Project Summary

Texas Department of Transportation

0-4746: Non-Vital Advance Rail Preemption of Signalized Intersections Near Highway-Rail Grade Crossings

Background

The Texas Department of Transportation (TxDOT) primarily uses simultaneous preemption of traffic signals near highway-rail grade crossings to clear queued vehicles prior to the arrival of a train at the crossing. With simultaneous preemption, the preemption sequence and the active warning devices (i.e., the gates and flashing lights) begin operating at the same time.

Federal regulations require that active warning devices "provide at least 20 seconds warning time … before the grade crossing is occupied by rail traffic." At some intersections, 20 seconds of advanced warning may not be sufficient to allow the traffic signal to clear pedestrians using the normal clearance intervals between phases. The *Texas Manual on Uniform Traffic Control Devices* permits "the shortening or omission of any pedestrian walk interval and/or pedestrian change interval" during preemption. However, shortening or omitting pedestrian walk and/or change intervals can lead to pedestrians being trapped in the crosswalk without any protection to finish crossing the intersection if a train arrives at the wrong time during the cycle.

What the Researchers Did

In this project, researchers at the Texas Transportation Institute (TTI) developed and tested two alternative strategies for ensuring safe pedestrian clearance at highway-rail grade crossings. The strategies were called Non-Vital Advance Preemption (NVAP). The first strategy, NVAP – Type 1, uses a second, lower-level preemption sequence to guarantee full pedestrian clearance is provided to a terminating phase before the traffic signal starts the preemption sequence. The second strategy, NVAP – Type 2, uses the pedestrian-omit feature to prevent the controller from activating the pedestrian interval if there is not sufficient time in advance of the start of the preemption sequence to provide full pedestrian clearance. Both strategies were tested in TTI's TransLink® laboratory using hardware-in-the-loop simulation and in the field at a test intersection in College Station, Texas.

Both of the strategies require accurate and continuous updates of the estimated arrival time of a train at the target grade crossing. The grade crossing where the two strategies were initially tested (College Station) is part of a system where estimates of train arrival time are readily available; however, most TxDOT intersections do not have technology deployed that will allow more than the federally mandated warning.

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To address this problem, TTI researchers examined the possibility of using a series of preemption requests from upstream grade crossings to provide estimates of the arrival time of a train at downstream grade crossings. This system was developed and tested in a series of grade crossings in Alice, Texas.

What They Found

In terms of enhancing pedestrian safety, the researchers found that both the NVAP –Type 1 and NVAP – Type 2 strategies were able to reduce the number of times the pedestrian clearance interval required truncation compared to simultaneous preemption strategies. The NVAP – Type 2 strategy resulted in fewer truncations of the pedestrian walk interval. Using the NVAP – Type 1 strategy resulted in a 30% reduction in the number of times that the vehicle green interval was truncated during the preemption sequencing.

In terms of intersection operations, the NVAP – Type 1 strategy caused the average intersection delay to increase approximately 13% compared to other strategies used at the test intersections. Neither of the NVAP strategies caused a significant change in the average queue lengths on the intersection approaches.

The researchers also found that it is extremely difficult to predict the arrival time of trains at a grade crossing using solely the preemptions from upstream intersections. In the test bed in College Station, train speeds could change radically between crossings. At the Alice site, problems with false and sometimes erratic preemptions made it difficult to calculate accurate estimates of train arrival times. As a result of these problems, the researchers were not able to perform a full-scale field testing of the NVAP strategies using preemptions from upstream crossings as a means of providing estimates of train arrival times.

What This Means

This research showed that TxDOT could potentially enhance pedestrian safety by using non-vital advance preemption. Non-vital advance preemption strategies use existing functionality of current traffic signal detectors to safely provide track clearance without needing shortened pedestrian walk or clearance intervals; however, these strategies require accurate estimates of train arrival times at grade crossings. To achieve the necessary accuracy, TxDOT should not rely solely on monitoring the preemptions from upstream intersections, but deploy active devices to measure train speeds and movements directly in a rail corridor. Using these devices, TxDOT can minimize the arrival time estimation problems observed in this project.

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