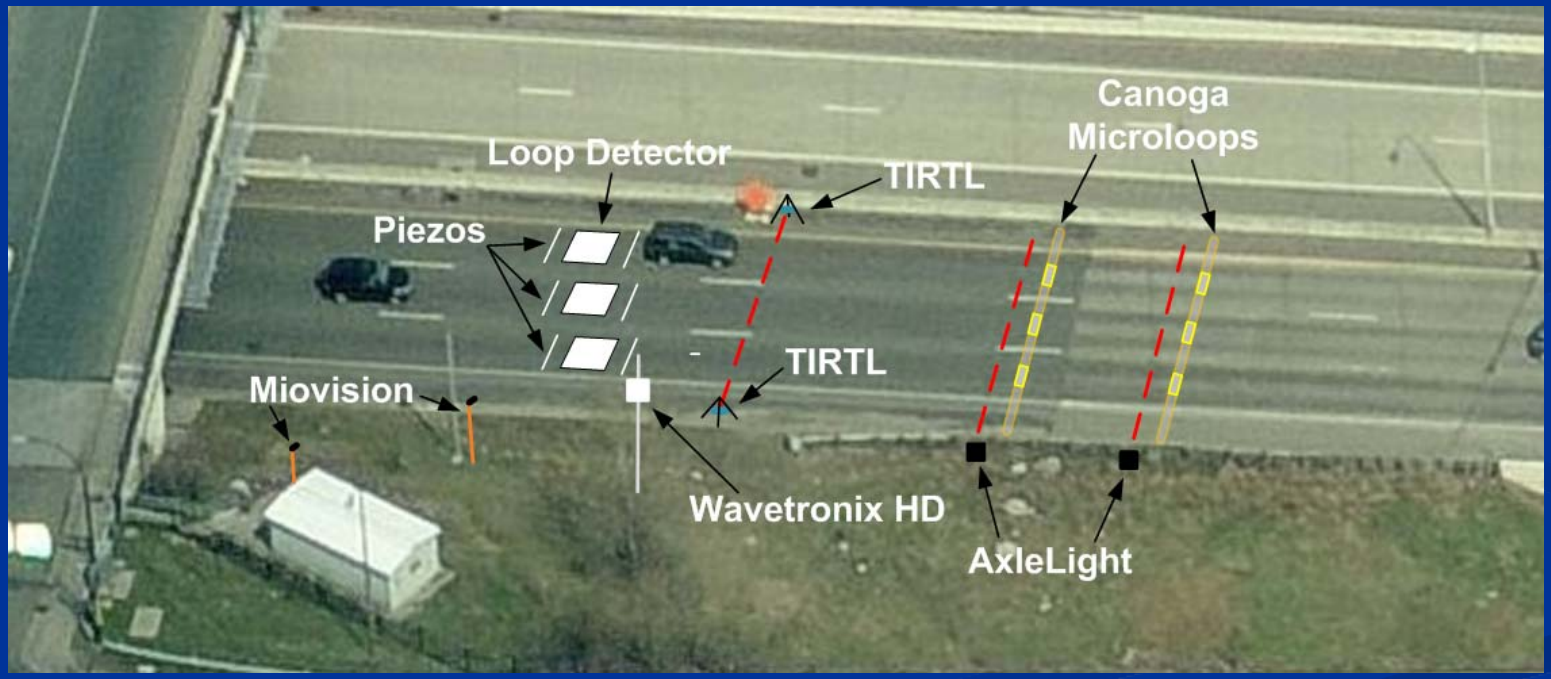
TPF-5(171)
Evaluation of Non-intrusive Traffic Detection Technologies – Phase III

NATMEC Conference - June 24, 2010



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Project Management Team

- Jerry Kotzenmacher, Mn/DOT
- Steven Jessberger, FHWA
- Erik Minge, SRF Consulting Group
- Scott Petersen, SRF Consulting Group

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Participating Agencies

- Connecticut, Anne-Marie McDonnell
- Florida, Steve Bentz/Richard Reel
- Georgia, Scott Knight
- Hawaii, Goro Sulijoadikusumo
- Idaho, Jack Helton
- Illinois, Rob Robinson
- Iowa, Troy Jerman
- Minnesota, Jerry Kotzenmacher
- Mississippi, Mike Stokes
- Montana, Tedd Little
- New York, Kurt Matias
- Ohio, Lindsey Pflum/Anthony Manch
- Texas, Robert Wheeler
- Wisconsin, Susie Ford

