Technology Showcase | Miovision Scout

miovision

Quantifying the performance of a traffic data collection system: Scout Connect match rate evaluation

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Executive summary

The ability for a city operations department to access fast, and highly accurate traffic data begins with their confidence in the measures deployed to collect that same data. Multimodal forms of transportation (representing many forms of transportation from buses, to pedestrians, to bicycles), and variable traffic volumes can impact the performance of the traffic data collection system.

An important measure for quantifying the performance of traffic data collection systems is a measure called, “match rate.” Match rate is defined as the ratio of trips detected (excluding the outliers) between point A and B to the total number of trips that actually occurred between the points.

This technology showcase evaluates the Miovision Scout Connect’s match rate in an urban setting. The match rate analysis is followed by a sample size analysis to verify the sufficiency of the sample data in providing accurate travel time measurements.

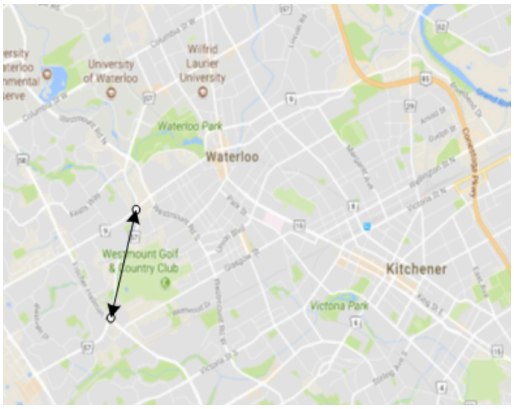
Objectives

Use match rate analysis to identify the proportion of the trips the detection sensors are collecting.

Use sample size analysis to verify that the sample size collected is representative to provide an accurate view into average travel time measured.

Study location

The evaluation took place on a 1.7 km stretch of roadway between the intersections of Fischer-Hallman and University Ave. W and Erb St. W and University Ave. W in Waterloo, ON, Canada.



Scout Connect match rate evaluation

The purpose of this study is to evaluate Scout Connect's match rate in an urban setting. Match rate is an important measure for quantifying the performance of a traffic data collection system. The match rate analysis is followed by a sample size analysis to verify the sufficiency of the sample data in providing accurate travel time measurements.

Study location

The evaluation took place on a 1.7 km (1.1 mile) stretch of roadway between the intersections of Fischer-Hallman and University Ave. W, and Erb St. W and University Ave. W. This roadway contains one lane for each of the northbound and southbound directions. This roadway was selected for the study because most vehicles along this corridor travel the entire route.
The roadway is located in an urban residential area within the City of Waterloo. For the evaluation, Connect-enabled Scouts were installed at the subject intersections.

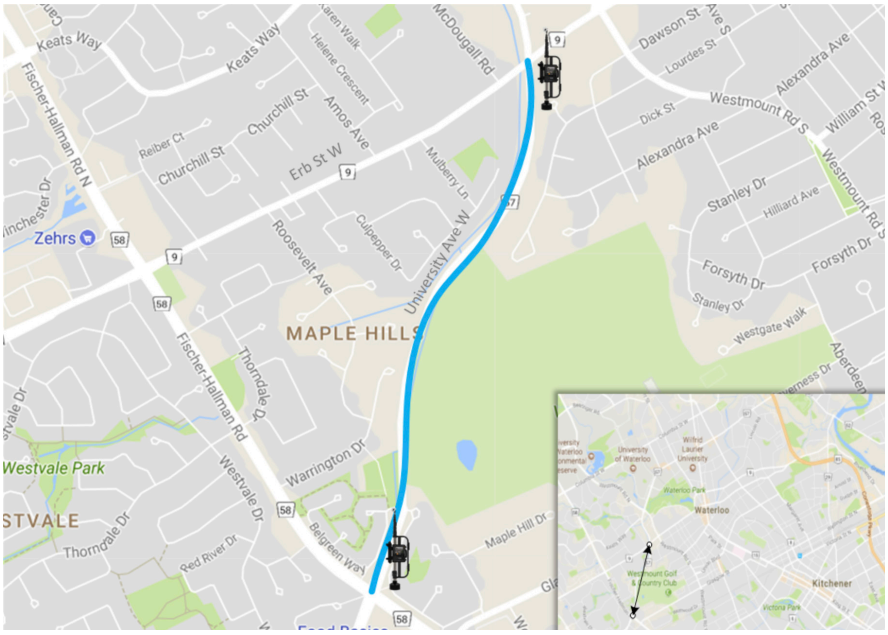


Figure 1. Study location

The time and conditions of the study period are listed below:

- The data was collected from September 12, 2017 at 10:45 am to September 13 2017 at 10:45 am
- A weekday was chosen to evaluate the system performance and accuracy during both off-peak and peak hours
- The weather conditions were clear throughout the day

Study objectives:

- Match rate analysis: Determines the proportion of the total trips that the detection sensors are collecting
- Sample size analysis: Determines whether the sample size collected is sufficient to provide accurate average travel time information

Study objectives:

- Volume counts
- Filtered WiFi MAC addresses from Scout Connect

Match rate analysis

The travel time graphs in *Figures 2* and *3* from the Miovision DataLink platform show the filtered, matched MAC addresses both on the NB and SB directions for the study duration.

