MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 23-503 (project 679) | August 2023

Framework of Adaptive Intersection Traffic Control Strategy for Urban Traffic Network Subjected to Disruptions

the ISSUE

Traffic signal designs are critical to traffic safety and efficiency at intersections during day-to-day service, including during normal or heavy traffic scenarios. Most existing studies focus on congestion mitigation under normal traffic conditions, or during the crash recovery stage, rather than the entire process following a crash occurrence. There are usually more traffic crashes when driving environments deteriorate before, during, and after natural or human-caused hazards and major incidents. During these critical moments, every second counts to mitigate the congestion, maximize the evacuation and rescue efficiency, save more lives, and prevent a hazard from becoming a disaster. Therefore, it is critical to have a more adaptive and smarter traffic control strategy for an entire disruptive event, including both emergency response and long-term recovery.

the RESEARCH

This study proposes an adaptive traffic signal control strategy in response to traffic disruptions at a typical intersection by integrating microscopic traffic simulation, traffic signal design with dynamic phase selection (DPS) technology, the queue length dissipation (QLD) algorithm, and a resilience modeling concept. After the methodology is introduced, disruptions caused by typical vehicle crashes, including rear-end, angle-impact, and opposite-direction (left-turn vs. through) crashes, at intersections are specifically studied. The proposed resilience-based strategy is applied to adjust the traffic signal control plan adaptively, covering the entire period immediately following the incident until traffic returns to normal by aiming to achieve the optimal traffic efficiency and resilience outcome. With the adaptive strategy, the sequence of signal phases is adjusted based on the near real-time optimization and calculation of optimal signal timing without fixed cycle length and phase sequence, which may vary from cycle to cycle based on the real-time traffic conditions.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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Utah State University
University of Wyoming

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Project Title

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the FINDINGS

This study has proposed a new adaptive traffic signal strategy integrating DPS and QLD for disrupted scenarios with incidents at a single intersection. Optimal green time is further decided by applying a QLD signal timing optimization algorithm. During the study, a typical major intersection in the City of Fort Collins was modeled using actual PM peak-hour weekday traffic data. Three typical crash types were studied as disruption scenarios: rear-end, angle-impact, and opposite direction crashes. Comparative investigations of the three traffic signal control plans (i.e., fixed, adaptive, and DPS+QLD plans) suggest that the proposed traffic signal control plan DPS+QLD exhibits superior performance than the other two plans in terms of quickly dissipating the queue and improving the overall intersection efficiency and potential safety performance.

the IMPACT

The new adaptive traffic signal strategy, which integrates DPS and QLD for disrupted scenarios with incidents at a single intersection, improves the resiliency of a typical intersection against disruptions caused by hazards or incidents by clearing queues faster, reducing overall traffic loss time, and recovering intersection mobility quickly. The DPS technique is used to skip unused phases during the incident period to avoid wasted time for drivers at the intersection. This approach may not only shorten the queue lengths at the impacted approaches, but also improve overall traffic performance at the intersection.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1138

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.