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Assessment of Pedestrian-to-Vehicle Communication Pre-Crash Safety Warnings to Avoid Collisions

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ABSTRACT

In recent years, road safety is getting more attention to reduce road pedestrian accidents caused by vehicles. The research community is trying to find new techniques related to accident avoidance in the existing vehicle driver assistance systems. These techniques involve the exchange of safety critical information between pedestrians and vehicles. This is called vehicle-to-pedestrian (V2P) communication system, which provides road safety and management to different Vulnerable-Road-Users (VRUs). Furthermore, V2P communication systems use various technologies and different methods to cooperate with the VRUs. These attributes can be considered to design constraints for V2P communication system. In this paper, the authors examine V2P safety aspects and have simulated different V2P scenarios considering real environments. Moreover, the authors analyze the V2P safety in different scenarios by considering the timely exchange of safety messages. The authors presented these results in different V2P approaches for separate VRU groups in different pre-crash situations.

KEYWORDS

5G, ITS-G5, V2P, V2X, VRUs

1. INTRODUCTION

From the start of 21st century, the automobile industry has evolved with the introduction ofConnected and Automated (CA) vehicular systems. This CA vehicular communication system is aimed to enhance road safety. In a CA system, the VRUs include pedestrians, bicyclists, and two-wheel rides. In 2018, the International Traffic Safety Data and Analysis Group (IRTAD) reported that there were 1605 and 10,386 VRU accidents in USA and Germany, respectively (Hess, 2004). Researchers are continuously striving to develop techniques to reduce VRU fatalities. Advanced techniques have been developed as a part of Intelligent Transportation Systems (ITS). In an ITS system, there is a communication system called Vehicle-to-Everything (V2X), that supports communication between several elements on

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road for CA safety (fig. 1). V2X includes a networking between vehicles and road-side-infrastructure known as Vehicle-to-Pedestrian (V2P), Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I). The term V2P integrates the networking among different VRUs and vehicles. Road safety can be enhanced by designing an active ITS safety critical system where V2P exchanges information with different VRUs (Lu, Men, 2005).

To provide safety critical messages, the V2P communication system needs to enable a collision detection feature. In this collision detection system, the vehicles, pedestrians, and smartphones need to periodically exchange beacon messages and after receiving the beacon messages, a Collision-Detection-Algorithm (CDA) is initiated. The exchange of beacon messages between vehicles and VRUs needs a seamless connectivity to effectively avoid road accidents. This seamless connectivity can be provided by combining communication technologies by creating a heterogeneous network (e.g., ITS-G5 + 4G/5G) (Cheng, Hong, 2005, Gandhi, Tarak, 2007).

2. AIMS, SCOPE, EXPECTED OUTCOME, AND STRUCTURE

In recent years, the majority of tresearch on vehicular communications considers V2V and V2I scenarios. In his paper, we introduce V2P scenarios considering a VRU group. We discuss characteristics of different VRUs and propose a framework for VRU group safety. We also present a comprehensive evaluation of prior work related to V2P and V2P safety applications together with their design challenges. In addition, we perform a case-study that evaluates the performance of different V2P safety approaches considering several VRU groups in four different pre-crash scenarios. Furthermore, we discuss the technical challenges to integrate VRUs safety system into a V2X systems.

The study also estimates the amount of information to be collected during the simulation process that is exchanged between vehicles, and this information is sufficient to warn pedestrians. These simulations result illustrate that the drivers would also be able to avoid V2P collisions by generating alerts. Finally, this study not only offers road safety for VRU groups but would also assist the stakeholders to develop ITS solutions. In this paper, we develop and execute a V2P communication

Figure 1.
Key elements involved in V2X communication