Privacy-preserving trajectory-based intersection safety assessment

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Abstract

Traffic crosses, converges, and diverges at intersections. At intersections, vehicles have a higher chance to approach each other in time and space, resulting in traffic conflicts. Traffic conflicts are considered the precursor state to collisions. Indeed, although intersections account for only a small proportion of the entire road system, from 30% to 60% depending on the region or country, a significant proportion of road collisions occur at intersections.

The design and management of intersections aim to resolve conflicts and thus minimize collisions. How well does an intersection achieve this aim? Many studies have attempted to answer the question by assessing the safety level of an intersection. Due to the rarity of reported accident data and the plausibility of microsimulation data, existing methodologies are inadequate for the safety assessment of specific locations at an intersection. The growing maturity of object detection and tracking with computer vision has made the location-specific assessment based on realistic trajectories possible. However, video recordings and trajectories, even if anonymised, are vulnerable to privacy attacks due to drivers' stable driving patterns that can be recognized by algorithms.

In this study, we present a privacy-preserving framework for trajectory-based intersection safety assessment. With real-time traffic videos inputted but never stored, the framework can output visualised expectations of conflict characteristics at any location within an intersection. Four advantages are offered by this framework over the existing solutions. It
1) is fully automatic and privacy-preserving, with video recordings as input and visualized assessment results as output,
2) is based on real-life road use and takes thorough account of individual conflicts,
3) assesses the expectations of conflict size, duration, and speed at any location within an intersection, and
4) is flexible to be real-time or hourly/daily updated.

This is the first solution that assesses intersection safety in real time according to real-life road use, yet also protects the road users from being tracked. It will help the traffic management department to automatically and securely monitor the use of intersections and identify bottlenecks that need improvement. For the public, such intelligent management and improvement will lead to two benefits. On the one hand, it will facilitate the efficiency of intersections and in turn the entire transportation network. On the other hand, it will reduce conflicts and collisions, offering a safer traffic environment.

Currently, our solution only looks at one single intersection, whereas intersections are connected by roadways in reality. Traffic flows from one intersection through the roadways to another, which together form the transportation network. Intersections thus interplay with each other. Such interactive influence may lead to unknown challenges to overcome in the future.