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RESEARCH SUMMARY

DESIGN AND EVALUATION OF A DYNAMIC DILEMMA ZONE SYSTEM FOR A HIGH SPEED RURAL INTERSECTION

Problem

Improving traffic safety is a priority transportation issue. A tremendous amount of resources has been invested on improving safety and efficiency at signalized intersections. Although programs such as driver education, red-light camera deployment, and operational improvements to roadway geometry have all contributed to a safer driving environment, significantly reducing traffic signal-related crashes remains a challenging task. For example, with the rapid urban sprawl, many signals have been installed at high-speed rural intersections due to their increasing traffic volumes. Most of those intersections have posted speed limits over 50 mph, which can pose a hazardous situation for motorists when approaching a signal during its yellow phase. Drivers in such situations could be caught in a so-called dilemma zone: they can neither pass through the intersection before the light turns red, nor can they slow down comfortably at the stop line. Insufficient protection of motorists within the dilemma zone often leads to red-light running and could result in severe accidents due to the high speeds.

Objective

The objective of this research was to develop an effective system to protect drivers trapped in the intersection dynamic dilemma zone. The study included the following three principal tasks: (1) understanding critical factors contributing to a driver's decision during a signal yellow phase and their relations to the distribution of intersection dilemma zones; (2) designing a dynamic dilemma-zone protection system to reduce the potential for accidents at high-speed intersections; and (3) implementing the designed protection system at the intersection of US 40 and Red Toad Road and evaluating its effectiveness with field data.

Description

The report consisted of two parts. Using extensive field observations from a previous phase of the study, Part I focuses on identifying critical factors affecting a driver's decision when encountering a yellow signal phase. Part II centers on developing a dynamic dilemma-zone protection system, based on the response patterns of different populations at high-speed intersections as observed in the Part I study. The developed system has been deployed by SHA at the intersection of

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US 40 and Red Toad Road and evaluated by the research team to confirm its effectiveness in preventing accidents caused by dilemma zones

Results

This research, utilizing the dynamic detection technology to design an intelligent dilemma zone protection system, has yielded the following findings:

- The dilemma zone is dynamic in nature, varying with the driving population. Thus, the dilemma zone computed with the conventional method reflects only a sub-segment of the spatial distribution of dilemma zones.
- The spatial distribution of dilemma zones at a high-speed intersection varies with the speed distribution of its approaching vehicles, whose drivers can be generally classified as aggressive, normal, and conservative. The length that covers the dilemma zones of all driving groups increases with the variance of the speed distribution among the driving populations.
- The designed system for dynamic dilemma zone protection seemed to function effectively during the field evaluation period. The field image data actually evidenced its effectiveness in preventing a potential side-collision accident.
- The implemented protection system had no false negative detections during the evaluation period; that is, no vehicle meeting the criteria to call the all-red extension was missed by the dynamic detection system.
- A hazardous intersection, such as US 40 at Red Toad Road, can be monitored effectively with the relatively simple system developed in this study to improve its traffic safety.
- A variety of factors may affect a driver's decision to take an aggressive or a conservative action during the yellow phase. Factors include: average traffic flow speed, green splits, traffic volume, signal coordination, the number of approach lanes, talking on the phone or not, vehicle type, driver age, and gender.

Report Information

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