A NEW ROUTING BASED APPLICATION TO ENHANCE REAL-TIME EMERGENCY SERVICES OCCURRED IN VANET

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Abstract

Wireless communication technology is the biggest contribution to mankind. Vehicular ad hoc networks (VANETs) are the extensions to wireless network provide data transmission and emergency services. Vehicle-to-Vehicle communication (V2V) offers many services for vehicular environment, mainly to improve the safety in emergency rescue application. This kind of decentralized network requires new routing based technique to broadcast message. The V2V communication requires proper co-ordination between On-Board Units (OBUs) in the vehicles, and Road-Side Units (RSUs) on the roads to exchange any information among them. The proposed routing based application uses the combination of OBUs and RSUs of the VANETs to advise danger or emergency situations with V2V and RSUs message exchange. The desired routing protocol for this new application is AOMDV (Multipath) which is based on dynamic path selection over a IEEE 802.11p standard. The performance of the application will be evaluated through many simulations parameters of AOMDV protocol executed in highway city scenarios.

Key Words : V2V, RSUs, VANET, AOMDV, Emergency Services.

1. Introduction

The various applications of vehicular adhoc networks are widely utilized in road safety. This is further categories into two different types: Information Routing and Safety Applications. The basic routing information is provided one to one or one-to-many by information broadcasting scheme for various applications in demand, such as emergency rescue operations, reliable route planning, congestion avoidance, route failure and communications. The information routing is to check the reliability for the successful delivery of packets from source to destination. Whereas the safety application provide assistance to broadcast any emergency message to the RSUs nearby such as alternative path selection (lane Changing), congestion alert, traffic management and road conditions in emergency applications. In such situations the routing of information should be reliable and fast without any delay. Any emergency vehicle like ambulance, fire brigade etc. should be able provides its assistance on time under any sudden accident prone area. Such situation is only control when cooperative efforts have been initialized by both the OBUs and RSUs in network. In this paper we proposed co-operative congestion avoidance (CCA) scheme to resolve the problem of emergency prone area. The CCA scheme will broadcast the emergency message among its adjacent vehicle through OBUs on vehicle to RSUs. This CCA scheme will avoid the congestion on road and make the emergency vehicle to reach the destination without any delay to enable its services.
covering the entire high risk zone; thus we suggest multi-hop scheme which can be achieved by several adjacent vehicles within its define communication range.

Figure 1 elaborates an emergency message broadcasting application. If the nearby adjacent vehicle (observer) locate any accident prone situation, it promptly invoked an high alert message among its adjacent vehicle through OBUs; mean while one of the vehicle will act as a forwarder is identify by the network for relaying such messages to RSUs under CCA scheme. Likewise, newly identified forwarder will release the message and also handover to next adjacent forwarder of the network. The above process extends till the message being received by its destination range of risk zone. For this purpose CCA is equipped with proper routing. The AOMDV routing protocol (Multipath Routing) is best suited for this application. In this particular routing any dedicated path fails, it reaches out and find out the alternate path without any delay. Once the emergency message has been released into the network it is handed over to reliable adjacent node so that it reaches successfully from source to destination. In this way message is distributed over a range of risk zone within time. RSUs further guide the emergency rescue vehicle to reach the destination where congestion in traffic has been drop down. This also avoids the long delay for any emergency services to reach at accident zone. In this proposed research work we are more focused on traffic management in any emergency rescue application. This work will reduce congestion on busy road and broadcasting of emergency message will make services like Fire Brigade, Police Vehicle; and Ambulance to reach on time at accident prone area.

2. Related Approach and Outline

Many research papers have been proposed to improve road safety in accident prone area. To prevent accidents, emergency message broadcasting scheme is used. After locating of the accident prone area by the adjacent vehicle by on board unit (OBUs), and the notification is automatically delivered to nearby Road side control unit (RSUs) over a dedicated server. This helps in reducing long delays to accident prone area and emergency services are available faster at ease. With the help of numerous wireless techniques it has become easy to help accident prone areas. As specified in [1] the main objective is to find the vehicle density within its transmission range of the present forwarder. Also, they introduces a vehicle location indicator mechanism VDEB forwarding scheme. In first method they described, the neighbor vehicle table maintenance. Then in further method various message schemes and the range identification are illustrated. This unique phenomena, can easily resolve the maximal and minimal ring width of specified range. The maximum ring width is when all the vehicles drive adjacent or parallel to each other. Thus the maximum ring coverage or width can be estimated by:

$$\text{MaxRingWidth} = \frac{R \times L}{N} \quad (1)$$

Where R is the transmission range for the ring radius, L is the total lanes in the ring, and N is the total number of vehicles within its ring transmission range.

