Research Report Summary

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Virtual Road Safety Audits

Recommended Procedures for Using Driving Simulation and Technology to Expand Existing Practices

A signalized intersection was identified as a potential candidate for a virtual road safety audit (VRSA). A VRSA involves adding an additional level of analysis focused on measuring driver behavior and expectations using driving simulation, dynamic surveys, or advanced data collection.

Project Summary

The feasibility of conducting a VRSA at the intersection of Park Street and Badger Road in Madison, WI, was evaluated.

Alternatives for conducting VRSA were reviewed. Alternatives identified included the use of a full-scale driving simulator experiment, the use of dynamic surveys, and the use of trajectory data obtained from vehicle detection systems.

Analysis Approach

A 3D model of the Park Street intersection capable of supporting full-scale driving simulator or dynamic surveys was created using consumer-grade modeling tools.

VRSA completion paths required for each alternative were analyzed from the perspective of time and effort requirements for similar intersection evaluations.

Recommendations

Based on an analysis of alternatives available, dynamic surveys were identified as a potential solution for conducting VRSA of intersections, and the scenario creation procedures were presented.

Dynamic surveys allow introducing a human performance component into the safety evaluation process without the complexities associated with full-scale driving simulator experiments.

A summary of the alternatives available that should be considered when conducting a VRSA is presented in the next page.

The selection of an evaluation process should be based on the needs of the project and the nature of the intersection being evaluated. The selection process should also consider the resources and timeline of the project.

Levels of Scenario Detail for VRSA

LiDAR-Based Scenario (Left) Side-by-Side with Actual Photo

Scenario Using Consumer-Grade Modeling Tools

Data-Driven Evaluation Tools

Example of Equipment Used to Obtain Vehicle Trajectory Data from Radar-Based Vehicle

Full-Scale Driving Simulator Evaluation

A full-scale driving simulator scenario provides insight into the behavior of drivers who navigate an intersection that is not possible to obtain using traditional road safety audit techniques. The controlled nature of the experiment allows for the isolation of factors that could impact driver performance, thus bringing the benefits of a controlled experiment to the road safety audit process. A key and critical component of a driving simulator experiment is the scenario used. Multiple scenario creation options exist, defined by the level of detail, and need to be considered prior to conducting an experiment. Depending on the goals of the project, the level of detail of the scenario is selected to meet the needs of the experiment. Levels of detail possible range from game-studio-quality scenarios created using LiDAR scans, high-resolution images, and professional-grade software to scenarios created using consumer-grade 3D modeling software. Regardless of the scenario level of detail selected, the full-scale driving simulator evaluation is one of the most complex alternatives for conducting virtual road safety audits.

Example of Device Used to Measure Reaction Times in Dynamic Surveys

Dynamic Survey (3D Model) Evaluation

Conducting full-scale driving simulator studies introduces time and complexity overheads in the process which, while often justified, are not required for all projects; especially if the experimental needs can be addressed with simpler experimental tools such as surveys. 3D models created for a full-scale driving simulator scenario can be streamlined, simplified, and used to render animations of roadway scenarios/conditions. The animations can be used to create dynamic surveys in which subjects are presented with scenarios and are asked to react to events, such as the appearance of a pedestrian, within the animation. Reaction to events by subjects can be done using traditional data collection tools such as push buttons and clickers. The main benefit of using dynamic surveys is that, due to the reduced time and complexity overheads, a larger number of subjects can be evaluated. When compared to a full-scale driving simulator experiment the main tradeoff is the lack of physics and reduced realism. Therefore, the dynamic survey method can provide an insight into how drivers comprehend scenario in which vehicle dynamics do not play a significant role.

Data-Driven Evaluation

Traditional road safety audits often involve field reviews of an intersection by a group of experts. Field reviews, while providing an opportunity to observe driver behavior directly, don't provide strong and objective measurements of driver performance. For decades, researchers have identified surrogate safety measures as an objective method to understand the safety of the transportation system without the need to wait for crash history to become available. Unfortunately, obtaining the necessary data to perform the evaluation could be a time-consuming process. For example, identifying issues that could eventually result in rear-end crashes requires constant monitoring of braking activity, which is often infeasible over long periods of time. Due to advances in vehicle detection technology, software can be used to monitor vehicle trajectories. Vehicle trajectories can then be used to analyze vehicle behavior at intersections, understand vehicle interactions, and compute surrogate safety measures values such as time to collision. Data-driven evaluations that rely on automated data collection tools provide an economically feasible method to conduct virtual road safety audits.