Technical Advisory Committee

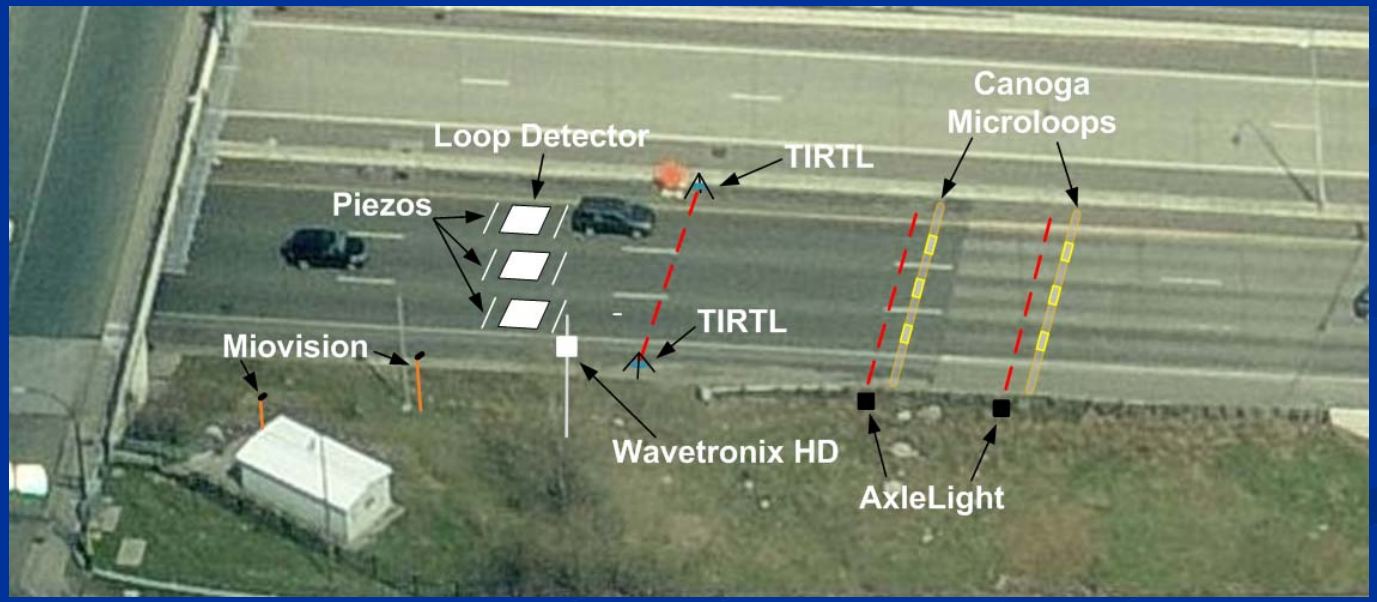
- Emphasis on heavy congestion in urban areas.
- Strong interest in examining volume, speed and class (axle and length-based). Some interest in travel times, turning movements, and bike/pedestrian.
- Examine various weather conditions and different mounting configurations.
- Evaluate specific sensors of interest.
- Do not: evaluate prototype sensors, emerging travel time technologies (i.e. Bluetooth), solar.

Non-Intrusive Detectors

- Wavetronix Smartsensor HD (Radar)
- GTT Canoga Microloops (Magnetometer)
- Peek AxleLight (Laser)
- TIRTL (Laser)
- Miovision (Video)

Baseline

- Piezo-Loop-Piezo (PLP)
  - Installed six 11-foot piezos
  - Provide volume, speed and axle-based classification
- Manual observation to verify axle-based classification
- Manual frame-by-frame video observation



