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Research Notes

Enhancing Work Zone Safety Through Work Zone Speed Limit Reduction (WZSLR)

Test and evaluation of the most effective Work Zone Speed Limit Reduction (WZSLR) Strategies.

Traffic Operations Research

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Project Title:
Work Zone Speed Limit Reduction (WZSLR) Research

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WHAT IS THE NEED?

The work zone (WZ) is a complex driving environment for drivers due to elevated cognitive load, safety risk, and enforced speed management. Despite various efforts to improve worker and motorist safety in work zones, work zone-related fatal crashes have increased by 53% in California since 2010. Moreover, California also ranked in the top 10 states with the highest number of fatal work zone crashes and fatalities involving commercial motor vehicles from 2012 to 2017, imposing approximately $1.2 billion in societal costs.

In recent years, the California Department of Transportation (Caltrans) has marked safety as the primary goal in their 2020-2024 Strategic Plan and designed several educational programs, including (a) the California move-over law, (b) work zone alert, and (c) slow for the cone zone. Following the recommendations from the annual safety summit, Caltrans has spearheaded Work Zone Speed Limit Reduction (WZSLR) strategies and technologies in the field to improve safety. However, the effectiveness of these strategies in improving work zone safety has not been studied under variations of work zone type, traffic mix, traffic volume, time, and location of construction with extensive field data.

WHAT ARE WE DOING?

From meetings with Caltrans personnel, the researchers learned that for work zone projects that implement WZSLR, Caltrans has a general work zone management plan that documents the work zone speed reduction request from the local districts and requires contractors to collect traffic speed and other related traffic data during construction. However, the traffic data collected is not centralized, categorized, and evaluated over the entire California highway network based

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on the work zone type and location. Thus, a rigorous evaluation of any WZSLR strategy requires the assimilation of data from different Caltrans districts. The proposed study will address the needs and proceed in two phases.

The first phase will gather and centralize the traffic data from the previous work zone projects throughout California in the last five years (which will need close collaboration with various Caltrans districts), assess data quality, and perform a preliminary analysis of the effectiveness of WZSLR based on this assembled data set.

This preiminary analysis will help guide the Phase 2 project, where the most used WZSLR strategies identified by Caltrans will be tested in the field with thoughtful experimental design and data collection that can help the researchers draw convincing conclusions about the effectiveness of the tested WZSLR strategies. The execution of Phase 2 needs close cooperation from the Caltrans districts where the field tests are carried out.

WHAT IS OUR GOAL?

The project aims to assess the effectiveness of WZSLR strategies across California based on work zone location and type, traffic volume, and classification. To achieve this, the project is divided into two phases with Phase 1 focusing on existing literature, data, and work zone safety practices in and outside of California. Phase 2 uses controlled experiments to dig deeper into the safety impact of selected WZSLR strategies through field studies in California.

WHAT IS THE BENEFIT?

The research will assess the effectiveness of WZSLR strategies across California based on work zone location and type, traffic volume, and classification. In addition, the WZSLR strategies identified by Caltrans will be tested in the field with thoughtful experimental design and data. This research will provide impacts of selected WZSLR strategies and results in a recommendation for Caltrans to use.

WHAT IS THE PROGRESS TO DATE?

- **Identify Top WZSLR Strategies:**
  Researchers conducted a comprehensive review of state-of-the-art literature to identify the most commonly used devices and practices for speed reduction strategies in work zones across various states. Numerous studies have assessed the effectiveness of these strategies through field experiments, driving simulator tests, and survey-based approaches. The findings from their literature review were compiled into a detailed table, which was presented to Caltrans during monthly meetings. Following in-depth discussions and an evaluation of specific conditions, the researchers identified dynamic speed feedback signs and law enforcement presence as the most promising control measures to investigate and assess further in selected work zones.
- **Design Experiments and Measurement Specifications**
  After identifying potential speed reduction strategies, the researchers focused on studying speed limit compliance as a key measure of safety in work zones that implement these strategies. This decision was informed by findings from Phase I of the research, where the researchers demonstrated a strong correlation between speeding and injury severity in work zone crashes. For this task, we developed a set of experimental designs to guide data collection, which included the selected speed limit reduction (SLR) strategies, detailed work zone layouts, specific data collection locations, and other relevant parameters. The researchers then prepared a comprehensive plan outlining our request for speed data collection in California work zones that meet those criteria. This plan was shared with Caltrans for their review and collaboration in facilitating the data collection process.
- **Collect Real-Time Data**
  The researchers conducted a data collection trip to Southern California, specifically in Santa Barbara from July 25th to 27th. During this trip, they gathered 45 minutes of data at a work zone along US 101, where a lane closure was in effect. To capture detailed information, they used a drone to collect video footage near a dynamic speed feedback sign, where the speed limit had been reduced from 65 to 55 mph. This approach allowed them to gather real-time data while also observing drivers' behavior in work zones.
- **Data Processing and Analysis**
  Since the video data collected from the Santa

Barbara work zone was the only available source of speed data so far, the researchers dedicated most of the past month to processing this footage. The primary focus is on capturing vehicle speeds to assess whether the dynamic speed feedback sign was effective in reducing speeds within the work zone. This analysis will help determine the sign's impact on improving speed compliance and overall safety. To process the videos, the researchers primarily used YOLOv8 (You Only Look Once) models to detect vehicles and their types (cars, trucks, etc.) and SORT (Simple Online and Real-Time Tracking) to track the detected objects across frames. The researchers then defined a Region of Interest (ROI) and calculated the position based on the absolute difference between the vehicle's initial position and its position at the end of each frame. Finally, they measured the distance and calculated the speed of each vehicle based on the time between video frames. By applying this algorithm to the collected video data, they extracted speed data and further analyzed the distribution to determine the mean speed, the 85th percentile speed, and the percentage of high-speed vehicles.

IMAGES

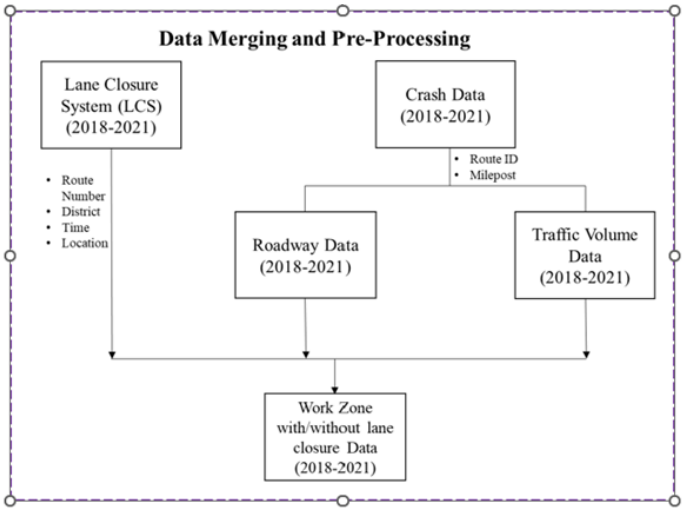

Image 1: Data Merging and Pre-processing

Image 2: Research Framework

Image 3: Sample video using YOLOv8 Detection and Tracking

Image 4: Raw video from drones

Image 5: Processed video including Type, Position, Speed, and Lane number.