Application of Computer Vision to Diagnosis of Pedestrian Safety Issues

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The potential for using computer vision techniques to solve several shortcomings associated with traditional road safety and behavior analysis is demonstrated. Surrogate data such as traffic conflicts provide invaluable information that can be used to understand collision-contributing factors and the collision failure mechanism better. Recent advances in computer vision techniques have encouraged the use of proactive safety surrogate measures such as detection of conflicts and violations. The objective of this study is to demonstrate the automated safety diagnosis of pedestrian crossing safety issues by using computer vision techniques. The automated safety diagnosis is applied at a major signalized intersection in downtown Vancouver, British Columbia, Canada, at which concerns had been raised regarding the high conflict rate between vehicles and pedestrians as well as the elevated number of traffic violations (i.e., jaywalking). This study is unique in its attempt to extract conflict indicators and detect violations from video sequences in a fully automated way. This line of research benefits safety experts because it provides a prompt and objective safety evaluation for intersections. The research also provides a permanent database for traffic information that can be beneficial for a sound safety diagnosis as well as for developing safety countermeasures.

Active modes of travel such as walking are recognized as alternatives to vehicle travel in order to improve the sustainability of the transportation system. However, these active modes usually suffer from an elevated risk of collision involvement because of their physical vulnerability. Therefore, a thorough investigation of pedestrian exposure to the risk of collisions as well as identification of contributing factors to pedestrian safety issues are of significant importance.

The purpose of a safety diagnosis study is to identify factors that may be causing or contributing to safety issues at a particular location. Traditionally, pedestrian safety diagnosis studies have relied on the analysis of collision data and use of the judgment and experience of traffic safety professionals to determine specific problems and to develop countermeasures. However, in these approaches, the identification of pedestrian exposure to the risk of collisions is a challenging task. Reliance solely on collision data statistics is usually insufficient for the study of pedestrian–vehicle interactions because of data quantity and quality issues. Surrogate safety data such as traffic conflicts and violations can be used to better understand collision-contributing factors and the collision failure mechanism. Current field-based methods for collecting pedestrian data are labor-intensive, unreliable, time consuming, and costly. Reliability issues stem from the fact that pedestrians move in a less organized fashion than vehicles, at higher densities, and in more complex spaces than vehicular traffic (*1*).

Video sensors are now advocated as an alternative data collection procedure, solving many issues in the manual data collection and providing a more practical and efficient way to capture, store, and analyze traffic information. The challenging tasks in video-based analysis are the interpretation of the traffic scene as well as the identification of important traffic events. Video data analysis is sustained with practical computer vision applications. Computer vision systems are developed to automatically detect and track moving objects in videos. They provide an automated interpretation of the different scenes.

The potential for using computer vision techniques to solve some shortcomings associated with traditional road safety diagnosis and behavior analysis is demonstrated. Despite the potential benefits of automated traffic safety analysis based on video sensors, limited computer vision research has been directly applied to pedestrian safety. The precise estimation of exposure as well as other road safety parameters, such as the severity of traffic conflicts, can be undertaken by analyzing road users' trajectories, that is, their spatial and temporal positions (*2*). The objective of this study is to demonstrate the automated safety diagnosis of pedestrian safety issues using computer vision techniques. The elements of the automated safety diagnosis are as follows:

1. Conflict analysis. The use of traffic conflicts for safety diagnosis has been gaining acceptance as a proactive surrogate for collision data analysis since they provide insight into the failure mechanism that leads to road collisions (*3*). Traffic conflicts address several shortcomings associated with collision data such as the scarcity of collisions, the need for long observation times, and the poor quality of collision data. Traffic conflicts are more frequent than road collisions and are of marginal social cost. Conflict indicators are automatically measured for all pedestrian–vehicle events and provide detailed insight into the conflict process.
2. Violation detection. Traffic violations can reveal indispensable information about the safety of a location. Traffic violations occur when road users seek to increase mobility by disregarding existing traffic regulations (e.g., spatial violations in which pedestrians decide to cross in nondesignated crossing regions); this behavior can come at the expense of accepting additional collision risk. In many situations, traffic violations can provide a reliable surrogate road safety measure, especially where road collisions are attributable to noncompliance (*4–6*). This practical benefit of observing violations as safety surrogates is especially realized when observation periods are limited, a characteristic shared with traffic conflicts. Spatial violations are automatically detected for all pedestrians in this study.

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