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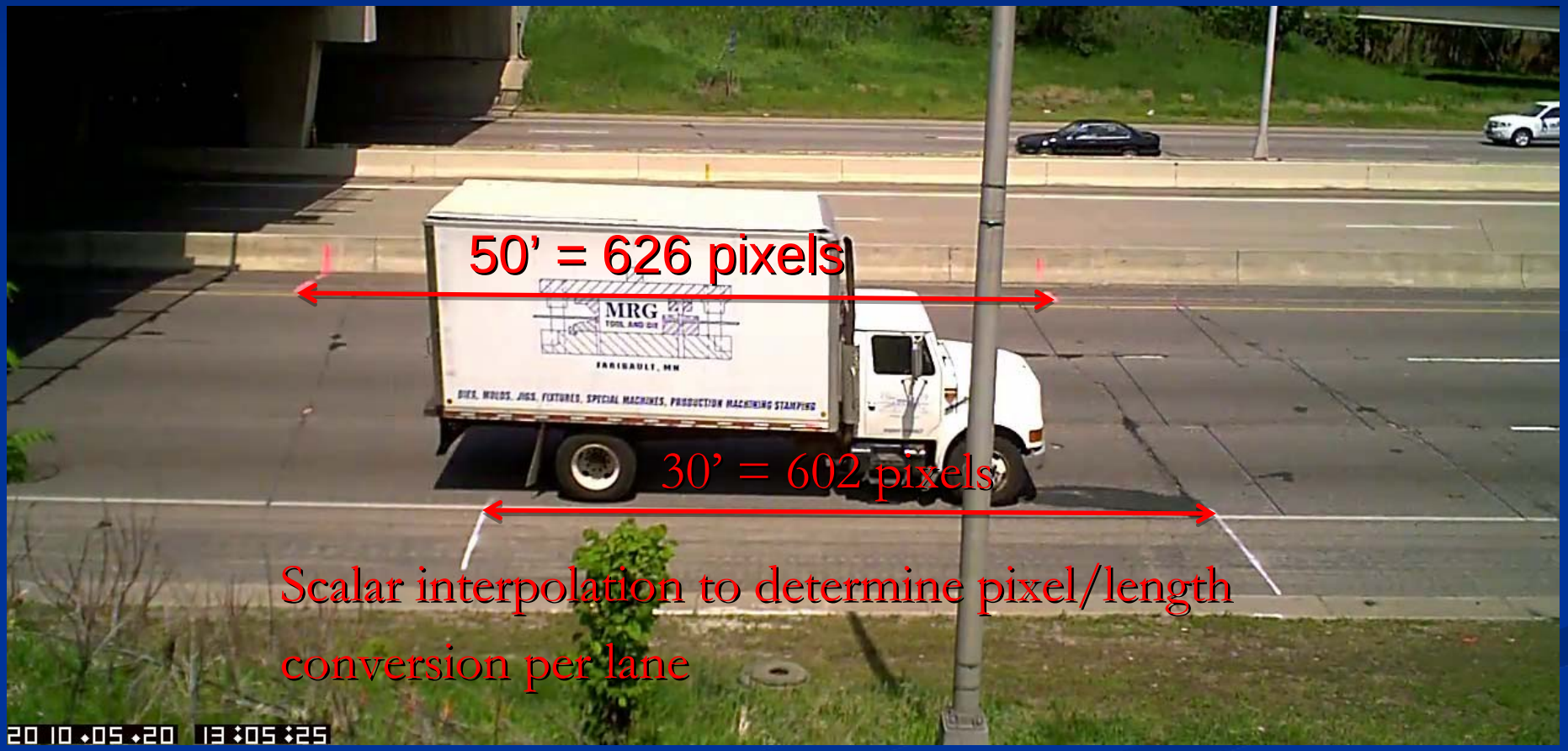
NIT Phase 3 – Video Length Ground Truthing



Classification

Table 7. FHWA 13 Class Axle-Based Classification Scheme

Class Bin	No. of Axles	Vehicle Description
1	2	Motorcycles
2	2	Passenger Vehicles
3	2	Other 2-axle, four tire single unit vehicles
4	2 or more	Buses
5	2	2-Axle, 6-Tire, Single Unit Trucks
6	3	3-Axle Single Unit Trucks
7	4 or more	4-Axle Single Unit Trucks
8	3,4	4 or fewer Axle Single-Trailer Trucks
9	5	5-Axle Single-Trailer Trucks
10	6 or more	6 or more Axle Single-Trailer Trucks
11	4,5	5 or fewer Axle Multi-Trailer Trucks
12	6	6-Axle Multi-Trailer Trucks
13	7 or more	7 or more Axle Twin Trailer Semi Trucks

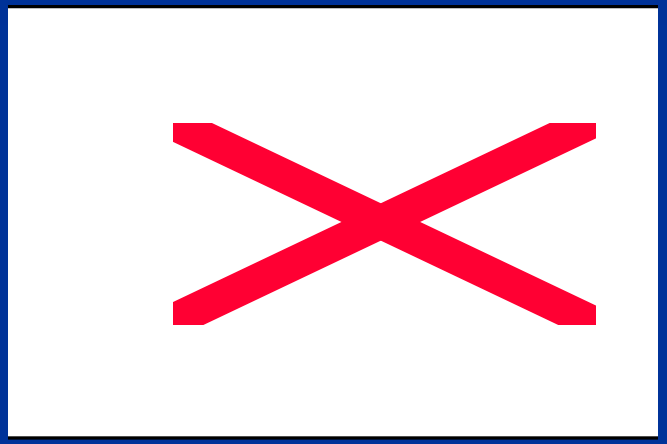
Table 8. Vehicle Length-Based Classifications

Vehicle Class	Vehicle Length	Vehicle Class
Motorcycle	0 to 7ft	1
Passenger Vehicles (PV)	7 to 22 ft	2, 3
Single Unit Truck (SU)	22 to 37 ft	4-7
Combination Trucks (MU)	Over 37 ft	8-13