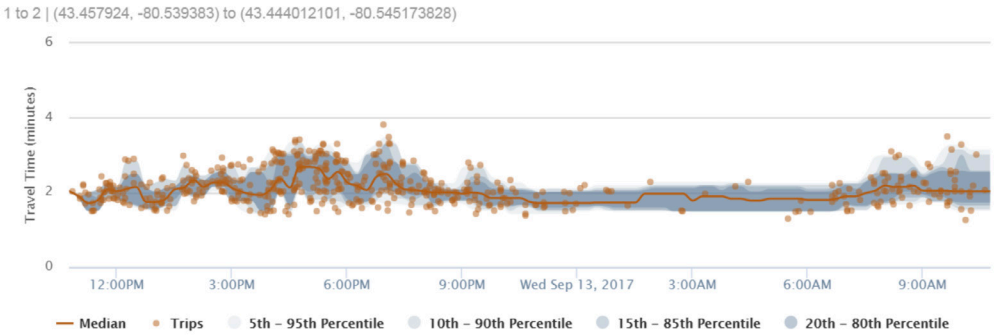


Figure 2. Travel time graph SB University Ave. W from matched MAC addresses

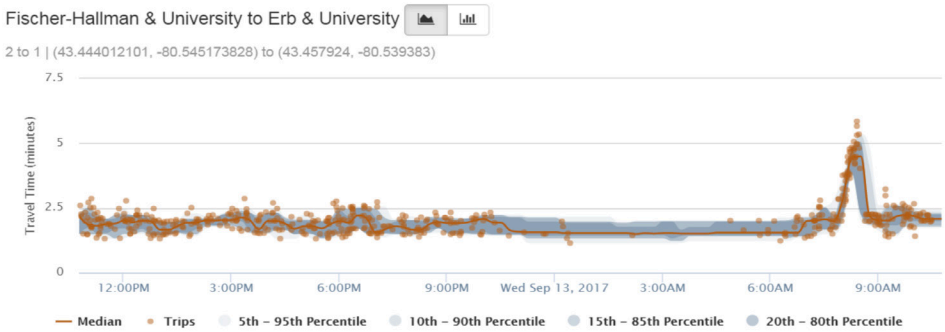


Figure 3. Travel time graph NB University Ave. W from matched MAC addresses

The match rate is defined as the ratio of trips detected (excluding the outliers) between point A and B to the total number of trips that actually occurred between the points. This measure should not be confused with detection rate which is defined as the total unique detections at one sensor divided by the total number of vehicles that were within the detection range of the sensor. Detection rates are higher than match rates considering that a device would have to be detected at both locations in order generate a valid match. In this study, based on the rule of probabilities, the capture rate is estimated as the square root of the match rate.

Considering that the roadway under evaluation does not contain major sinks or sources in-between, it is assumed that the total number of vehicles entering University Ave. W in the NB direction at the intersection of Fischer-Hallman accurately represents the total number of trips between the two intersections. The calculated match and capture rate are provided in Table 1.

Table 1. Match rate analysis results summary

	Total trips	Matched trips	Measured match rate	Estimated capture rate
NB	7039	503	7.1%	27%

Sample size analysis

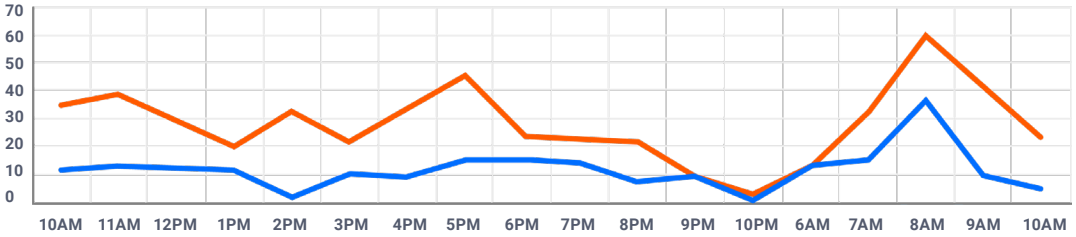
Travel times at signalized intersections are subject to high variability due to signalized traffic control. Therefore, the travel time of a single trip cannot accurately represent the prevailing traffic conditions in a given time interval between two signalized intersections. Even with accurate individual travel time readings, a reliable (within an acceptable statistical confidence) average reading cannot be guaranteed if the minimum sample size is not satisfied. Failure to satisfy the minimum sample size would statistically result in sampling error. The following calculations are conducted to ensure that Scout Connect's match rate provides sufficient data points for a statistically accurate average travel time reading.