In [7, 8] authors proposed the modified distance based one-hop and multi-hop broadcast scheme for vehicle to vehicle communication. The Dedicated Short Range Communication (DSRC) based application are expected to be installed on vehicles unit and in co-ordination with RSUs sensors. As a result it will enhance road safety in any emergency prone area. One-hop broadcast emergency messages will be activated when an unsafe situation is detected. They also provide provision for two different applications in one application they will reduce the waiting time of vehicle and in other they will provide high priority to waiting vehicle at the intersection point. Depending on distance based routing the multiple hop broadcast scheme not only guarantee fast delivery but also give reliable probability of successful transmission in case of emergency. It also proved the predictable performance improvement in any traffic scenarios.

The authors develop an application which is depends on the use of WAVE protocol, which enables VANET communication. The main objective of this paper is to provide an application which reduces congestion and risk factor generated by an accident. Neighboring vehicles to the accident prone area will receive information and immediately have alternate path for escaping the road where the accident took place. Using such operation, overcrowding to that particular risk zone will drop down through adjacent vehicles in a network. Also emergency vehicles will sense automatically the fastest and reliable path to the destination. Message exchange between vehicles using the application maintains traffic information also updated. The proposed application in their paper had two different message schemes: Cooperative Awareness Message (CAM) and Decentralized Environmental Notification Message (DENM). They also provide some important information like exact position, actual speed of the vehicle etc. [2].

In [4] authors has proposed the Traffic Information, Management & Emergency Response Service (TIMER) architecture for centralized co-ordination services among all the stake holders. This architecture is intended to provide the specialized services like Vehicle tracking, Emergency alarms, nearby utility guide, Traffic management etc. TIMER circuit can produce one or more periodic message for position tracking information whenever new base station signals are received and an alert message on generation of relevant emergency event, via automatic or static control. All the adjacent base station will broadcast the updated information on regional server. TIMER circuit will behave like data storage and powered by battery source of vehicles which contain all
the informative data of each vehicle in the network. This circuit also contains a small Read Only Memory (ROM) which holds vehicle related data like its Vehicle unique identification number and Owner unique identification number. Using this kind of circuit the emergency services are access for vehicular traffic information. This system also measured relative distance of several meters where any accident or emergency situation can be easily detected at prior notice.

The number of vehicles on roads is increasing every year, as a result of this the number of accidents, traffic congestions and emergencies is being increased. On the other hand, if public vehicles are informed in advance about emergency route both public and emergency vehicles can reduce a risk of collision. The destinations of emergency vehicles keep changing as the topology changes. In [9], authors presented a method where the total time required is reduced by the proposed network for emergency vehicles to travel from the source to their destinations by enabling these vehicles to run safely with high priority. The routing of messages from such emergency vehicles may reach other vehicles through multiple hops. This is achieved by multiple path through intermediate vehicle have an inter-vehicle communication. Such application is installed in them which work with several RSUs available for assistance. The network is considered to use a simple carry forward routing on priority of message for consent vehicle.

In [3], author target on presenting a Vehicular Adhoc Network for telemedicine for emergency primary healthcare using 802.11p networking standard. The verification of some standards is analyzed for the parameters like Packet delivery Ratio, End to End and Throughput considering video and audio transmission. The performance for these results is evaluated for all three standards based on mobility and varying speeds of vehicles. The various parameters for different scenario are compared to obtain the better performing standard of this kind. All the simulations are carried out using, whereas for traffic simulation SUMO (Simulation of Urban Mobility) is used.

The rapidly growing advancement in wireless technology has proved to have prior information regarding any incoming emergencies in advance. The main objective is to obtained instant help from rescue team in case of any emergency with the help of adjacent vehicle in co-operation with road side unit (RSUs). The proposed network should be capable of delivering fast service in this regard without any delay to cope up with any emergency in an network.