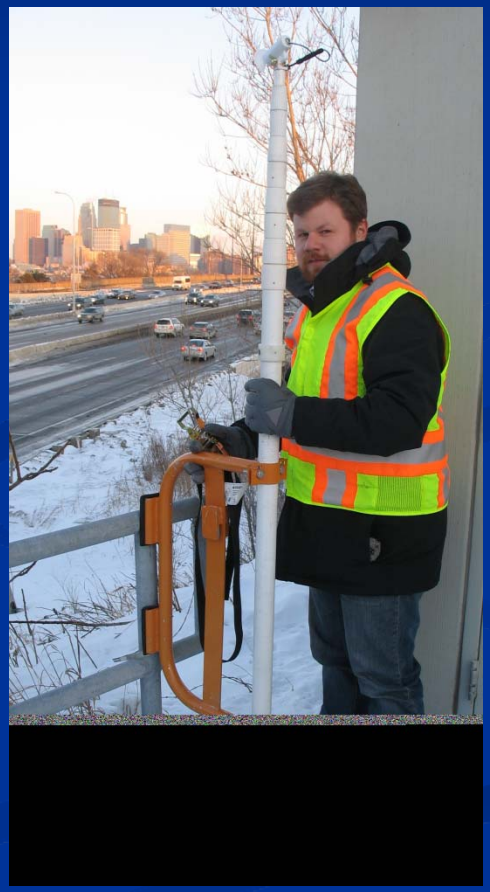
Detector Placement Options

Pole

Guardrail



Stand-Alone/Flexible



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Research Findings

- Wavetronix SmartSensor HD
- GTT Canoga Microloops
- PEEK AxleLight
- TIRTL
- Miovision

Wavetronix SmartSensor HD

- Installed 30’ offset, 28’ high
- Volume error 1.6 percent
- Speed error less than 1 mph
- Vehicle length absolute average error 1.6 feet for passenger vehicles and 2.8 feet for large trucks

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Wavetronix SmartSensor HD

- Slow moving trucks caused 20 percent undercounting in occluded lanes

Wavetronix SmartSensor HD

Volume

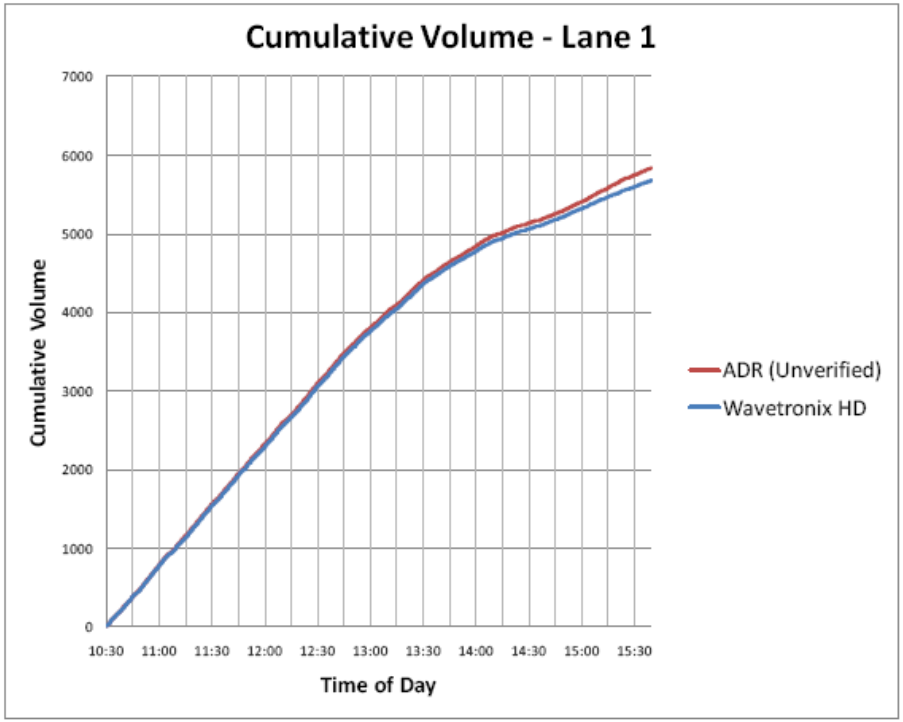
	LOS A-D (>50 mph)	LOS E-F (20-50 mph)	LOS F (<10 mph)
Non-occluded lane	-1.3%	-1.8%	-10%
Occluded Lane	-3%	-11%	-21%

