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EDITOR'S NOTE

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Performance-Based Assessment of Road Design Elements Using Lidar Technology: Toward Adopting a Safe System Approach

Suliman Gargoum

Abstract

The dissertation proposes the adoption of a performance-based design (PBD) approach whereby links between driver capabilities, safety performance, and geometric design elements on existing roads are first established before formulating design requirements for new facilities. The first phase of the thesis focuses on the development of novel algorithms that employ statistical pattern recognition techniques and machine learning tools to facilitate the large-scale extraction and assessment of different geometric elements, including the available sight distance on highways that were scanned using mobile lidar technology. The second phase focuses on conducting a performance-based assessment of stopping sight distance (SSD) requirements on highways.

The performance-based assessment is conducted deterministically and probabilistically with the aims of 1) developing an understanding of the underlying links between the demand for sight distance, geometric integrity, and safety performance on existing highways and 2) developing a framework for future studies interested in conducting a performance-based evaluation of other geometric design elements. The examination revealed that a significant proportion of the analyzed highways did not satisfy the SSD requirements of up to 70% of the driving population. These finding indicate the importance of adopting a probabilistic performance-based approach, which integrates driver capabilities and anticipated safety performance when designing new highway facilities. Besides introducing the concept of PBD in highway engineering with the aim of improving safety on roadways, the thesis develops novel algorithms that can be used for efficient network-level assessment of existing road infrastructure.

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Modeling the Risk of Wrong-Way Driving at Freeway Exit Ramp Terminals

Md Atiquzzaman

Abstract

Wrong-way driving (WWD) crashes are a critical safety issue on freeways. Although these crashes are rare in nature, they often result in severe injuries and/or fatalities. Typically, exit ramp terminals are the

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initial point of entry for most wrong-way drivers on freeways. Therefore, it is important for transportation agencies to identify the exit ramp terminals with a high risk of WWD and adopt a systemic safety approach to proactively reduce the probability of WWD crashes before they happen. However, the rare nature of WWD crashes and the difficulty of identifying the actual entry points make it hard to assess the risk of WWD at an exit ramp terminal. To overcome this issue, in this study, logistic regression models have been calibrated for predicting the risk of WWD at the exit ramp terminals of full diamond and partial cloverleaf (parclo) interchanges. Geometric design features, the use of traffic control devices, traffic volumes, and area types were used as the potential predictors of WWD.

To evaluate their performance, the calibrated models were used as a network screening tool to rank the exit ramp terminals of full diamond and parclo interchanges in Alabama from high to low risk of WWD, and the occurrences of WWD events were observed during a 48-h period by using video cameras. The observation of WWD incidents at high-risk locations demonstrates strong evidence that the models calibrated in this study can identify the exit ramp terminals that have a high likelihood of WWD. Transportation agencies can use these models to assess the danger of WWD at the exit ramp terminals within their jurisdictions and identify high-risk locations to facilitate countermeasure implementation.

> The study of human factors based on physiological and psychological data has become a hot research topic in many fields.

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Electroencephalogram-Based Seafarers' Performance Recognition

Jinglei Chen

Abstract

Today, 80% of water traffic accidents are related to human factors. Most of the existing research on human factors is based on qualitative and quantitative examinations of accident reports from a macro perspective, which makes it difficult to reflect the relationships between human behaviors and maritime accidents. With the development of signal acquisition technologies, the study of human factors based on physiological and psychological data has become a hot research topic in many fields. Based on the physiological data of seafarers, this study examined the influence of human error on water traffic accidents from the perspective of driving behavior characteristics by carrying out sailing simulation experiments and establishing common navigation scenarios.

Taking the captain of a four-person group as the research object, the real-time electroencephalogram signals of the captain were collected. Wavelet decomposition was used to extract the theta band. By extracting features through power spectrum analysis and establishing seafarers' workload classification model by using support vector machine and neural network algorithms, an average accuracy of 85.06% and 86.26%, respectively, was achieved with the proposed model. Finally, the seafarers' workload during the simulation experiments is identified. By collecting data about sailors' mistakes during the experiment, the relationship among seafarers' workloads, the navigation scene, and human error is further analyzed. A 61.92% increase of seafarers' workloads can be assumed to cause human error. The method proposed in this study can effectively explore the internal relationship between the physiological and psychological states of seafarers, so it can play a good role in explaining, in more detail, sailors' error rates and ensuring navigation safety.

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