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EFFICIENT AND RELIABLE VEHICLE-TO-VEHICLE COMMUNICATION USING ON-DEMAND ROUTING PROTOCOL

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ABSTRACT

The cooperative vehicle safety systems (CVSs) of Vehicular Ad-hoc Network (VANET) provides vital vehicle tracking information. In CVS, the physical state information about the vehicles is transmitted over a shared wireless channel in order to let the neighbors to track the location of the vehicle and predict possible accidents. However, the physical state information's are beneficial only if they delivered in a timely manner. Thus, the need of efficient and robust routing protocol arises in order to enable more efficient communication. Thus, in this paper an efficient on demand routing protocol is employed in the communication sub component of the CVS system to generate and transmit the location information of the vehicle rapidly. The performance of the proposed approach is analyzed in terms of energy consumption, throughput, packet drop, and delay and packet delivery ratio. Thus, the results indicate that the proposed approach provides efficient and robust communication over VANET.

Keywords: cooperative vehicle safety systems, Vehicular Ad-hoc Network, vehicle tracking information, on demand routing protocol.

INTRODUCTION

VANET [1] is an evolving technology and a vital Intelligent Transportation System (ITS) [2] component that are integrated with medium and short range wireless communication. They support a wide variety of applications such as infotainment, intelligent transportation, passenger convenience, road safety and so on [3]. The primary goal of VANET is deliver comfort and safety journey. Therefore various electronic devices are positioned inside every vehicle to enable ad-hoc network connectivity between the vehicles. Every vehicle equipped with the VANET devices forwards and receives messages to and from other vehicles via wireless medium. Delivering the vehicles with the information regarding their neighbors improves the efficiency and safety of the intelligent vehicle system.

The cyber aspects of the system such as delivering safety messages and detecting threats are firmly coupled with the dynamic behavior of the vehicles and the driver. The current research on such CVS (cooperative vehicle safety) system has indicated that major performance improvement is conceivable by integrating the system design components associated with the vehicle dynamics with the components that are liable for tracking the location of other vehicles and identifying threats[4] [5].

The cooperative vehicle safety systems (CVSs) of Vehicular Ad-hoc Network (VANET) provides vital vehicle tracking information. In CVS, the physical state information about the vehicles is transmitted over a shared wireless channel in order to let the neighbors to track the location of the vehicle and predict possible accidents. However, the physical state information's are beneficial only if they delivered in a timely manner. Thus, the need of efficient and robust routing protocol arises in order to enable more efficient communication.

In this paper, an efficient on demand routing protocol such as Ad hoc On-demand Distance Vector (AODV) routing protocol is used for efficient and robust delivery of messages to other vehicles. Using this protocol, the communication subcomponent sends and receives safety messages. The computation subcomponent is responsible for tracking neighboring vehicles, generating safety messages and managing communication time, transmission control logic and issuing warning indicators to the user-interface subcomponent such as collision detection module.

RELATED WORK

In [6] a scheduling algorithm has been proposed in the application layer to alleviate the CSMA feature of the (DSRC) Dedicated Short Range Communications in the MAC layer. In this approach the roads are divided into number of geographical zones and clustering of moving vehicles is carried out in each zone. Then scheduling algorithm is applied in two levels. At the first level, the non-adjacent clusters could disseminate information at the same time and in the second level scheduling is done within each cluster in which a TDMA like approach is employed.

In [7] a new congestion control framework has been proposed for uni-priority of event-driven safety messages. Here, priority-based Earliest Deadline First (EDF) scheduling algorithm has been introduced schedule uni-priority of event driven safety messages. Moreover, a novel broadcasting technique has been developed to prevent the broadcast storm.

In [8] cluster-based risk-aware CCA (C-RACCA) system has been introduced in which a cooperative collision-avoidance (CCA) approach has been employed to avoid flooding of emergency messages and the target vehicles are organized into clusters. The clustering of the vehicles is done based on the movement and the inter-vehicular distance. The vehicles within each cluster are linked with an emergency level. Moreover, the system uses a risk aware medium access control protocol to enhance the proposed CCA approach's responsiveness. To deal with the stable and safe operation of the vehicle intra platoon information management approaches haven been proposed [9]. It has been demonstrated that the utilization of proactive information of both the platoon leader and the follower considerably affects the stability of the platoon string.

In [10] scheduling algorithms has been used to categorize and prioritize emergency or warning messages. The peer vehicles broadcasts the risk notification message from the risk area utilizing inter and intra- zone cluster communication to the rear vehicles using the proposed algorithm. [11] Employs vehicle trajectories of the traffic simulation in order to analyze the effects of Adaptive Cruise Control (ACC) on the acceleration and deceleration rates of the vehicle. The simulation indicates that the ACC improves the traffic condition in terms of decreased acceleration and deceleration rate however the macroscopic traffic properties remains unaffected.