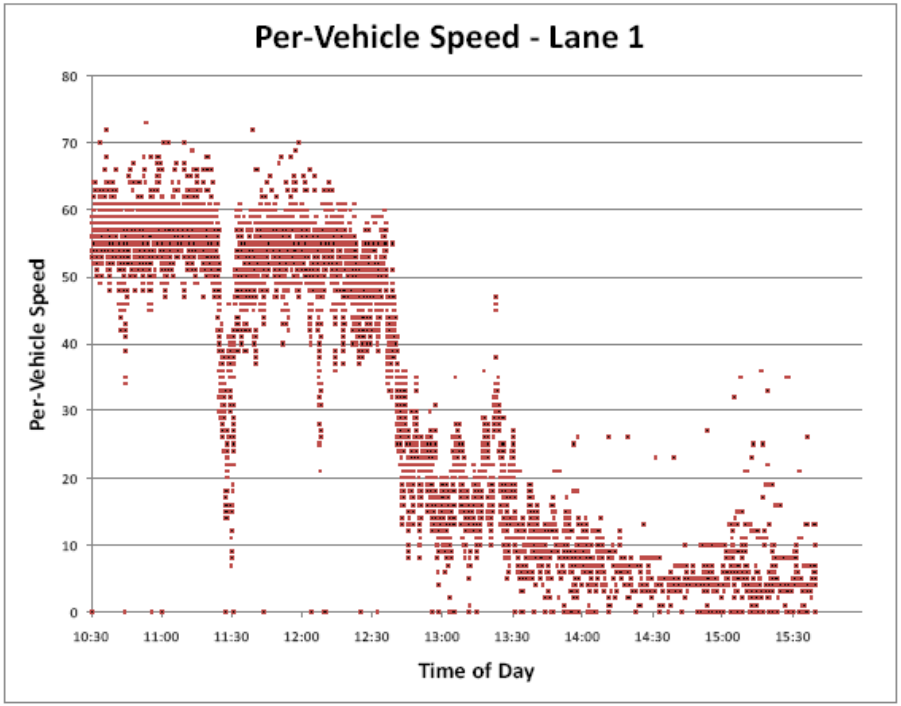
Speed

Speed	Error
60 mph	-0.3
50 mph	0.5
40 mph	0.8
30 mph	-0.8
20 mph	-1.1
10 mph	0.2

Wavetronix SmartSensor HD

Wavetronix HD sample data





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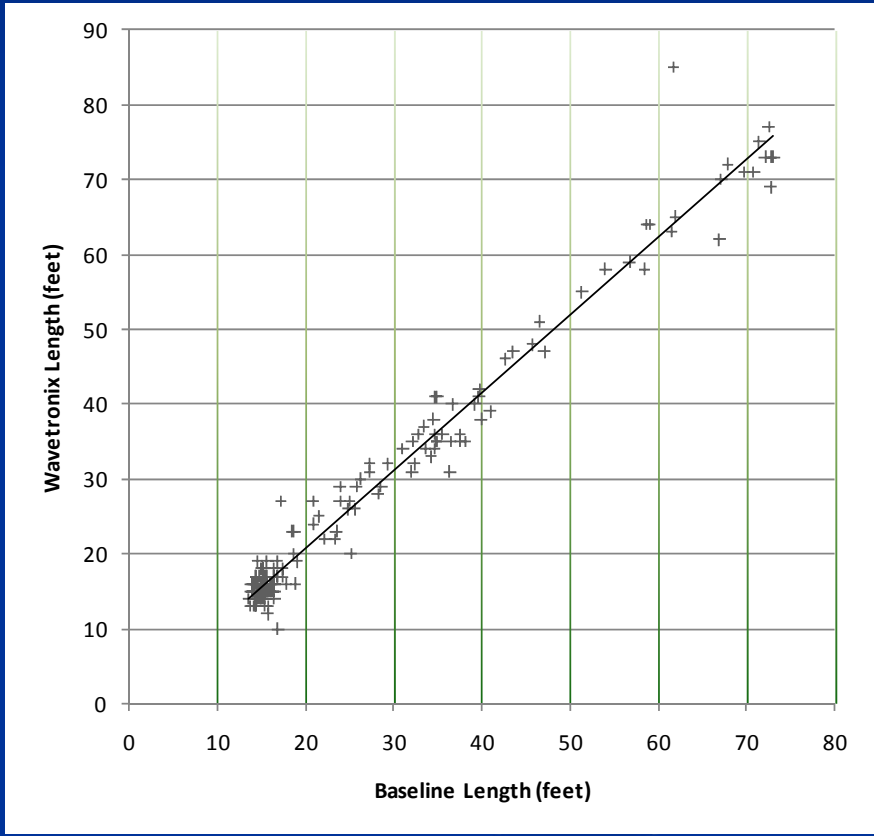
Wavetronix SmartSensor HD

Baseline (video) vs. Sensor Vehicle Length



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GTT Canoga Microloops

- Installed in two conduits beneath roadway
- Volume accuracy typically within 2.5 percent
- Aggregate speed less than 1 mph error
- Reported vehicle length with an absolute average error of 3.7 feet for passenger vehicles and 4.0 feet for large trucks
- Permanent installation required

GTT Canoga Microloops

Volume

	Baseline	GTT Microloops	Percent Error	Absolute Percent Error
Lane 1	663	680	2.6%	2.6%
Lane 2	530	510	-3.7%	3.7%
Lane 3	470	475	1.1%	1.1%
Total	1663	1665	0.1%	2.5%

Speed

	Baseline	GTT Microloops	Error	Absolute Error
Lane 1	57.8 mph	57.5 mph	-0.3 mph	0.3 mph
Lane 2	60.9 mph	60.9 mph	-0.0 mph	0.0 mph
Lane 3	64.0 mph	63.2 mph	-0.8 mph	0.8 mph
Average	60.9 mph	60.5 mph	-0.4 mph	0.4 mph

