

Transportation
Safety and
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Project Title:
Analysis of Intelligent Vehicle
Technologies to Improve Vulnerable
Road Users Safety at Signalized
Intersections

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Analysis of Intelligent Vehicle Technologies to Improve Vulnerable Road Users Safety at Signalized Intersections.

Analyze crashes between vehicles and vulnerable road users (i.e., cyclists and pedestrians).

WHAT IS THE NEED?

Fatalities from motor vehicle crashes lead all accident deaths in the US, with a great economic loss (NHTSA 2018). In 2017, 34,247 people lost their lives in car-related crashes and there were 121,000 injured vulnerable road users (VRUs) (NHTSA 2017). Moreover, in California, 27.2% (982) of all reported crash-related fatalities were VRUs (NHTSA 2017). Besides, as the COVID-19 raised people's concern about personal health, more and more travelers prefer to drive personal vehicles, cycle, or walk, which can provide enough social distance. Thus, more trips by bike and walking are expected in the post-COVID19 era, which shows the importance of this research.

Often, crashes involving VRUs occur at intersections (NHTSA 2017). There are three main categories of factors influencing crashes between vehicles and VRUs: VRUs' demographic information, drivers' behavior, intersection condition, and weather. Habibovic and Davidsson (2012) used the SafetyNet Accident Causation System (SNACS) to create an aggregated causation chart for VRUs as well as for different inter-section types, injury severity levels, and trajectory types. They found that 30% of VRUs had visual obstructions before the crashes, and many would have benefited from active safety systems to avoid misunderstanding the traffic conditions or making inadequate actions.

Besides crashes at intersections, Robartes and Chen (2017) analyzed general crashes between vehicles and cyclists. Among all factors, the intoxication of both drivers and cyclists could hugely influence the severity of cyclists' injuries. Additionally, other factors, such as bicycle and automobile speeds, obscured



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automobile driver vision, vehicle types (SUV, truck, and van), and road design, would increase the probability of more severe bicyclist injuries. Silla et al. (2017) further quantitatively analyzed the influence of five intelligent transport systems in terms of decreasing motor vehicle VRU related crashes.

Among all the systems examined, Bicycle to Vehicle Communication (B2V) shows the highest impact on safety since it can cover all potential accident conditions. They also highlight the importance of technology adoption rates as a critical factor for their safety improvement potential. Patil (2016) and Ellen, Pace, and Yoon (2015) studied the adaptation of Vehicle to Bicycle (V2B) communication technologies in the real world. Their studies show that cyclists are willing to equip their bicycles with specific technology considering the potential improvement of personal safety.

As reflected by the literature, several sensor technologies in personal vehicles, freight trucks, and other users (e.g., VRUs) could help improve safety. Moreover, it is reasonable to assume that the incoming 5G Era would help mitigate telecommunication challenges for some of these advanced intelligent vehicle technologies (IVTs). Therefore, Caltrans needs to know how these IVTs will affect VRUs' safety in different environmental and system conditions (e.g., weather, traffic flow) at signalized intersections.

Furthermore, there are technical, operational, and financial differences between the various IVTs, and there are no studies about their suitability. To address these knowledge gaps, the research team will develop an empirical microsimulation tool to quantify the safety impacts of these IVTs on VRUs.

WHAT ARE WE DOING?

To accomplish the objective of this project, the researchers will first analyze the features mainly causing crashes between VRUs and vehicles at intersections. In details, they will estimate a statistical regression model to help predict VRUs' injury levels. Based on the modeling results, they will characterize typical scenarios that are more likely to cause traffic crashes between vehicles and VRUs at intersections.

Then, the researcher team will summarize the features and influence of different intelligent vehicle technologies (IVTs). Among IVTs, there are four main types related to potential safety impacts to VRUs: Blind Spot Detection (BSD), Bicycle/ Pedestrian to Vehicle communication (BPTV), and Intersection Safety (INS), VRU beacon system (VBS). The team will inspect how the four IVTs will influence drivers and/or VRUs behaviors in the simulation.

After the statistical analysis and IVTs summary, the team will conduct a microsimulation analysis to study the influences of different IVTs on typical crashes. Finally, the researchers will quantify the safety improvements for VRUs based on different penetration scenarios.

WHAT IS OUR GOAL?

The research team will finish a technical report on summarizing project results. Besides, this research will generate two peer-reviewed journal articles.

WHAT IS THE BENEFIT?

The goals and expected results of this project are consistent with one of the tenets of Caltrans: "Safety - improve the safety of VRUs at signalized Crosswalks." In general, this research will develop a simulation tool to help quantify safety improvement from various intelligent vehicle technologies (IVTs), including Vehicle-to-infrastructure (V2I). In particular, the work will contribute to fill the knowledge gap on IVT's influence on vulnerable road users' (VRUs)' safety.

The analysis of these technologies can help both public and related stakeholders to better understand how different IVTs will improve the safety of cyclists and pedestrians under various conditions at intersections. Thus, this research will eventually promote the adoption of IVTs in future transportation scenarios. The research would inform State agencies such as Caltrans, and local (Metropolitan) planning organizations about how to develop various IVTs and would have implications for improving the mobility of people and goods. Improving safety conditions to all users and especially to VRUs, is of great importance to the goals of Caltrans.

WHAT IS THE PROGRESS TO DATE?

Task completed. Close-out package submitted to ORM.