vehicles in the network. The major problem in this scenario is that vehicles are not having information about relative position of all other vehicles. Consider a emergency situation if wrong message get delivered to other vehicle it may create a panic situation and hence create a traffic jam. While finding the relative position most important aspect should be kept in consideration is the direction of travelling because that the only parameter decides the travelling time relative position between vehicles. In case of emergency like accident there is no point in sharing informing with front vehicle, it is not necessary to message front vehicle. Hence by calculating the vehicles behind the accident vehicle, system can prevent broadcasting the packet rather then it will multicast the messages. Road side unit will manage all the vehicle information and detect the failure vehicle and calculate the detail of the vehicles get affected by the failure vehicle using the relative positioning and multicast alert packet to identified vehicles.



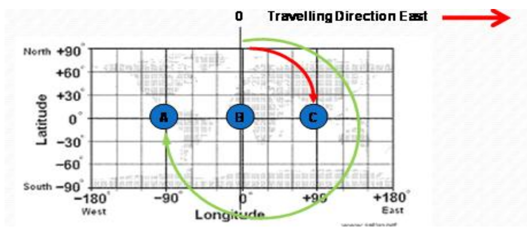




**Figure. 6. Direction of travelling Effects**

Figure 6 describe the changes in the relative positioning on the basis of travelling direction. Consider three vehicles A B and C ,if they are moving toward east then C is ahead of B and A,B is ahead of A. if the direction is towards west then A is ahead of B and C. If bearing angle is known and the direction are known then we can find relative position between them. Now Consider a scenario Vehicle B meet with the accident and travelling direction is east so after calculating angle of 'C' and 'A' we get that 'C' is at minor angle and 'A' at major angle hence 'C' is Leading vehicle and 'A' is Following vehicle so alert will go to 'A'.

## V. PARSING THE GPS DATA AND DISPLAYING

The proliferation of consumer GPS products has provided engineers with a wide variety of low-cost, high-quality GPS modules that are ideally suited for embedded location and navigation applications. Embedded and hand-held GPS devices provide raw output through a serial connection in the form of comma delimited, CrLf (carriage return/line feed) terminated NMEA strings, typically at 4800 baud.

Each string begins with a unique identifier and contains one or more fields; for example:
$GPRMC,032606,A,3410.2358,N,11819.0865,W,0.0,207.2,180211,13.5,E,A*32
Sample program execution to read the GPS data. GPS provide different protocols to provide different Information GPS device can connect to PC using USB or Bluetooth. Both are physical connection. For programming we need Logical port ie. COM port. O.S Map physical device to logical Application use these. Once device is connected to the system need to read data from device i.e. from COM port. As the GPS data fetched from device is in multiple line and every line holding specific information separated by ',' so we need to identify the proper protocol data and parse it in order to get the exact data. Using the split() function system will parse the data. Using the Google API the parsed geo data is mapped on the Google map.

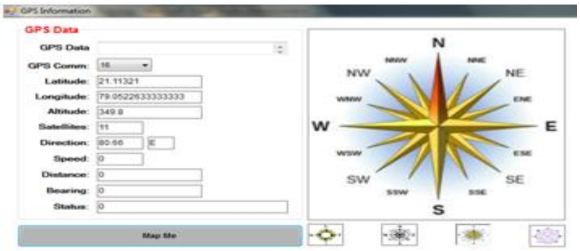



**Figure 7.parsing of data**

Figure 7 shows the parsed data from the fetched data from the GPS device. After parsing the data system will get the travelling direction.