The following formula, developed on the basis of the central limit theorem, has been recommended by the FHWA Travel Time Data Collection Handbook (1), to estimate the minimum license plate matching sample size. In this formula "n" represents the minimum sample size, "Zα/2" is the z value for a given level of confidence, alpha, which the user defines. "CV" represents the coefficient of variation, and E is the maximum permitted error of the mean travel time estimated. For this analysis a confidence level of 95% and margin of error of 10% of the mean is considered. The FHWA Travel Time Data Collection Handbook acknowledges the validity of the combination of these assumptions for travel time data collection purposes.

$$n=\left[\frac{Z\alpha/_2\ CV}{E}\right]^2$$

CV: Coefficient of variance = Stdev/Mean
α: Level of confidence
Z: Z value
E: Error, % of the mean

Using this formula, the minimum sample size is calculated for each hour of the evaluation and compared with the number of data points collected in the same hour. The result of this analysis is provided in *Figure 4*. The orange line represents the number of collected data points in each hour and the blue line represents the minimum sample size required. As can be seen, given the assumptions mentioned, Scout Connect is able to consistently provide sample sizes higher than the minimum required sample size throughout the day.



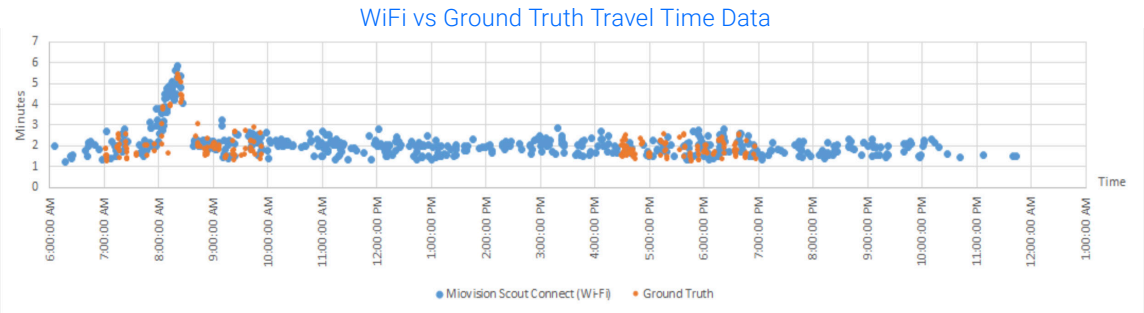
Sample size analysis

- n min
- n available

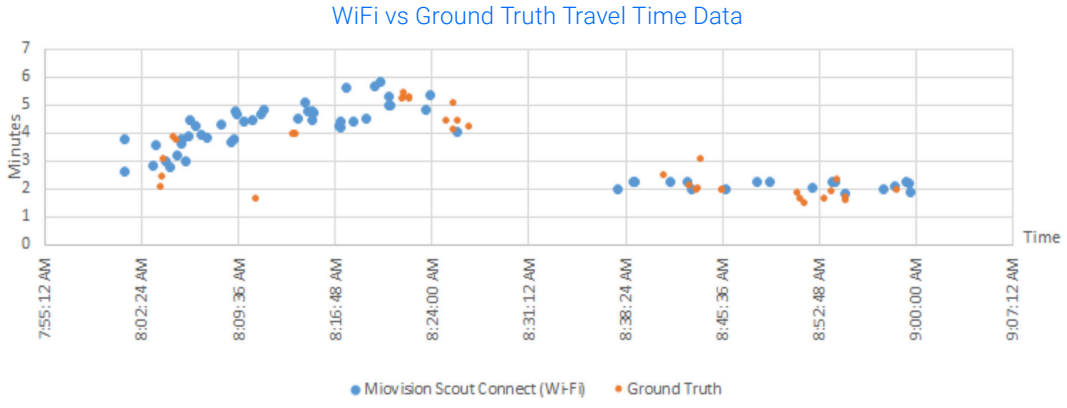
Figure 4. Sample size analysis results

Scout Connect versus ground truth

As the final part of this analysis, ground truth travel times are extracted from video footage by manually detecting vehicles at the origin and destination locations for the AM and PM peak periods of the study. The chart below shows the Scout Connect travel times (blue dots) overlaid with the manually extracted ground truth travel times (orange dots). The two datasets show clear similarities and validate the Miovision Scout Connect product from raw data collection, to filtering and final presentation of the data.



For example, this closer view of 8 am to 9 am shows ground truth and Scout Connect travel converging on similar travel times, such as at 8:45 am when both methods detect travel times around 2 minutes.



References

Travel Time Data Collection, FHWA, Report No. FHWA-PL-98-035