VANET : Achieving Secured, Distributed, Bandwidth-Efficient Mobility Pattern

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Abstract — **This study focuses on the Wireless Collision Avoidance (CA) system, which is critical for a Vehicular Ad Hoc Network (VANET) that sends out emergency warning signals to drivers as they approach a potentially dangerous region on the road. We proposed the Collision Avoidance- Emergency Message Broadcasting (CA-EMB) protocol, which is used to send a warning message to all linked vehicles in the Region of Interest (RoI). To implement the suggested protocol, which is based on priority-based emergency message, all vehicles are equipped with a wireless CA system. The warning messages, which are in the form of signals, are used to avert rear and end collisions between any two vehicles travelling in the same direction. The distance tracking technology, which lowers the latency, is used to transmit these warning signals on a regular basis. Finally, the simulation is completed, and the proposed protocol's performance is assessed; the simulation results are presented below.**

Index Terms— VANET, CA system, warning message, Safety application, Region of Interest and CA-EMB

1. INTRODUCTION

VANET (Vehicular Ad hoc Network) is a primary classification of Mobile Ad hoc Network (MANET), in which vehicular nodes connect with each other utilizing Dedicated Short-Range Communication (DSRC) devices (DSRC). The vehicular nodes or vehicles are equipped with a variety of smart sensors to detect their own motion status, such as acceleration, braking, and lane changes. Weather and road conditions are also detected using these sensors (like icy roads). Vehicular Ad hoc Networks have a wide range of appealing applications, and our primary goal is to improve efficiency and road safety by allowing vehicles to communicate with one another. For different types of vehicular network applications, the size of the Region of Interest (RoI) may vary. The effective application range of various safety applications is medium, ranging from a few hundred metres to one kilometre. In its intermediate vicinities, each vehicle must be aware of the kinematic status of other participating vehicles (few hundred meters). [1]. In addition, it is necessary to discuss an important feature of this vehicular application known as convenience application, which requires a medium to large effective application range because it is critical for drivers to recognize the current traffic situation in order to make important decisions and trip plans. Accidents are thought to be caused primarily by poor driving performance. [2]. The VANET application must meet the following criteria: it must enable drivers to anticipate dangerous situations or high-risk traffic zones. However, due to the high mob ility and frequent topological changes of vehicular nodes, data communication in vehicle networks is a difficult issue. Collision avoidance has gotten a lot of attention in VANET, and we're focusing on a wireless Collision Avoidance (CA) system that alerts drivers before they enter a problematic region on the road.

The vehicles' wireless Collision Avoidance system is used to send urgent or emergency messages to the vehicles before a vehicular crash or emergency breaking happens, both of which are known as abrupt events. Because the propagation delay of wireless devices is much shorter than the cumulative response time of drivers, As a result, a driver who receives an early emergency notification will have more time to respond in an emergency. As a result, if vehicles are fitted with Collision Avoidance systems that generate emergency warnings to drivers before entering potentially risky areas, the number of road accidents will likely be reduced. Various studies on the safety applications of VANET have been undertaken, and here we will primarily focus on simulation without a thorough mathematical analysis. [3]. The location of vehicles must be assessed to see if they are in a risky zone, i.e., RoI is connected to VANET. This is an essential wireless collision avoidance system network design. When automobiles are equipped with the CA system, VANET sends out emergency messages to drivers, giving them additional time to react to threats. The following is a breakdown of the paper's structure.

2.RELATED WORK

There has been a lot of interest in VANET-related research in the last few years. Various studies have advocated the examination of DSRC technology as a way to improve road safety. Biswas et al. [2], for example, gave an outline of Collision Avoidance. The use of vehicle cooperation that is mostly dependent on DSRC devices. This paper explains how vehicle-to-vehicle communications have enhanced highway traffic safety. It also demonstrated the need for data prioritizing, which is employed in critical circumstance safety applications. Xu et al. [4] provided a vehicle chain collision reaction that focused on the intensity of the chain collision. This intensity can be lessened by shortening the time between when the emergency occurs and when the cars are notified of the situation. Mak et al. [5] measured the performance of Medium Access Control (MAC) in terms of channel busy time and data reception probability in a periodic safety message mechanism. Yin et al. [6] reported a study on DSRC-based delay critical VANET road safety applications. Xue et al. [7] proposed a communication protocol for CA systems that assessed MAC transmission delay.

Li et al. [9] looked at gateway placement issues in order to reduce the number of hops between access points and gateways while also lowering VANET power consumption. Lochert et al. [10] introduced a VANET infrastructure that reduces data transmission time over long distances. Local density estimation and dynamic transmission-range assignment in VANET was proposed by M. Artimy [8]. The projected local density is divided into two categories: free flow and congested traffic. A vehicular node can allocate a suitable transmission range in a dynamic way in accordance with the traffic density under local traffic circumstances based on the traffic density. In this study, we suggested a Collision Avoidance (CA) system to avoid vehicle collisions and evaluated the proposed CA system's quality of performance on terms of a realistic vehicle headway model and communication disconnection issues in a VANET.