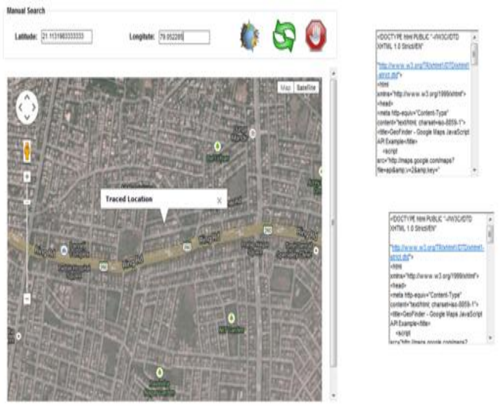
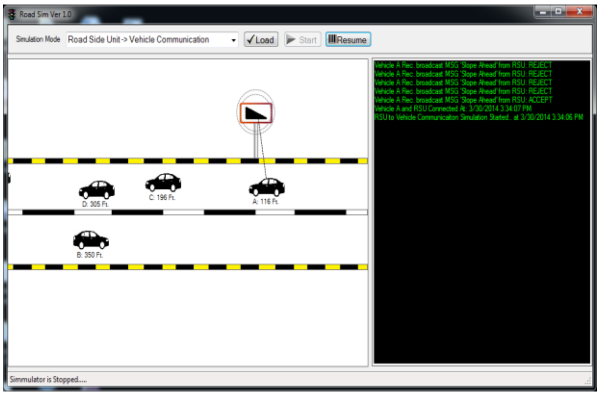



**Figure 8. Mapping Geo Data on Google Map**

Figure 8 shows the mapping of the parsed data from the GPS device by using the Google API. So that the vehicle will know the current location of its own. Which can be shared with the RSU to notify the RSU of its current position?

## VI. COMMUNICATION OF VEHICLES WITH RSUs AND CONNECTIVITY

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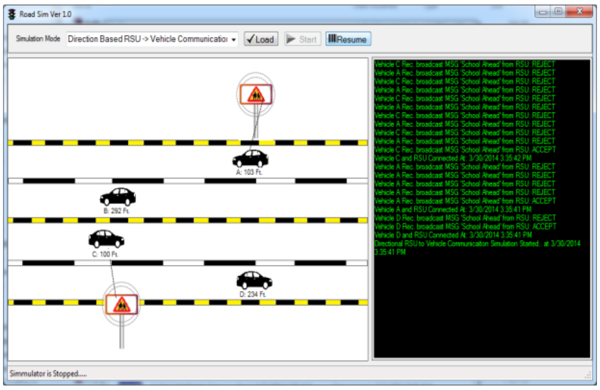


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**Figure 9.Roadside unit communicating with vehicles**.

Figure 9(a) shows RSus communicating with all the entity vehicle having current location of its own,these information can be shared with the RSU to notify the RSU of its current position.RSU calculate the relative position on the basis of Great circle algorithm i.e on basis of every vehicle location and the distance between each other. In figure 9(b) RSU will take the decision on the basis of travelling direction and the every vehicle location and calculate the relative position between all vehicle.RSU can find the relative positioning between multiple vehicle and multicast the alert packet to identified vehicles. Even after GPS device having its own few meters of error term but as system working at open air so it has been expected by the system to calculate the exact relative vehicle position and identity and sending proper messages to particular vehicle

## VII. CONCLUSION

One promising aspect of VANET is that it can considerably improve road safety and travel comfort. In case of emergency not all the vehicle get affected in network so broadcasting of alert packet is not feasible rather it has to be multicast.This will narrow down the broadcasting scenario and prevent the traffic conjunction due to wrong message delivery to unwanted vehicles in highway scenario. The number of vehicle collisions can potentially be reduced. Reduce the number of fatal roadway accidents by providing early Alert message. GPS data is fetched , parsed to get exact data After parsing the data, system will get the travelling direction. The Geo data is mapped on the Google map. So that the vehicle will get current location of its own. Which can be shared with the RSU to notify the RSU of its current position. RSU utilize this along with bearing angle and distance to find the Relative Positioning between multiple vehicles. And multicast the Alert message to Identified Vehicles.

As a final remark , the impact of RSU deployment and multicasting on the performance of safety applications for
VANETs in highway scenarios has been investigated in this paper and ,further research is needed to extend this model to urban scenarios, where the occurrence of accident are not distributed uniformly on the road, because of the complication of traffic intersection, and more prone to accidents.

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