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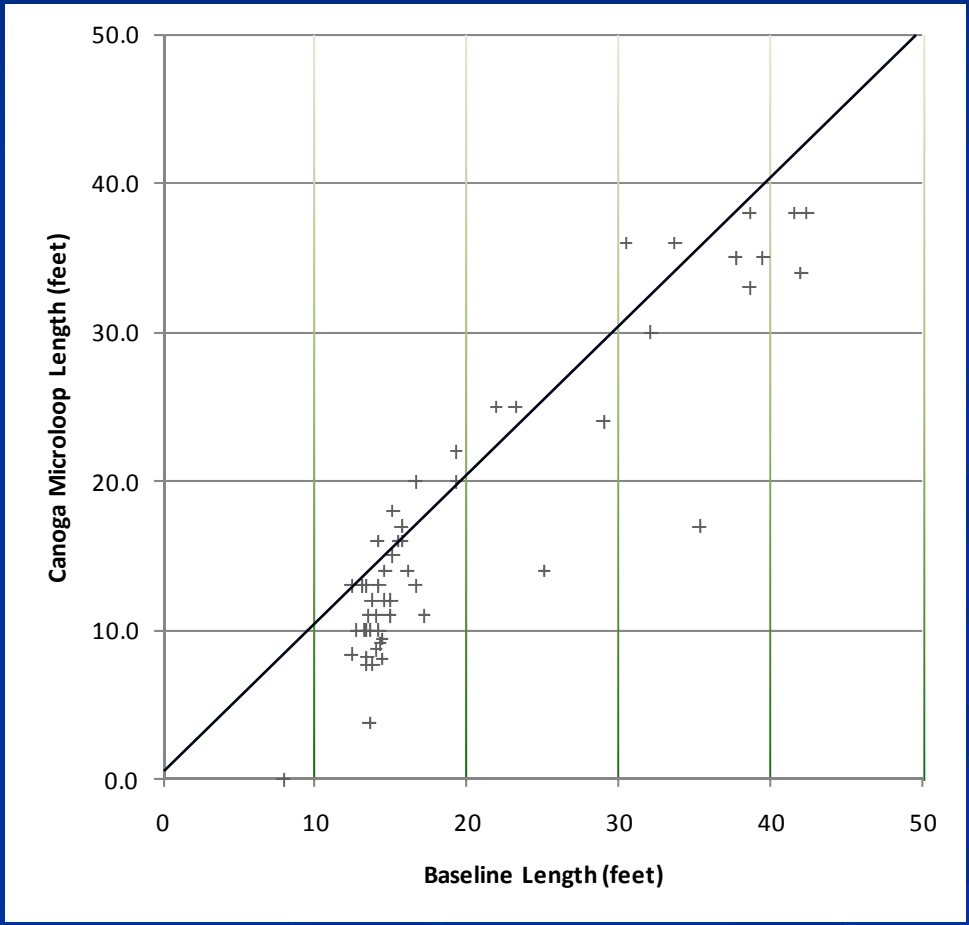
GTT Canoga Microloops

Baseline (Video) vs. Sensor Vehicle Length



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7.9-foot motorcycle measured at 0 feet long by Canoga Microloops.

35.3-foot SUV pulling trailer measured at 17 feet long by Canoga Microloops.

42-foot bus measured at 34 feet long by Canoga Microloops.

25.1 foot truck measured at 14 feet long by Canoga Microloops

Figure 14. Selected Vehicles That Canoga Microloops Measured Length Less Than Actual Length

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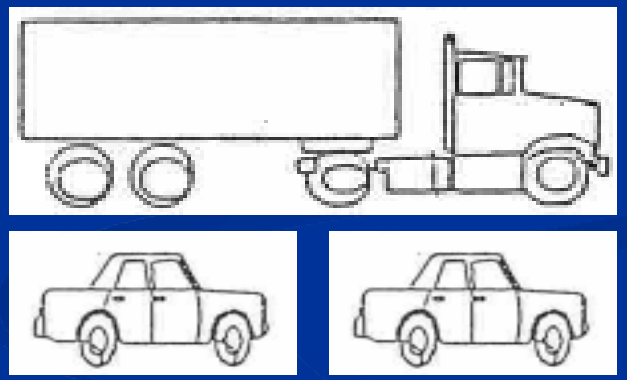
Axle-Based Detectors

- Issue with grouping vehicles (less than 45’ gap) due to lack of presence detector
- Example: Semi 2S2
  - Axle Spacing 1: 6-26’
  - Axle Spacing 2: 8-45’
  - Axle Spacing 3: 2.5-20’



- Recommend change third axle spacing from 2.5 to 6 feet
  - Vehicles would be put in a default class

PEEK AxleLight

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PEEK AxleLight

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PEEK AxleLight

- Install on guard rail or similar infrastructure
- Bidirectional setup possible, but requires significant iterative setup process
- Many steps required to deploy and calibrate the sensor
- Axle-based detection with sensors on one side of the roadway
- Permanent deployment possible with specially-designed cabinet

PEEK AxleLight

- Axle-spacing accuracy within 5 percent
- Speed values were consistently 2 mph lower than baseline.
- The raw sensor data typically undercounted by 5.4 percent
- Data prone to classification errors due to grouped tailgating vehicles
- Vendor recommends 20 mph minimum speed