3. Routing Based Application

In some proposed methodology, an emergency message is broadcast through the observer vehicle and spread into the network. This emergency message serves an alert to another vehicle in network to avoid further congestion in network. Specifically, each observer vehicle broadcast emergency message, which include route details that is to be followed by each vehicle in the network. Thus nearby vehicle when it receives message forward it to adjacent vehicle so that the message will be forwarded to each located road side unit (RSU). The Co-Operation of vehicles and RSU is responsible of clearing load to the accident prone area. The main routing protocol for this entire communication is carried out by selecting reliable and desired routing protocol. AVANET supports several existing protocol out of which AOMDV (Multipath) is selected in our proposed network. It is best suited multi hop routing protocol for broadcasting emergency message without any delay. If any path in a network fails it immediately switched to alternate adjacent path. In this way it delivers the packet from source to destination without fail. The emergency tag priority messages from observer vehicles are handover to the forwarder vehicles from numerous hops. The receive messages are routed to RSUs through a separate dedicated network established from vehicle to vehicle. On deciding their potential of each sender and receiver a relevant scheme (V2V) is installed in them. Here the intermediate or adjacent node plays an important role observer or forwarder as shown in Figure 1.

![Flow chart of Emergency Message Broadcasting](image)

Fig. 2 : Flow chart of Emergency Message Broadcasting

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In our proposed methodology the AOMDV routing protocol is utilized for broadcasting emergency message. This reactive routing is considered for two reasons, first it provides multipath (Alternate Path) for packets, and second it reduces delay. In real time applications of accident prone area this two factors are very important to reach out the destination at far distance. Figure 3 shows the flowchart of emergency message broadcasting. In a single hop if message is delivered then it will be able to fetch the data of adjacent vehicle. This vehicle is considered as observer and further message broadcasting is carried. If message goes through multiple hops, it keeps on rebroadcasting the same message again and again. This process is repeated till it finds a proper observer. The originating or initial node are informed about the previous message delivery whether it is successful or not via redundancy of the message by the receivers.

4. Broadcasting Scheme

\[ T_{\text{max}} = \frac{n}{r} * d \]  \hspace{1cm} (2)

Tmax is average travel time, n is the number of nodes in network, d maximum distance between the vehicles.

A multi-hop or single hop broadcasting is one of the important scheme to provide various services in vehicular adhoc network. In such schemes vehicles is distributed over a far distance range. Most of the network has the provision for multi hop route recovery for successful delivery of messages like high alert, traffic congestion and collision awareness information in their database.

As shown in Figure 3, broadcasting scheme emergency messages are activated once by a nearby observer vehicle then it immediately starts scanning another adjacent vehicle. The Observer Vehicle of group A that arrived quickly into the accident area have to receive the emergency alarming packet with high priority to avoid further traffic accidents in advance. Vehicles of group B approaching towards should be warn to prevent traffic jams right into the accident area. This helps the RSUs for exchanging information fast and to avoid long delays for emergency services which can be made available to them on time.

5. Simulation Setup

The purpose of our proposed simulation is to compare the performance CCA with the other conventional emergency message broadcasting schemes. As per our methodology CCA we need to select the proper simulation parameters in specified range. The simulation environment is set up within a few kilometers which are extended several kilometers by OBUs and RSUs available at road side. This is labeled as a risk zone for a network under design. There are two parts in our simulations setup. First set is associated with the risk zone of accident prone area is covered by observer and forwarder. Second part works with the OBU's of the forwarder and observer and connects them with the RSUs. In this way emergency message is broadcast from accident prone area to RSUs which helps them to cope up with this situation RSUs keeps on forwarding message and alarming information is spread about the road. The performance evaluations were done on NS2.34. The performances parameters are analyzed by numerical results are then given.

| Parameters                  | Quantity          |
|-----------------------------|-------------------|
| Scenario                    | City              |
| Simulation area             | 5km               |
| Risk Zone                   | 1km               |
| Vehicle Density             | 50                |
| Vehicle speed               | 20km,70km,120km   |
| Transmission Range          | 500m              |
| Antenna                     | Omni directional  |
| Simulation Time             | 200s              |
| Routing Protocol            | AOMDV             |
| Routing Standard            | 802.11p           |

