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Efficient dissemination based on passive approach and dynamic clustering for VANET

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Abstract

The evolution of the Intelligent Transport System (ITS) has imposed a major impact on road safety by providing a wide variety of applications to decrease the number of accidents and traffic management. As an emerging component of ITS, Vehicular Ad-hoc Network (VANET) is considered as a promising technology for increasing road safety. Basically, VANET provides two types of communications: Vehicle-to-Vehicle (V2V) and Vehicle-Infrastructure (V2I) communications. To make the vehicles act in a cooperative way to enhance road traffic safety, we should adopt the V2V communication, also known as Inter-vehicle communication (IVC). The biggest challenge is how to address the overhead and stability issues that are caused by the important number of messages generated by vehicles at critical areas, such as intersections. In this paper, we focus on the implementation of distributed system based on a passive data dissemination approach. This consist on each vehicle sending periodical measures about the position, speed to other vehicles belonging to the same signal range and to the same cluster. Which implied an earlier division of the network into virtual sub-groups to ease management and data dissemination of messages. Afterward, we simulate the solution using micro-simulation taking in consideration the behavior of each vehicle.

Keywords: VANETs; Ad-hoc; V2V; Dynamic clustering; Collision avoidance

1. Introduction

Quite recently, road traffic accidents are classified the ninth cause of death in the world. Besides, they are estimated to be in the seventh place by 2030. As reported by [1], the number of road traffic deaths by injuries has been fixed to 1.25 million per year. Furthermore, over than 50 million people have non-fatal wounds as a consequence of road accidents. While there are additional indirect consequences that are associated to other fields, e.g. environment, economy, etc. In a perspective to reduce this disaster, several researches have been carried out, especially in the field of Intelligent Transportation Systems (ITS) [2]. ITS describe technology applied to the interaction of vehicles with each other and with the infrastructure, to ameliorate driving experience, as well as, to enhance the safety and ability of

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road traffic. As a subclass of Intelligent Transportation Systems, Vehicular Ad-hoc Networks (VANETs) are advanced applications conceived to provide deep insights into roads traffic and propose new solution to various issues [3]. In VANETs, vehicles are inter-connected for different purpose such as sending a safety messages to warn vicinity cars in case of a crash or even delivering information about the road traffic to authorities, besides, connecting vehicles to other resources, e.g., the Internet. Generally, the performances of VANETs depend on many features, compared to other Ad-hoc networks such as Mobile Ad-hoc Network (high mobility, variation of topology, unbounded network size, unlimited energy and storage resources) [4]. The challenges toward applying VANETs - as efficient collision avoidance system - mostly include network stability and overhead. According to the number of vehicles in urban areas or in congested space, vehicles exchange a large amount of messages, which provoke a high control overhead of network. Due to the proximity of vehicles [5], each vehicle requires disseminating the control messages within the network to alert other vehicles about its position and speed to avoid crashes. Therefore, minimizing sent messages is an important step toward efficient collision avoidance. For these reasons, in this paper, we will implement a protocol based on clustering approach to facilitate management and data dissemination of messages.

The remainder of the paper is organized into five sections: After the introduction, Section 2 provides application challenges; Section 3 presents the related work; Section 4 describes the dissemination road traffic protocol. Simulation and performance evaluation are presented in Section 5; Section 6 concludes the paper.

2. Context awareness

The collision warning system, also known as collision mitigation system, was created to decrease the number of collisions between vehicles using sensors, image recognition or cooperative collision warning. When an accident occurs, sensors control the braking system. The major disadvantage of those sensors is the restriction on detection distance [6], which left only a few milliseconds before a collision. In addition, image recognition may not be efficient in certain weather conditions (heavy rain, snow, thick fog ...) which can cause lack of visibility. The data provided by the cameras installed on the car, in this case, becomes untrusted and no longer reliable for collisions detection.

However, Collision Cooperative Warnings (CCW) are based on received messages from wireless communications sent by nearby vehicles. They help drivers to avoid accidents or to diminish the consequences by detecting other vehicles in large scale or in longer distances and informing them of a potential danger of collision. The concept of CCW can be classified into three approaches [7], namely: passive approach, active approach, and hybrid approach.

In a passive approach, each vehicle sends a periodically high precision measurement of its location and speed to neighbor vehicles, so each neighbor must update information and calculate the inter-vehicle distance to determine the possible collision and warn the driver. In active approach, if a vehicle reacts in an abnormal behavior, such as hard braking or a breakdown, it sends automatically a warning message to the neighbors, which includes the cause of breaking, location, and speed. Each recipient of this message can then make the decision, for example, braking and notify the driver. However, the hybrid approach combines both approaches together to support different applications. So, to ensure the correct achievement of these three approaches, it is necessary that each vehicle sends accurate measurements of location and speed.

3. Related work

In the passive approach, messages are sent proactively using periodic broadcast. This technique is usually used in safety application, such as collision warning system and road condition. Contrary to delay-tolerant applications, the passive approach requires strict latency constraints.

In [8], authors developed a novel clustering algorithm, that classifies vehicles according to congested traffic flow, the algorithm was adapted to use trajectory abstraction as a metric, which groups vehicles that travel in the same location into the same cluster. The results obtained from the solution provides highly precise and real-time traffic data that reduce traffic congestion in an urban environment. By locating a vehicle at the head of a congested traffic flow, drivers can receive efficient traffic data. Moreover, to compensate the error caused by GPS equipment during the selection of the vehicle in the head of congested traffic, the algorithm employs an abstracted location and trajectory representation.