TIRTL

Portable Application

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TIRTL

Portable Application Traffic Control

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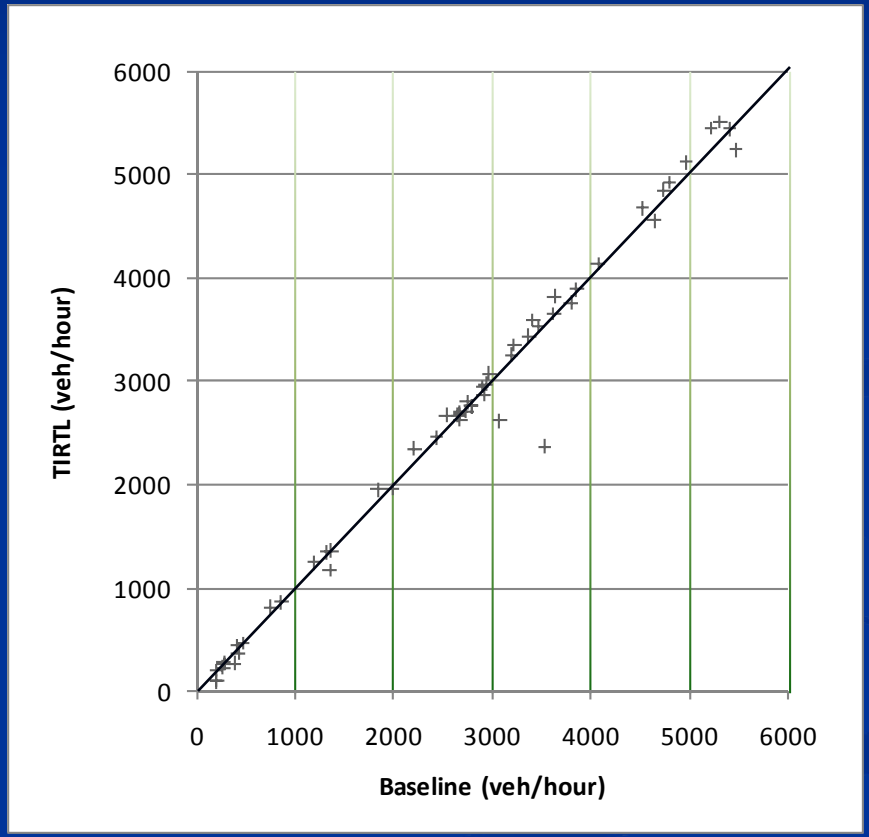
TIRTL

- One set of sensors covered four lanes of bidirectional traffic on a divided roadway
- Portable deployment requires significant traffic control on both sides of the roadway
- Permanent deployment possible by placing the sensors in a specially-designed cabinet
- Volume accuracy was 3.8 percent
- Speed and axle-spacing data was typically within 2 percent

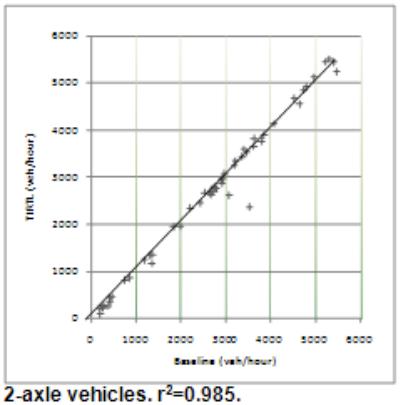
TIRTL

Volume

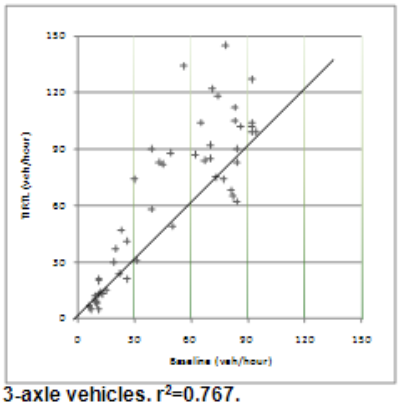


TIRTL

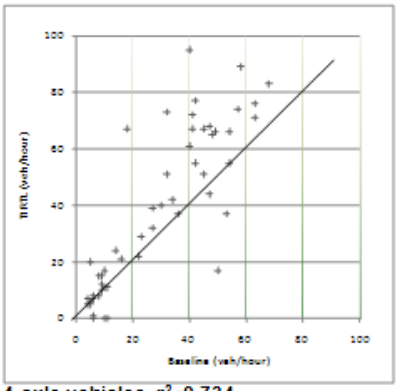
Classification



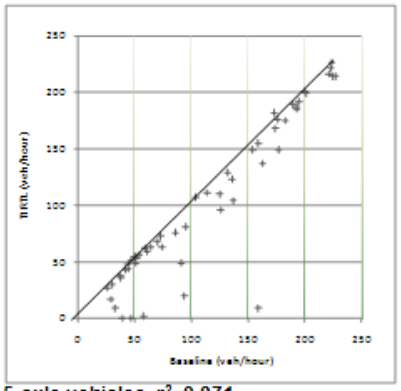
2-axle vehicles. r^2=0.985.



