Estimating truck travel speed from GPS spot speed

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Background

- Advantages of using probe vehicles equipped with GPS
- Application of truck GPS data
  - Measure freight corridor performance
  - Obtain information about commercial vehicle tours
- Most studies use space-mean speed instead of GPS spot speed
- Concerns with accuracy of truck GPS spot speed
Research Question

- Whether truck spot speed collected from GPS is accurate enough for estimating link travel speed and travel time?

Research Contribution

- Provide an alternative way for measuring freight corridor performance
- Shed light into estimating truck travel costs
Research Methodology

- Compare two different data sources
  - GPS spot speed
  - Loop detector data

- Compare different methods for estimating speed with GPS data only
  - Average spot speed by segments
  - Use time/location data
GPS Data

- 2,500 trucks in Puget Sound area from GPS device vendors
- Collected from September 2008 to present
- In-vehicle GPS with data read every 15 minutes, and stop
- Data content:
  - Vehicle ID, Location, Timestamp, GPS status, Mileage

Loop Detector Data

- Dual loop detector data from WSDOT
- Data content:
  - Speed, volume, vehicle count by length classes
Case Study

- SR 167 connecting Renton and Tacoma
- Important freight corridor
- 20.857 miles in length
Data Analysis

- Use data collected in October 2009
- Divide SR 167 into ten segments for data comparison
- Aggregate GPS spot speed over segments and 1-hour time period
- Aggregate loop detector speed collected on rightmost lane over one month
GPS speed and Rightmost lane Loop detector speed comparison

Average GPS spot speed along Northbound SR 167

5-min average loop detector speed along Northbound SR 167
Speed difference

Speed difference between loop detector data and GPS data

- Segment 4
- Segment 5
- Segment 6
- Segment 7

Time Period
Mile/hour
GPS speed and Loop detector speed comparison

Average GPS spot speed along southbound SR 167

Average loop detector speed along southbound SR 167
Speed Difference

- Generally truck GPS data matches with loop detector data
- Truck speed is lower during peak hours, depends on geometry
- However truck travels differently from passenger vehicles
Average Link Speed and Estimated speed

Average link speed—Use location/time data
- Identify truck trips with data reads collected near A and B
- Calculate speed based on travel time between points

Estimated link speed—Use GPS spot speed
- Calculate link speed by averaging all observed spot speed per segment

\[ V_e = \frac{L}{\sum_{i=1}^{n} \frac{S_i}{v_i}} \]
Trip Identification

[Map with segments labeled: Segment 2, Segment 3, Segment 4, Segment 5, Segment 6, Segment 7, Segment 8. Nodes labeled: A, B. Route labeled: SR 167 SB for the left map, SR 167 NB for the right map.]
Speed Comparison for NB SR167

Comparison between estimated speed and average link speed

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Absolute difference between estimated speed and average link speed

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Speed Comparison for SB SR167

Comparison between estimated speed and average link speed

Absolute difference between estimated speed and average link speed
Result Analysis

- Estimated speed is consistent with average link speed
- Estimated travel speed could capture typical travel condition
- The estimated trip speed is slightly lower than average trip speed
  - Sample is different for two methods
  - Existing traffic may travel slower than through traffic
Conclusion

- GPS data is consistent with loop detector data
- GPS spot speed is consistent with time/location from GPS
- GPS spot speed is accurate enough for estimating link travel speed and time
- GPS spot speed can be used to estimate travel speed where data read frequency is low
Thank you!
GPS Data Processing

- Extract data from database by specifying latitude and longitude

- Data pre-processing:
  - Remove duplicate records
  - Remove erroneous records

- Geo-code candidate data points to road using ArcGIS
GPS Data Processing

• Generate 100-feet buffer area to further filter data
• Discard data points within 40 feet distance of underpasses or ramps
• Moving data type:
  - Check vehicle headings by comparing GPS travel heading with road segment’s bearing
• Parking and other data types with zero-direction
  - Adopt narrower buffer area (70 feet)