6. Result Evaluation

The proposed scheme performance is analyzed using high speed network, for which real time city scenario is implemented using NS2.34. In city, the traffic mobility depends on traffic signals, accordingly they change their direction in define range due to intersections as shown in Figure 4, and traffic density is variable time to time. The traffic is high generally at peak hours in some regions. These regions are at higher risk of any sort of emergency.
Therefore, we have extracted traffic movement patterns based on city scenarios using the simulation. In our approach message broadcasting is initiated by nearby vehicle (Observer) and further handed over the adjacent vehicle (Forwarder). This message is evaluated by broadcast delivery time from OBU to RSU where it is terminated for further action. The quick response is activated and further information is distributed to the approaching vehicles. However to achieve this multi-hop (AOMDV) broadcasting scheme is initiated for successfully delivery of packets without any delay. Thus multiple route routing scheme should guarantee not only reliability of successful transmission but also reduced in delay.

The result shows that, our propose scheme improves the quality of vehicular services in city environments. Vehicles receive real-time communication about danger generated by the accident, so they can take alternate path. The advantage provided by the application is higher when there are more vehicles on the road network. A better and more realistic model would be presented to obtain more accurate results about application performance. The simulation setup is about 1km, single lane, section of city scenario is considered. The total vehicles in this region are 50 with the single base station (RSU's) shown in Figure.4. This particular section is termed as risk zone of a design network. The mobility of vehicles is evaluated by their speed and density. The emergency message is broadcast by risk zone and further advanced parameters are evaluated by AOMDV routing protocol. The performance parameters are Advance Packet Delivery Ratio (APDR), Advance Throughput, and Authentication Delay. The simulation result is compared with existing routing verses advance routing to broadcast the emergency message. The test results are obtain on our network setup shown in Figure 4.

The packet delivery ratio is shown in Figure 5. This ratio shows APDR can be reached 78%- 82% in case of emergency as compared to existing protocol where it is very low about 55% to 64%. This ensures the successful delivery or broadcasting of emergency message in case of any emergency. The advance PDR is achieved with CCA scheme in real time event. This requires the co-ordination of both OBU and RSUs. It is expected to improve more when vehicle density is drop down.

The average throughput is the number of emergency message received successfully and the number of message successfully transferred during a specified amount of travel time from source to destination. The Figure 6 shows the maximize throughput is obtained with our CCA advance system as compared to existing system. The advance system throughput is 3.786 mbps. This throughput values for real time scenario improved as compared to existing system where it is about in between 2.489 to 2.5000 mbps.

The most of the results generated by simulations, to evaluate the exact time and location about emergency vehicle, and to know the final distance from the accident area, the time needed to reach it and the average speed during the trip. Average speed is:
The real time application allows the emergency vehicle to drive through the fastest path, avoiding traffic jams. A comparison between authentication delay and existing delay in city scenarios is shown in Figure 7. Where over delay is better as compare to existing system in case of emergency it is about 120 to 130 msec.

\[ S = \frac{\text{Travel Distance}}{\text{Travel Time}} \]  

7. Conclusion and Future Work

In this paper we have used emergency broadcasting scheme to improved safety in road emergencies. The simulation results show that our CCA scheme provides good performance parameters with improved PDR, Delay and Throughput that does not disturb the ongoing important services in VANETs. In addition, with the help of observer and forwarder vehicle it delivered the packets successfully to the RSUs. Also multi hop scheme provides the alternate path to the destination in case of any emergencies. Vehicles receive real-time communication about risk arises by the accident, so they avoid engaged roads and provide the alternate path. Using this application, emergency situations can be resolved timely without any delay in rescue of life.

In future work more better and realistic VANET model would be useful to obtain accurate results about emergency application and improve its performance in every aspect. After performing simulation and tests on specific part of network, we would like to add a real time test on larger area coverage for several kilometers. A mutual coordination is required for provision of broadcasting alarming message in advance to arriving vehicle with requisite control and linked with database through centralize server. Our results reveals that the proposed schemes are effective to further enhance the realistic network and their performance in order to achieve reliability and safety so that the requirements for safety-related applications can be improved while comparing them with existing VANET safety services.

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