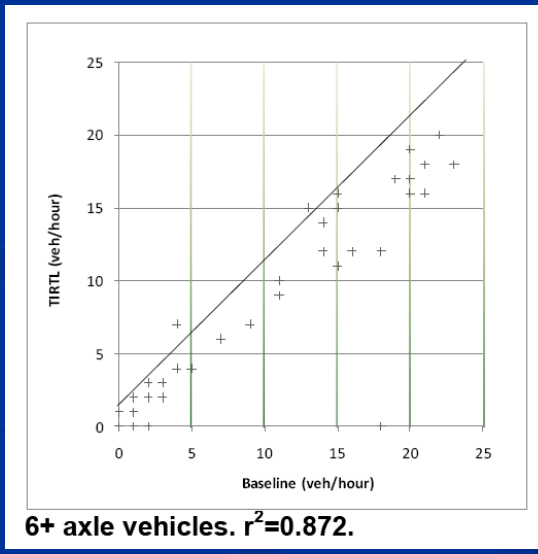
3-axle vehicles. r^2=0.767.



4-axle vehicles. r^2=0.734.



5-axle vehicles. r^2=0.871.



6+ axle vehicles. r^2=0.872.

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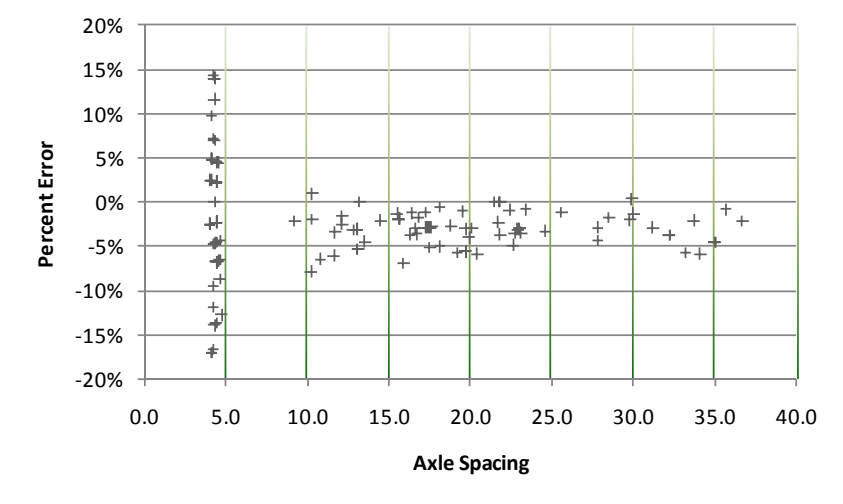
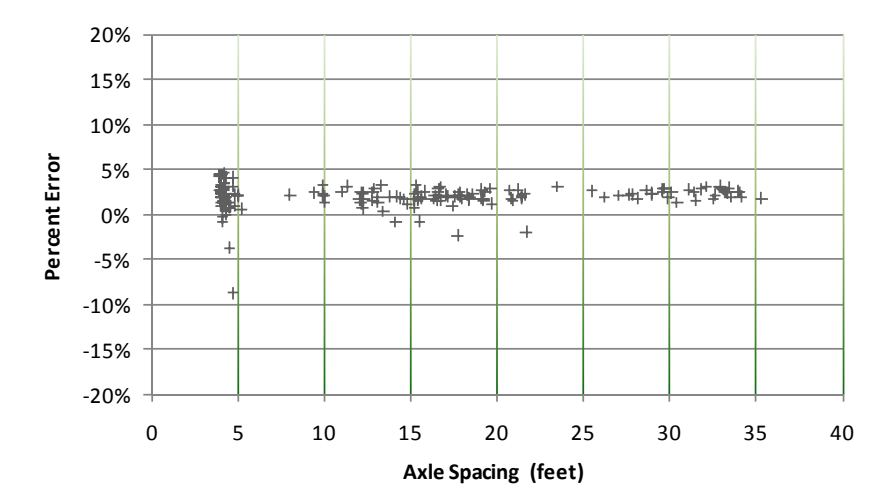
Axle-Based Sensor Comparison

Axle-Spacing Accuracy

AxleLight



TIRTL



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Miovision

- Intersection turning movement counts
- Volume accuracy matched ability to manually verify
- Classification by car, medium truck, heavy truck, bus and RV
- No speed data or per-vehicle records
- Video files are submitted to the vendor for remote processing on a per-hour basis
- Quick setup

Miovision

- I-394 volume test
  - Error less than 2 percent

Miovision

- Intersection turning movement counts
  - Error less than 0.5% for each movement
  - 2 hour test, 4-6 pm

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Project Findings

- Weather had minimal effect on Wavetronix and Microloops
- Axle-based sensors not recommended during heavy rain
- Axle-based sensors not effective in congested conditions (<20 mph)
- Occlusion an issue for most sensors
  - Error increases with congestion
- Sensor setup and calibration time is important

Project Website:

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