Urban Freight Performance Evaluation Using GPS Data
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Overview

Study Objective
Propose procedures and methods of using second-by-second GPS data for urban freight performance evaluation.

Data for Case Study
Drivers’ daily logs and second-by-second GPS data for 11 tours from a grocery company with all stores located in Manhattan, NY

Major Findings

- GPS data can be used as a valuable source for urban freight performance evaluation.
- Disparities are expected between the performance measures calculated using GPS data and daily logs.
- Measures based on GPS data might be more accurate and reliable.
- The case study shows that off-hour deliveries could help improve delivery efficiency:
  - Reduce service time
  - Increase travel speed
  - Reduce fuel consumption and emissions

Background

- Urban freight transportation is crucial to the quality of life, producing significant externalities.
- Characterizing urban freight activities is challenging due to its complex and multifaceted nature.
- Traditional tools such loop detectors and traffic cameras can only gather data from limited network location while GPS units are much cheaper and have wider network coverage.
- Identifying delivery stops using GPS data is challenging.
- Existing studies focus on mobility performance of the commercial vehicles, little effort has been made to quantify the externalities (e.g., emission)
- Our research focus is on using second-by-second GPS data for performance evaluation of urban freight activities, including mobility, fuel consumption and emissions.

Freight Performance Evaluation Flowchart

Input
- Second-by-second GPS data
- Delivery logs
- Network Geometrics

Freight performance measurements

Output
- Mobility
- Fuel Consumption
- Emission

Data Description

Two Datasets
Second-by-second GPS data and drivers’ daily logs for validation.

Data are from a grocery company with all stores located in Manhattan, NY.

Table 1: Samples of second-by-second GPS data

| Stop Identification for Given GPS Dataset |

Table 2: Samples of drivers’ daily logs

Tour Identification
- For the given GPS dataset, each GPS data file records a tour.
- 11 files represent 11 tours in total.

Stop Identification
- Proposed a three-stage method based on a Linear Support Vector Machine (SVM)
  - Stage 1: Preprocessing GPS data to obtain all stops
  - Stage 2: Feature extraction for the SVM model
  - Stage 3: Implementation of linear SVM model with nested K-fold cross validation.
- 42 delivery stops are recorded in daily logs.
- SVM-based method produce an error rate of 0.2%

Mobile Analysis Results

| Table 3: Three major components:

Tour analysis
- Delivery stops analysis
- Segment analysis

GPM
- 2008
- 2010
- 2012

Tour Analysis Results

| Table 4: Service time analysis using second-by-second GPS data

Delivery Stop Analysis Results

| Table 5: Service analysis using drivers’ daily log

Segment Types

- Type 1 segment travel between delivery stops.
- Type 2 segment travel between the warehouse and delivery stops
- Segment travel speeds will be analyzed.

Conclusion and Future Work

- Off-hour deliveries could help improve delivery efficiency in terms of reducing service time, improving travel speeds, and reducing fuel consumption and emission rates.
- Test the proposed freight performance evaluation procedure and the SVM-based delivery stop identification method with larger datasets.

Fuel Consumption and Emissions

- Fuel consumption and emission are analyzed with the Software CNEM.
- 9 road segments with different road conditions are selected (see Figure 2)

Figure 1: Average CO2 emission rates in gray scale

Figure 2: Average CO2 emission rates in gray scale

Table 6: Type 1 segment analysis using second-by-second GPS data

Table 7: Type 2 segment analysis using second-by-second GPS data