In [12] reliable protocol for roadside to vehicle communication has been studied and a novel routing protocol has been proposed in which the stationary access point plays a significant role in route maintenance. The protocol is the combination of the prediction and the routing algorithm in which the prediction algorithm predict the wireless link lifetime considering the terrain impacts, and the routing algorithm finds the optimal stable path for transmitting the data based on the prediction.

Proposed Methodology

Vehicles are required to be continuously aware of their peers of few hundred meters to identify possible threats. This task may be achieved by frequent real time communication between vehicles using the design of Cooperative Vehicle Safety (CVS) systems over Dedicated Short Range Communication (DSRC) channels. The main requirement of this safety system is the possibility of delivering real-time acquired information to and between vehicles at latencies of lower than few hundred milliseconds. This real time communication of information is achieved by means of routing which is the process of forwarding a message from a source vehicle to a destination via wireless medium. In this paper the communication sub component that is responsible for sending and receiving the information uses Ad-hoc On-demand Distance Vector (AODV) routing protocol.

In the proposed system the location of the vehicle is continuously monitored by means of HELLO message broadcast. Initially the movement of the vehicle is identified. If the vehicle is in motion, the current speed of the vehicle is obtained. If any variation in the speed or direction of the vehicle is observed then hello messages are generated. The position (dx,dy) of the target vehicle are obtained by using global positioning system equipped with each vehicle and the co-ordinates are incorporated into the hello messages and broadcasted over the wireless channel. Figure-1 illustrates the pseudo code for transmitting HELLO messages. A vehicle upon receiving the HELLO messages destination coordinates and the speed of the vehicle from the HELLO messages. Based on this information the location of the target vehicle is obtained by calculating the inter-vehicular distance.

```
Pseudo code for Sending Hello message
Step 1: while motion of the vehicle is not stationary then
Step 2:obtain current speed of the vehicle
Step 3: if variation in the speed or direction is observed
then
Step 4: Generate hello message
Step 5:obtain destination coordinates  (dx, dy) and
incorporate in hello message
Step 6: Broadcast HELLO message
Step 7: end if
Step 8: end while
```

Figure-1. Pseudo code for Sending Hello message

Once the inter-vehicular distance is obtained these values are stored in the routing of the vehicular node. Figure-2 illustrates the pseudo code for receiving the HELLO messages. The data packets are then transmitted to the target vehicle as illustrated in Figure-3 and Figure-4 respectively.

```
Pseudo code for Receiving Hello message
Step 1:Step 4: Read the node_id,dx,dy,speed from the
hello packet
Step 2:Temporarily store the neighbouring vehicle
information
Step 3: Calculate the inter vehicular distance
Step 4:if nodeid exists in neighbouring table then
Step 5: Update the neighbouring table with new values
Step 6: else insert the new value  in the neighbouring table
Step 7: end if
```

Figure-2. Reception of HELLO messages.

```
Pseudo code for Sending Data Packets
Step 1: Generate data to send.
Step 2: Set destination vehicle as nodeid.
Step 3: if nodeid is exists in the table then
Step 4: Transmit the packet
Step 5: else if nodeid exists in packet information table
then
Step 6: Search the next hop in the packet table
Step 7:Set the next hop with nodeid
Step 8: Transmit the packet
Step 9: End if
```

Figure-3. Transmission of Data Packets.

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Pseudo code for Sending Data Packets
Step 1:Read destination nodeid
Step 2: if nodeid is received is the vehicle id then
Step 3: if nodeid is exists in the table then
Step 4:Read the data packet
Step 5: else Transmit the data
Step 6: End if

Figure-4. Reception of Data Packets.

Simulation Results

Simulations are carried out to evaluate the performance of the proposed approach. Here, NS2 is used as simulation environment to perform simulation. The performance of the proposed approach is analyzed in terms of Energy consumption, throughput, packet drop, and delay and packet delivery ratio respectively. Table-1 indicates the performance metrics and their corresponding formula.

Table-1. Performance Metrics.

S. No.	Performance Metric	Formula
1	Energy Consumption (E)	$E = \frac{\text{Average energy consumed on Ideal, sleep, transmit, receiver state}}{\text{Total energy consumed}}$
2	Throughput (T)	$T = \frac{\text{Number of packet sent}}{\text{time period}}$
3	Packet drop (pd)	$pd = \text{number of packets received} - \text{number of packets sent}$
4	Delay (d)	$d = \text{packet departure time} - \text{packet arrival time}$
5	Packet delivery ratio (pdr)	$pdr = \frac{\text{number of packets received}}{\text{total packets sent}} x100$

Results

Figure-5 shows the energy consumed by the proposed technique at varying time units. The horizontal line represents the time in seconds while the vertical line represents the total energy consumed in joules (j). It is obvious from the graph that the energy consumed in case of the proposed approach is less when compared to that existing DA-PLATOON technique.

