

Turning Rate Estimation in an Intersection Using Probe Data

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Key words: detector, infrared beacon, turning rate

Background

In Japan, several communication infrastructure have been installed to aid in traffic management and control:

Ultrasonic Wave (UW) Detector

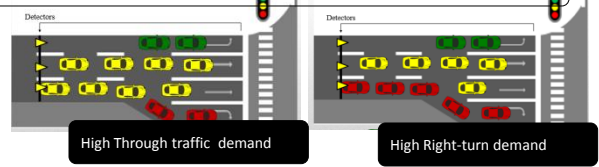
- Vehicle counts
- Occupancy
- Passing time

Infrared (IR) beacon

- Vehicles with special on-board units can send data to the IR beacons containing
- Vehicle ID
 - Passing time
 - Previous links passed
- These data are considered as "probe" data.

Traffic volume information collected by UW Detectors is used to minimize delays between legs of the intersection (example: between major and minor roads). However, it cannot accurately detect the difference in demand between movements of a single approach.

UW Detectors cannot accurately recognize the difference between the 2 situations.



Purpose

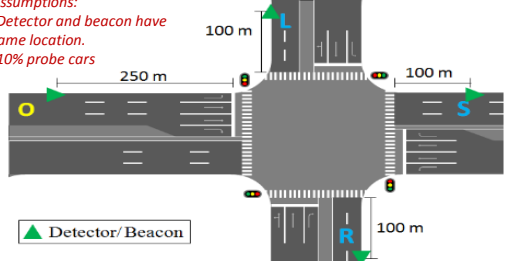
To develop a methodology for estimating the turning behavior (turning rates) of vehicles coming from one intersection approach by using probe and UW detector data.

Simulation Set-up

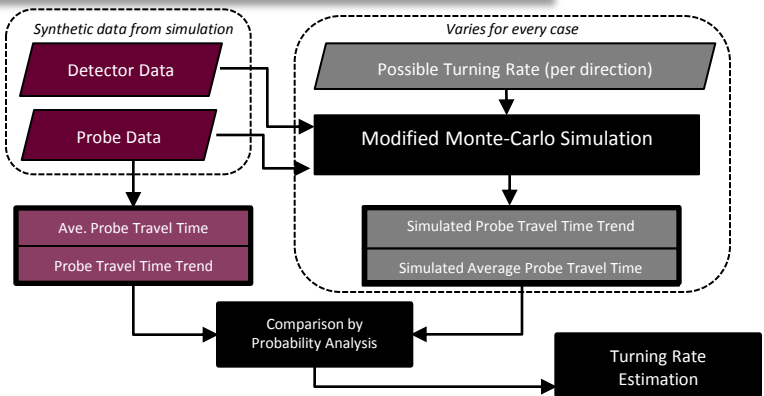
Traffic simulation by AVENUE is done to see which of the assumed turning rates can best replicate the observed probe car travel times.

Assumptions:

- Detector and beacon have same location.
- 10% probe cars

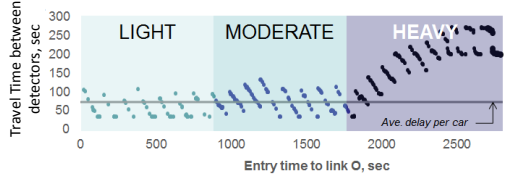


Turning Rate Estimation Process



Trends

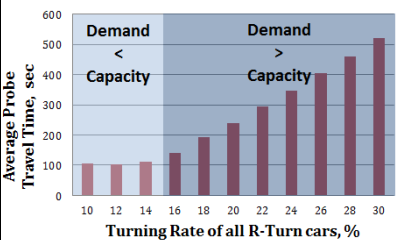
TRAVEL TIME TRENDS UNDER DIFFERENT TRAFFIC CONDITIONS



The trends in probe car travel times are observed in this study. Under heavy traffic, travel times exhibit an increasing trend. The slope of the trend line increases with increasing turning rate until capacity is reached.

Average Probe Travel Time

Data for 14 Right-turning probe cars



At traffic conditions where Demand < Capacity, the average travel times do not significantly vary even if turning rates are increases.

Once Demand > Capacity, average travel times increase with increasing turning rates.

Estimation Results

The estimation methods were tested using simulated probe and detector data (Ground Truth data).

- Traffic Demand: 450 cars/ 10 mins
- 10% probe cars
- Only Right and Through traffic were analyzed

The 2 methods were also applied to several traffic demand scenarios for Right and Through traffic. Errors are within 0-4% for Trend Method and 0-2% for Travel Time Method.

	Right	Through	Error
Ground Truth	22%	48%	-
Turning Rate Estimates			
by Travel Time Method	20%	50%	±2%
by Trend Method	22%	48%	0%

Conclusion

Two methods for estimating the turning rate of vehicles from an intersection approach have been developed. The results show that Average Probe Travel Times and Travel Time Trend Lines are sensitive to changes in turning rates and can thus be used to estimate turning rates accurately.

The estimation method works well, having errors of 0-4% for the scenarios considered. However, bias exists from a) using synthetic data and b) simplifying simulation conditions. For future work, the methodology will be improved to minimize the bias caused by a) and b).

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