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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Long Range Automated Lookout for Roadside Operations

Creating a camera-based detection system that recognizes abnormal approaching vehicles and delivers immediate safety warnings to the California Department of Transportation (Caltrans) crews.

Maintenance

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Project Title: Long Range Automated Lookout for Roadside Operations

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WHAT IS THE NEED?

Roadside operations require workers to maintain continuous awareness of approaching traffic. Crews often rely on a designated lookout whose only role is to watch oncoming vehicles and warn others when a driver behaves unsafely. This method depends on human attention and does not always provide enough reaction time. Hazardous situations can develop faster than workers are able to identify and communicate danger, especially on high-speed facilities.

There are limits to how long a worker can maintain uninterrupted focus on incoming traffic. Fatigue and distraction can reduce the effectiveness of a lookout. In some cases, unsafe driver behavior should be detected at a greater distance from the work zone to give workers more time to move to a safe location. These limitations show the need for a system that can monitor traffic continuously and provide earlier warning than a person can. A monitoring system that detects abnormal or unsafe vehicle behavior and alerts crews could reduce risk for both workers and motorists. A reliable, automated lookout could support field operations and address longstanding safety concerns.

WHAT ARE WE DOING?

The research team is examining how to create a long range camera based detection system that identifies abnormal approaching vehicles and provides timely warnings to Caltrans field crews. The team is reviewing operating conditions in temporary maintenance work zones and the safety challenges that crews face when relying only on a human lookout to monitor traffic. The work includes defining the functional and performance requirements needed for a system that can monitor incoming traffic continuously and

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detect unsafe behavior at a greater distance than a person can.

Advanced Highway Maintenance and Construction Technology (AHMCT) is evaluating available camera technologies, image characteristics, and placement options that support long range detection. The team is studying how factors such as distance, angle, roadway type, and lighting influence the ability of a camera to capture useful information about approaching vehicles. AHMCT are identifying the ranges, resolutions, and environmental conditions that shape system performance and determine what hardware is practical for roadside deployment.

The team is developing a framework that will support automated analysis of camera feeds to recognize abnormal vehicle behavior. This includes identifying suitable detection methods, establishing data needs, and outlining how warning messages will be delivered to workers. The work will guide the design of a prototype system that can provide near real time alerts during maintenance operations.

WHAT IS OUR GOAL?

The goal is to develop and evaluate a real time video based anomaly detection system that identifies unsafe driving behavior, such as high speed or erratic movement, and alerts Caltrans workers through a wireless communication system. The task will produce a validated system concept, prototype components, and guidance for future deployment.

WHAT IS THE BENEFIT?

A system that detects hazardous vehicle behavior earlier than a human lookout can improve worker safety and reduce the risk of incidents in roadside environments. Workers could receive timely warning even when traffic conditions change suddenly. This research supports Caltrans efforts to enhance field safety and modernize work zone practices.

The results may inform decisions about future equipment, provide a foundation for integrating automated lookout functions into maintenance operations, and offer guidance that other agencies may adopt.

WHAT IS THE PROGRESS TO DATE?

AHMCT has completed a review of relevant prior work, including Caltrans tasks and national studies related to anomaly detection and safety monitoring. The team conducted an extensive literature review on machine learning frameworks used for identifying abnormal behavior in traffic and safety critical applications. Initial findings were presented at the previous panel meeting.

The research team has begun early concept development. Several modeling strategies are being evaluated to understand what each approach requires for data inputs, labeling, and operating conditions. Work is focused on achieving robustness across varied roadway and lighting conditions, identifying resolution and frame rate needs, and determining latency requirements for a near real time alert system. The team is also preparing data collection specifications and evaluation parameters for testing the model in representative highway environments.

Next steps include finalizing the system concept, concluding the literature review, defining data collection requirements, and preparing for initial model development. Field testing and alert system evaluation will begin after the concept is validated.