Automated Safety Evaluation of Intersections using Advanced Video Recognition Technology

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Abstract

The present study aims to assess the utility of advanced video recognition technology in assessing road safety at intersections. In particular, this study assessed safety performance of three complex intersections in Brisbane by using safety surrogates automatically measured by an advanced video recognition technology. Traffic movement data on typical weekdays at the chosen intersections were video recorded. Conflict analysis was then performed by analyzing traffic interactions among vehicles, pedestrians and cyclists. In particular, Time-To-Collision (TTC) and Post Encroachment Time (PET) were used to identify frequency, severity and locations of the conflicts at each intersection. Subsequently, suitable countermeasures were identified to reduce these conflicts and improve safety at these intersections

Background

The traditional approach of safety assessment mainly focuses on crash occurrence and consequences gleaned from police reported crash data. However, there are several well-known ethical as well as scientific issues of using post-hoc crash data for traffic safety analysis. In contrast, analysis of observable non-crash traffic events can provide with reliable surrogate measures for determining the road safety situation at a location of interest (Chin, Quek & Cheu, 1992; Chin & Quek, 1997; Parker & Zegeer, 1989; Allen, Shin & Cooper, 1978).

This study applies an advanced automated traffic safety diagnosis technique from prerecorded video data to evaluate safety performance of three complex intersections in Brisbane and suggest potential strategies for intersection improvement and risk mitigation.

Method

The three intersections, operated and maintained by the Brisbane City Council, selected for this study included: a) Vulture St Intersection, b) McCullough St Intersection, and c) Turbot St Intersection. The primary data consisted of video footage of traffic movements at the study intersections collected for two consecutive days using overhead video cameras placed on a trailer. Video data of the first of these two days was used for camera calibration, while the second day data collected between 7 am and 7 pm was used for conflict analysis.

Automated safety analysis included three components: automated volume count of various types of road users, conflict analysis, and violation analysis. Conflict analysis included counting conflict frequency, and identifying conflict severity and location (conflict points). The conflicts observed covered vehicle-vehicle, vehicle-pedestrian and vehicle-cyclist interactions.

In this project, two well-known conflict indicators viz. Time-To-Collision (TTC) and Post Encroachment Time (PET) were considered. Thus, a conflict with either TTC ≤ 3 seconds or PET ≤ 1.5 seconds was considered for further analysis.

The minimum time-to-collision (TTC) of each event was mapped to a Severity Index (SI) using a transformation developed by Saunier & Sayed (2008). The SI is a measure of conflict severity ranging from 0 (uninterrupted passages) to 1. Events with a higher severity index correspond to more severe traffic events.

Results

At the Vulture St Intersection, a total of 941 conflicts with TTC ≤ 3 seconds and 61 PET conflicts were observed. About 37% of TTC conflicts at this site had a SI of 0.8-1.0, indicating a larger proportion these conflicts are severe. About 72% of these conflicts were rear-end conflicts, and about 23% conflicts were side-swipe conflicts. These conflicts mostly occurred as a result of the interactions between right-turning traffic and through traffic along various approaches of the intersection. Countermeasures for this intersection included removal of left-turn slip lane, realignment of pedestrian crossing, and installing directional/lane type diagrammatic signs.

At McCullough St Intersection, a total of 336 TTC conflicts and 137 PET conflicts were observed. About 74% conflicts at this site were rear-end conflicts, about 13% were head-on conflicts, and about 6% were side-swipe conflicts. Countermeasures for this intersection included reversing priority at an approach by installing give-way treatment, extending left-turn stand-up lane and redesigning signal phases.

At Turbot St Intersection, a total of 465 TTC conflicts were observed; of these about 80% conflicts were rear-end conflicts, 13 were right-angle conflicts, and 7% were side-swipe conflicts. A significant number of these conflicts resulted from drivers not properly guided through the intersection. Countermeasures for this site included extending separator median by Chevron painting, demarking lane types by pavement directional arrows, installing pedestrian crossing ahead sign and directional diagrammatic signs.

Conclusions

The study demonstrates the capability of automated video analysis technique in diagnosing safety of complex intersections and identifying targeted countermeasures. These methods can be used to investigate particular road user behavior such as maneuvers of cyclists at roundabouts and lane filtering of motorcyclists or could be extended to conduct a before-after evaluation of safety countermeasures. A worthwhile research direction would be investigating the relationship between safety surrogates and historical crash records at these intersections.

References

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