A Framework for Evaluating Dynamic Methods of Multimodal Arterial Traffic Control

Ted Morris¹, John Hourdos², Vassilios Morellas¹, and Nikos Papanikolopoulos¹

¹Department of Computer Science
²Department of Civil, Environmental, and Geo Engineering

Industrial partner
Synopsis

• Project Background and Goals
• Study Area
• Field Deployment and Sensor Acquisition
• Traffic Measurement Strategies
• Traffic Simulation Model
• Future build-out plans and testing
Background

- Significant research has focused on controlling congestion on freeways and major highway networks.

- Traffic control within urban network of streets and arterials presents challenging problems due to varied mode choices, route choice selection, and traffic dynamics.

- Need for creating framework for testing and evaluating new urban traffic control strategies for arterial networks.

- Couple sensor traffic measurements with simulation, to build signal and sensor ‘in-the-loop’ simulation testbed.
Roundabout Utilization for Arterial Traffic Control

- Urban corridor intersection adaptation to roundabouts.
- Lower cost than signalized intersections.
- 16 turning movements.
- Safety benefits – pedestrians & vehicles.
- Integrate with ‘complete street’ designs.
City of Richfield Corridor ‘Test-bed’

Legend
- Town Hall
- Signalized Intersection
- Transit Routes
- Pedestrian Areas
- Project Area

2-Lane Roundabouts
Under Construction
Roundabout Capacity & Traffic Control

• Available capacity affected by:
  □ Pedestrian crossing events (*Kang & Hideki, 2014, Dahl et. al*)
  □ Origin/Destination flow variation through roundabout (*Z. Qu et. al, 2014*)
  □ Heavy vehicle traffic volumes (*Dahl et. al 2012*)
  □ Approach vehicle gap selection and follow-up time variation (*Polus et. al, 2003, HCM 2010*)

• Near entrance capacity (> 0.95) creates instabilities (queues). (*Z. Qu et. al, 2014*)
Roundabout Capacity Control

• Add push-button beacons or signals at pedestrian crossings (Baranowksi, 2005)
• …
General Traffic Control Strategy

• Don’t signalized the roundabout, instead:
• ‘Observe’ roundabout capacity, pedestrian crossing events, and approach traffic volume
• Estimate gap times
• Develop and ‘test’ traffic control laws to extend green phases at adjacent signalized intersections to regulate incoming traffic volumes
• Evaluate intersection total system delay and pedestrian crossing gap opportunities
• Omnidirectional outdoor 9 MP net camera
• Low Cost, single sensor solution
• Avoids multi-cam frame synch issues
• Traditional loops or ‘trip-wire’ sensors cannot be used to solve O/D problem
• Other COTSf Traffic Sensors have closed architecture (GridSmart, Inc.)
• Develop open architecture real-time tracking, calibration, and image stream acquisition
Roundabout sensor field deployment

- Deploy computational hardware at roadside (in cabinet).
- Wireless link to roadside cabinets and adjacent intersections.
- Broadband wired service to UMN.
- ‘Blend in’ with existing infrastructure.
Roundabout Sensor Field Deployment

- **Traffic Flow**: Pavement markings, curves at entry points and raised islands direct traffic into a one-way counter-clockwise flow around the central island.
- **Central Island**
- **Pedestrian Crossing**
- **Splitter Island**
- **Truck Apron**
- **Circulatory Roadway**
- **Curvature**: The size of the roundabout and the angles of entry are designed to slow the speed of vehicles.
- **Yield at Entry**: Traffic entering the circle yields to traffic already in the circle.
Traffic Simulation Model, Richfield

- 143 Signalized Intersections
- 21 square miles
- 124 O/D centroids (33 internal + 91 external)
- 483 Lane miles
Traffic Simulation Model Calibration

- Quantify approach gap acceptance variations
- In-roundabout (conflicting flow) vehicle speeds
- Traffic entrance and O/D flows
- Pedestrian yield and gap acceptance variations
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Traffic Simulation

- Need sensor and detection data for Parameter calibration as well as for Real-time traffic control.
Real-time track vehicles and pedestrians

- Accurate manual extraction of measurements for calibration, and real-time O/D flow extraction is a challenging problem.
- Pedestrian crossing events.
- Origin/destination traces.
- Quantify gap selection and follow-up times.
- Quantify travel time/speed of conflicting flow vehicles.
Event and Measurement Extraction

- Define intersection regions of interest (ROI) to classify events and extract measurements
  - At exit/entrance boundary of each approach
  - Crosswalk regions
  - Internal roundabout
Future Framework Development Efforts

- Deploy sensors at signalized adjacent intersections to measure traffic volume data from cross-arterial adjacent intersections
- Transfer 66th and Portland roundabout sensor design for reconstructed intersections.
- Refine real-time extraction of vehicle and computer vision pedestrian track algorithms for spherical panoramic vision sensors
- Calibration of Roundabout traffic dynamics
- Incorporate timing phase plans at signalized simulation intersection
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