UF Transportation Institute UNIVERSITY of FLORIDA STRIDE

Methods to Optimize Traffic Signal Timing During Non-Recurrent Conditions

(STRIDE Project M2: Comparing and Combining Existing and Emerging Data Collection and Modeling Strategies in Support of Signal Control Optimization and Management)

PROJECT OVERVIEW

According to the Federal Highway Administration, many traffic signals are only re-timed every three to five years. When they are re-timed, agencies traditionally use data that represents typical roadway conditions during different times-of-day. This data, however, does not account for atypical incidents, surges in demand, or weather events (called non-recurrent conditions). Researchers conducted a survey of transportation agencies and discovered barriers to traffic signal operations include limited funding and staff as well as lack of data.

In recent years, new technologies and data sources have emerged including high resolution controller data, video image detection, microwave detectors, automatic vehicle-based identification technologies, third party crowdsourcing data, connected vehicles, and connected automated vehicles data.

Researchers used these advanced technologies and data to create two models to improve traffic signal timing and reduce congestion under non-recurrent conditions. They then compared these new models with traditional methods currently used by transportation agencies.

RESEARCH GOAL

The goal was to propose and evaluate methods that combine data collected from existing and emerging sources in order to optimize and manage signal operations.

FINDINGS

1) The study demonstrated the benefits of using high-resolution controller data (input and output data from a traffic signal controller) in signal timing optimization over traditional calibration using turning movement counts only.
2) Changing the green times based on the **hybrid machine learning and fuzzy logic model** decreased the delays due to lane blockages or demand surge.
3) The **multi-objective optimization method** revealed that the new optimized signal timing plans reduced delays at intersections, increased the number of cars moving through the intersection at a given time, and improved travel time.

PRODUCTS

1) **Hybrid machine learning and fuzzy logic model** for signal timing selection under non-recurrent conditions
2) **Multi-objective optimization methods** to select signal timing plans under congestion conditions

IMPACT

Agencies can use the products to design and implement signal timing plans for activation during non-recurrent conditions like arterial incidents, diversions due to freeway incidents, surges in demands, and weather events. This is expected to improve the mobility and reliability of the transportation systems.

WHO BENEFITS?

State and local transportation agencies

RESEARCH TEAM

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PRODUCTS

Hybrid machine learning and fuzzy logic model for signal timing selection under non-recurrent conditions

This project investigated and assessed automating the process of updating the signal timing plans during non-recurrent (i.e., heavy traffic due to a large event) conditions by capturing the history of the responses of the traffic signal engineers to non-recurrent conditions and utilizing this experience to train a machine learning model. The project used a combination of Recursive Partitioning and Regression Decision Tree (RPART) and Fuzzy Rule-Based System (FRBS) to deal with the vagueness and uncertainty of human decisions. The model's decisions were compared to a previously recorded project case study using a simulation. The simulation revealed that the new model makes accurate recommendations for shifts in green times that would decrease the delays due to lane blockages or demand surge.

Multi-objective optimization methods to select signal timing plans under congestion conditions

This method uses a multi-objective optimization problem to optimize signal timing plans for non-recurrent conditions. The signal timing optimization problem is solved via a simulation-based optimization utilizing the Non-Dominated Sorting Genetic Algorithm (NSGA-III) algorithm to find a set of Pareto optimal fronts (a situation where one criterion cannot be improved without worsening the condition for another). The Pareto optimal fronts allow trade-offs among various objectives of the simulation. Microscopic simulation models were developed and calibrated using high-resolution controller data to better replicate real-world conditions.

For more information on M2: Comparing and Combining Existing and Emerging Data Collection and Modeling Strategies in Support of Signal Control Optimization and Management, visit the [STRIDE Project page].

About STRIDE

The Southeastern Transportation Research, Innovation, Development & Education Center (STRIDE) is the 2016 Region 4 (Southeast) U.S. Department of Transportation University Transportation Center headquartered at the University of Florida Transportation Institute (UFTI).