3. PROPOSED PROTOCOL

The Collision Avoidance - Emergency Message Broadcasting (CA-EMB) protocol is used to prevent any two cars from colliding by sending an emergency message before they enter the dangerous zone. The existing VANET protocols send warning messages hop-by-hop, which adds to the delay and makes it difficult for some cars to receive the messages. This may result in vehicle rear-end and end collisions. However, before entering a dangerous zone, the suggested protocol uses priority-based broadcasting of warning signals to cars. As a result, the CA-EMB protocol is employed to generate the priority-based warning message. [11]. The proposed CA-EMB protocol includes a priority algorithm that monitors vehicles and prioritizes their movement based on the number of vehicular nodes available in each risky zone. When the car receives a warning message, it reacts quickly as soon as the driver hits the brakes, necessitating the use of a braking model that checks the braking time and vehicle response.

In our proposed procedure for risky zone structure on the road, we apply the Dichotomized Headway (DH) model. This model is based on the headway process, such as the forward moment of cars, which is especially important when the vehicles are slow or in a tough condition. [12]. This DH model is used to depict automobiles travelling on highways with a significant volume of traffic. The major goal of this procedure is to avoid rear-end collisions by focusing on the headway process. As a major mechanism for transmitting the warning message, each vehicle must include a Collision Avoidance System. The warning message is initially generated by a vehicle in a specific collision site and delivered to a moving vehicle with a high signal reception priority. As a result, it looks for certain automobiles in the nearby pool first. When the signal is received, it is displayed on the device before being sent out. This procedure is repeated until all of the participating vehicles are alerted about the possibility of colliding with promoted vehicles. As a result, the risk of a rear-end collision is minimized, while alert time is raised. [13].

4. DICHOTIMIZED HEADWAY MODEL

Mobility is a key feature of wireless ad hoc networks, also known as Mobile Ad hoc Networks (MANETs), of which Vehicular Ad hoc Networks (VANETs) are a subset. In the VANET, vehicular mobility is tracked using the Dichotomized Headway Model, which separates the DHM into two traffic flows with a certain range of movement. [14]. This DH model provides vehicle location information, which is then used to simulate the distance to the collision site. The DH model assumes that a source vehicle oversees disseminating the warning message via the Collision Avoidance system. The vehicle that is closest to the accident scene is referred to as the source vehicle. The headway model is used to calculate the accident time and the distance between the accident zone and the vehicle, or any two cars involved in a rear-end collision. Our proposed approach includes the following two models.

1. Priority Based model
2. Collision-Avoidance System model

A. Priority Based Model

The following processes are used in this priority-based methodology to give priority-based signaling or messaging to participating cars. The priority model algorithm is shown below.

1. Assume that the vehicles are going in a random direction on the routes, such as highways.
2. If a vehicle's rear end reaches a certain distance from the vehicle's end, the vehicle near the accident zone will issue a warning message to the driver.
3. The signal that generates warning messages is used to check the priority of the Message Generator Pool.
4. The pool now broadcasts the message by using the CA transmitter to check the signal priority.
5. The driver is then shown the received emergency notification from the originating vehicle.

B. Collision Avoidance System Model

The collision avoidance system module allows the car to communicate with the outside world via a vehicular ad hoc network. E can collect messages to transmit from a message generating pool, and the acquired messages are in the form of text messages or signals. Important decisions are made using the sensor signal receiver, and then the message prioritizing function is done. This message prioritization function is controlled by the message priority that the vehicular node must receive. The transmitter must collect the alarm signal from prior vehicles in order to broadcast. This alert provides a high level of safety in order to prevent mishaps or collisions between any two cars in the rear and end. It is required to demonstrate the use of DSRC-based wireless communication to improve the efficiency of the CA vehicular network application in order to explain the Collision Avoidance System (CAS). The CAS model is then introduced to address the probability of a rear-end collision between any two cars travelling in the same direction while braking frequently. An example of a two-car highway platoon is used to describe the collision avoidance system in [15].

5. EXPERIMENTAL RESULTS

The performance of a network with a Wireless Collision Avoidance System is compared to the performance of a network without a Wireless Collision Avoidance System. These graphs depict the relationship between Vehicle Speed and Vehicle Density. When the network's Vehicle Density is reduced, the network's Vehicle Speed increases. In general, a network with a Wireless CA System has a lower Vehicle Density and hence performs better.

The performance of a network with a Wireless Collision Avoidance System is compared to the performance of a network without a Wireless Collision Avoidance System. These graphs show the relationship between the expected number of crashes and the average response time. While the expected number of crashes is lowered, the network's average response time is also reduced. The network using the Wireless CA System has enhanced network performance by lowering the Expected Number of Crashes. The performance of a network with a Wireless Collision Avoidance System is compared to the performance of a network without a Wireless Collision Avoidance System. These diagrams depict the relationship between traffic density and vehicle density. When the number of vehicles on the road increases, so does the network's traffic density. In general, networks employing Wireless CA Systems have lower Vehicle Density, which results in greater network performance due to lower Traffic Density.

6. CONCLUSION

By allowing inter-vehicular communication, which is the promise component of vehicular networks, VANET can considerably improve road safety and boost travel comfort. The CA-EMB protocol is suggested in this paper to prevent automobile collisions by generating an emergency warning message in the form of a signal. Driver behavior, road traffic density, and vehicle type all influence vehicle speed and deceleration rates. Collision avoidance system requirements and limitations are mostly determined by practical constraints and engineering perception. The CA system of the VANET safety program must broadcast new road and traffic information to drivers on a regular basis. The simulation was used to evaluate and analyze the suggested system's performance, and the simulation result is displayed, revealing the proposed system's efficiency.

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