Multi-Modal Traffic Control for Sustainable Urban Living

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Surtrac (Scalable Urban Traffic Control) System

Schedule-Driven Intersection Control
- Treat each intersection as a single machine scheduling problem
- Use aggregate representation of traffic flows to identify input jobs
- Use schedule to decide whether to extend or switch phase

Neighbor Coordination Mechanisms
- Communicate schedules to neighbors to extend visibility
- Layer mechanisms for coping with mis-coordinated situations

Challenges
- Traffic congestion significantly degrades the quality of life in urban environments, resulting in lost time, wasted fuel resources, and reduced air quality for urban residents
- Multi-modal traffic flows: in addition to vehicles, pedestrians, bicyclists, and transit riders move in urban environments
- Sustainable urban living requires that all traffic modes be appropriately balanced, and walking is critical to the overall effectiveness of urban mobility in supporting other modes

Our Work
- Investigate multi-modal urban traffic control in the context of Surtrac, a live, urban adaptive signal system testbed
- Design extensions that enable real-time adaptive control of multi-modal traffic flows, especially vehicles and pedestrians
- Evaluate the effectiveness and impacts of these extensions using both simulations and analysis based on field data

Maximal Wait Time Constraint
- Set a maximum wait time limit at intersections as pedestrians are detected
- Augment the scheduling process with phase switching analysis

Field Results: pedestrian wait time & vehicle queue clearance time

Simulation Results: Wait Time under Different Control Strategies

Field Pedestrian Arrival Statistics: Gamma(θ, k) Distribution

The East Liberty Adaptive Signal Testbed

Accommodating Multi-Model Traffic

Multi-Model Formulation

\[ \text{normalized cost of job } j = \sum_{m \in M} n^m_l V^m_0 O^m_l L^m \]

\( n \): a traffic mode in set \( M \{ \text{Ped, Veh, } \ldots \} \)
\( n \): the number of entities
\( V \): relative time value
\( O \): average occupancy
\( L \): coordination flag

Vehicle-Pedestrian Mixed Coordination Protocol
- Coordinate major vehicle flow through a “subordinate” neighbor
- Response to pedestrians waiting at side streets of the neighbor

Integration: MTC(\( n \) of Ped, wait time limit) or Coordination Protocol

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