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Developing a Computer Vision-Based Decision Support System for Intersection Safety Monitoring and Assessment of Vulnerable Road Users

Project 1858
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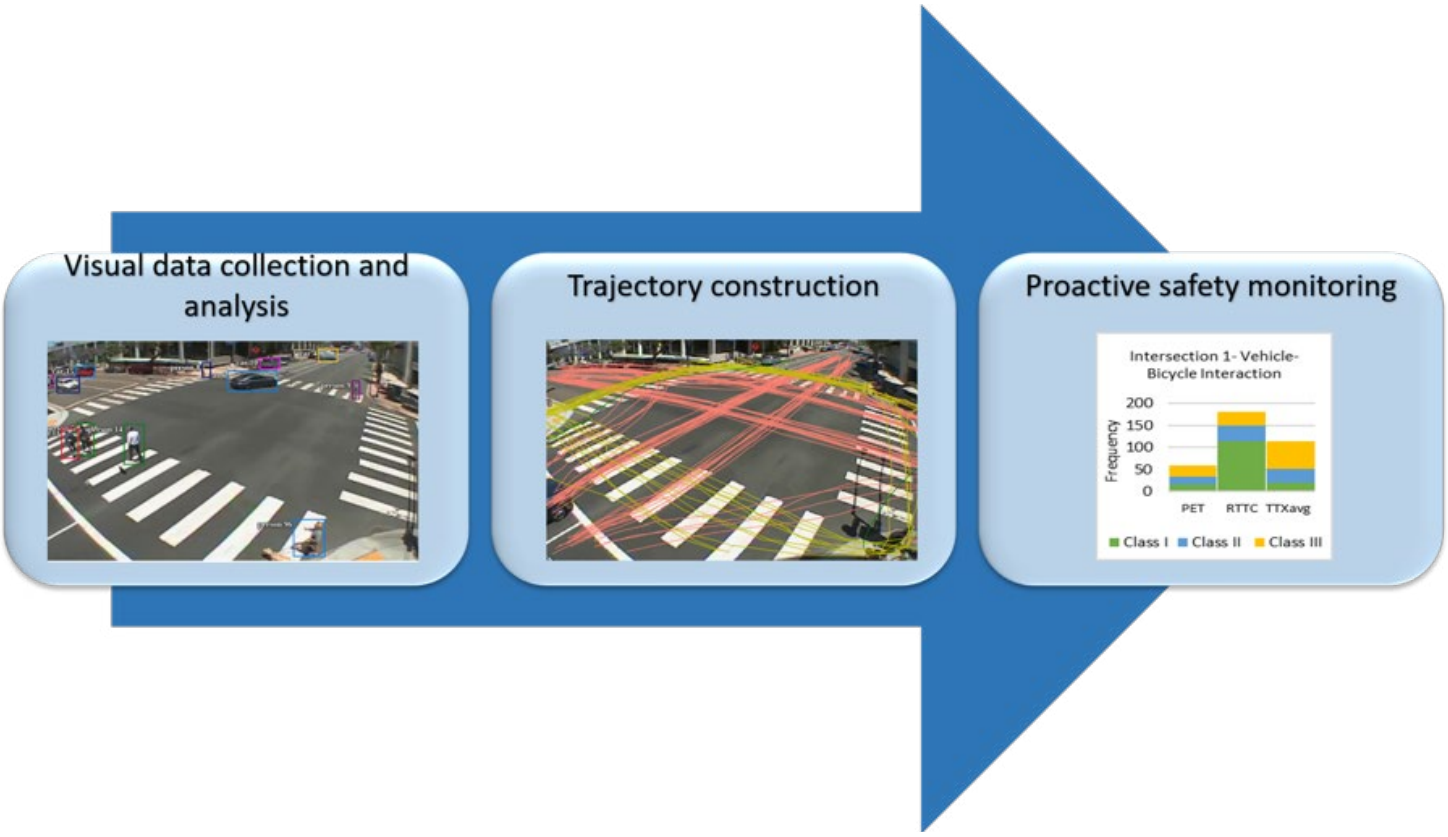

Measuring safety is a complex task. Roadway crashes are perhaps the best indicators of roadway safety. However, using crash frequency alone overlooks many dangerous situations that might have led to actual crashes. In addition, since crashes are rare events, one must wait years to observe a sufficient number of crashes to be able to measure safety. When it comes to evaluating safety, signalized intersections pose an intricate problem because many vulnerable road users are exposed to vehicular traffic. The primary goal of this research is to monitor interactions between vulnerable road users (i.e., pedestrians and bicyclists) and vehicles in order to proactively measure safety at signalized intersections. This research develops a safety assessment framework using real-world video data from ten signalized intersections in San Diego, California.

Study Methods

This research develops a decision support system that proactively evaluates the safety of vulnerable road users by identifying dangerous situations at signalized intersections. The decision support system consists of three steps in consecutive order: first, the system develops machine vision detection models to detect moving objects such as pedestrians, bicyclists, and vehicles in the video data; second, the system extracts object trajectories by adopting a machine vision tracking

model; and third, the system identifies dangerous situations (i.e., near-crashes) by utilizing several surrogate safety measures (SSMs). SSMs make use of machine vision models' outputs, such as object location, speed, and direction of travel in order to recognize a near-crash event.

The research shows that proactive safety monitoring should consider a combination of safety surrogate measures instead of a single measure.

Findings

Safety surrogate analysis identified intersections with the highest number of near-crashes for certain interaction types. For instance, the analysis showed which intersection experienced the highest number of vehicle–bicycle near-crashes. In addition, safety evaluation identified some events as critical using one SSM but non-critical using a different SSM. The reason for experiencing this discrepancy was because these SSMs are defined differently, and thus one should consider a combination of SSMs for a more reliable safety assessment. The decision support system showed how safety can be assessed automatically. For certain interaction types (e.g., vehicle–bicycle), the automated process identified a similar number of critical events comparing to the ground truth. The decision support system also showed decent results in terms of correctly detecting and tracking moving objects. Detection and tracking accuracies for certain object types at some locations were higher than 80% and 60%, respectively. The research also identified ways to improve the models' performance, such as utilizing video data with higher resolutions and using more data for model training.

Policy/Practice Recommendations

The decision support system developed in this study provides an opportunity for practitioners to proactively assess the safety of vulnerable road users at intersections using video data. Applying the framework of this study, transportation agencies can exploit the video data from existing surveillance cameras, or install new cameras, at intersections for the purpose of implementing a proactive and automated safety monitoring system. The system can also be utilized to measure the effectiveness of a certain treatment or design, such as a new signal timing plan.

About the Authors

Dr. Jahangiri, the project PI, is an Assistant Professor at SDSU. Drs. Machiani and Lui, the project Co-PIs, are Assistant Professors at SDSU. Dr. Balali is an Assistant Professor as CSULB. Anagha Katthe, Aryan Sohrabi, and Shashank Pulagam are graduate research assistants at SDSU.

To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/research/1853.

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