EXPLORING MULTI-SOURCE TRAFFIC SENSOR DATA FOR MULTI-MODAL ARTERIAL PERFORMANCE MEASUREMENT

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ABSTRACT

With the emerging development of Intelligent Transportation System (ITS) technologies, surface-transportation data can now be collected by a wide variety of ITS traffic detectors, including Bluetooth detectors, automatic vehicle location (AVL) devices, inductive loop detectors, and radar-based detectors. It has been challenging to take full advantage of multi-source ITS data by enabling them to exchange information with each other to compensate for their various disadvantages. This poster is focused on big data applications of multi-source traffic data in Tucson, Arizona. The City of Tucson is a dedicated traffic research living lab for the University of Arizona to develop data-driven applications to improve arterial performance (e.g., traffic signal timing optimization), transit system, and pedestrian and bicyclist environments.

Data Source and Collection

- Integrated Data
  - Open Big Data / Open Research
  - Integrated Solutions for the Region

- Video-based Sensors
  - Around 1,000 sensors in Tucson

- Probe Vehicle Data
  - Provide through and turning movement trajectories
  - Use trajectories to estimate travel times

- Bluetooth Data
  - General Transit Feed Specification (GTFS)

- Event-based Data
  - About 1.5 GB per day for storage

- GTFS Data
  - 49 routes in total
  - 2,310 bus stops in total
  - 2284 daily trips

Diagnosing Event-based Data

- Data quality control criteria includes:
  - Phase always-on
  - Unpaired on and off
  - Long duration
  - Two-step procedure is proposed to diagnose missing data:
    - Check data archiving statuses
    - Check data completeness for each interaction

Mitigating Missing Data of Bluetooth

- An innovative two-step approach is proposed:
  - A spatial traversal algorithm (STA) is introduced to maximize the travel time sample size.
  - Four different missing data imputation algorithms are used to obtain a complete dataset for aggregated link travel times.

Multi-Source Data Applications

- Real-Time Signal Timing Data & Video-based Sensors
  - Real-Time Queue Length Estimation
    - The vehicular queue lengths and delay can be estimated using the proposed methods with combining advance signal channel detectors with the information from upstream intersections.
  - Bandwidth Utilization
    - Real-time Signal Timing and Detector Status

- Real-Time Signal Timing Data & Video-based Sensors & Bluetooth Readers
  - Signal Timing Optimization
    - After optimizing signal timing in Speedway (Campbell-Euclid) based on multi-source data, travel time was reduced by 51%, speed was increased by 102% and the number of stops was decreased by 41%.

- Benefit Analysis
  - Assumptions:
    - Time value = $10/hour
    - Vehicle occupancy = 1.2 person/vehicle
  - Segment traffic throughput:
    - Average through volume = 1457 veh/h
    - Cost/hour = volume * vehicle occupancy * time value * travel time improvement

- System Development
  - We developed a series of practical tools and systems to collect, analyze and utilize multi-source data, including:
    - Traffic Signal Diagnosis
    - Bluetooth-based Travel Time Analysis

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