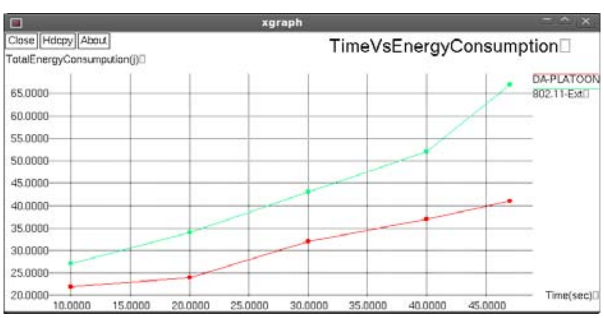

Figure-5. Energy Consumption.

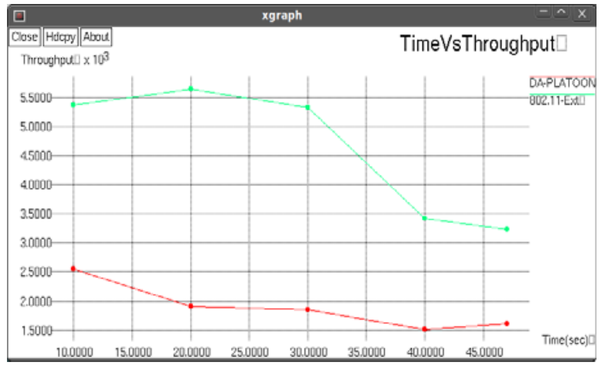

Figure-6. Throughput.

Figure-6 shows the number of packets that are transmitted by the proposed technique at varying time units. The horizontal line represents the time in seconds while the vertical line represents the throughput in bits per second. It is observed from the graph that the number of packets transmitted using the proposed approach is more when compared to the existing technique.

Figure-7 shows the number of packets that are dropped by the proposed technique at varying time units. The horizontal line represents the time in seconds while the vertical line represents the drop in packets. It is observed from the graph that the number of packets that are dropped using the proposed approach is less when compared to the existing technique.

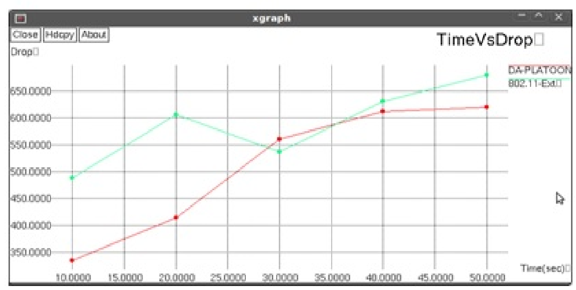

Figure-7. Packet drop.

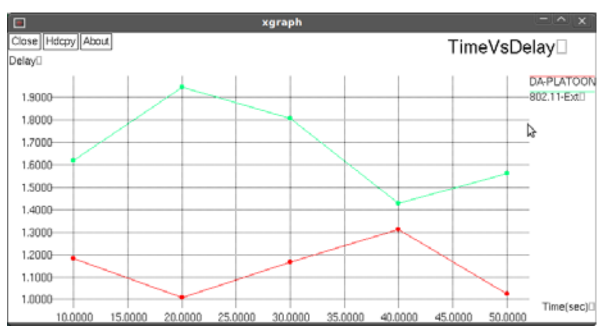

Figure-8. End-to-End Delay.

Figure-8 shows the end-to-end delay in case of proposed technique at varying time units. The horizontal line represents the time in seconds while the vertical line represents the delay in seconds. It is observed from the

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graph that the delay incurred using the proposed approach is less when compared to the existing technique.

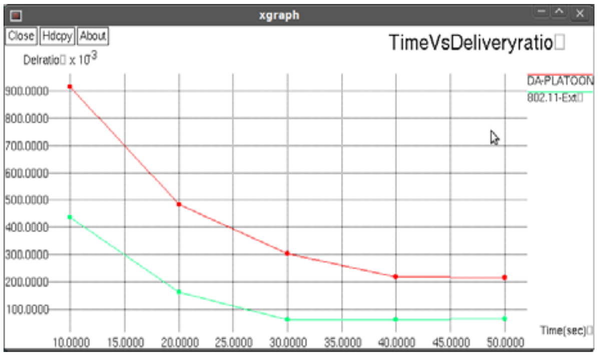

Figure-9. Packet Delivery Ratio.

Figure-9 shows the packet delivery ratio of proposed technique at varying time units. The horizontal line represents the time in seconds while the vertical line represents the packet delivery ratio. It is observed from the graph that the packet delivery ratio of the proposed approach is more when compared to the existing technique.

CONCLUSIONS

The development of intelligent vehicle safety systems is rapidly moving from autonomous systems relying on vehicle's own sensors towards cooperative systems utilizing Communications between vehicles or between infrastructure and vehicles. Cooperative vehicle safety system was developed for vehicles safety purpose. The cooperative vehicle safety systems (CVSs) of Vehicular Ad-hoc Network (VANET) provides vital vehicle tracking information. These are beneficial only if they delivered in a timely manner. Thus, in this paper an efficient on demand routing protocol is employed in the communication sub component of the CVS system to generate and transmit the location information of the vehicle rapidly. Simulations are performed to analyze the performance and the results indicate that the proposed approach provides efficient and robust communication between the vehicles.

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