"Improving the Quality of Motorcycle Travel Data Collection"

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Research Objectives

- Develop methodology for determining MC count locations
- Determine the accuracy of selected detection systems

Major Research Activities

- Literature review
- Agency engagement
- Field data collection
- Data analysis
- Documentation

Background

- Motorcycle Crashes
  - In 1997 MCs were 5% of total traffic fatalities
  - In 2009 MCs were 14% of fatalities
  - MC crashes 37 times more likely to result in fatalities than auto crashes
  - Rate of increase in fatalities exceeded MC registrations and estimated VMT
- Motorcycle Counts

Technology Selection Criteria

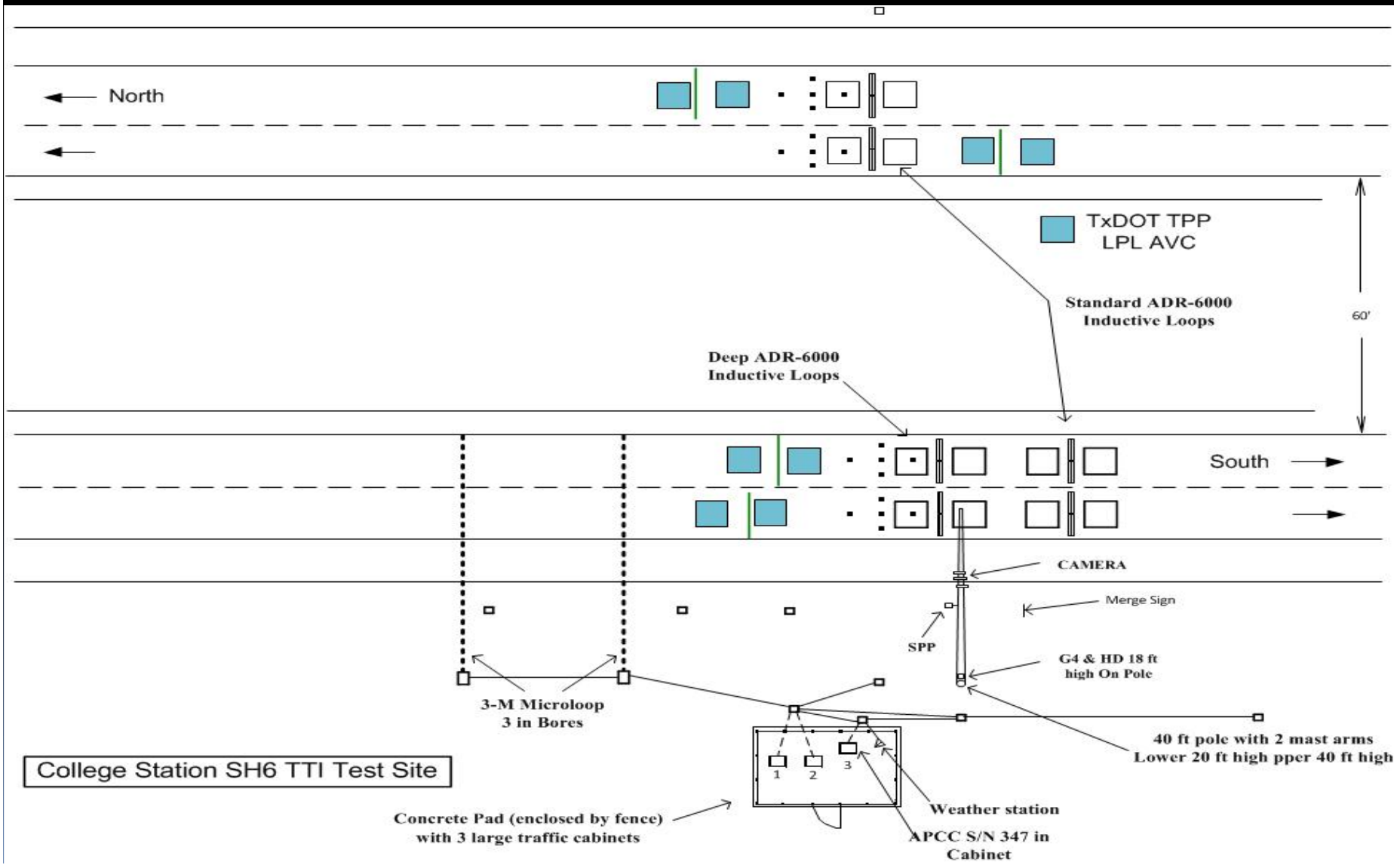
- Accurate in all weather and light conditions
- Reasonable cost
- Simple to install and operate
- Adequate technical support
- Non-intrusive desired
- Covers full lane width

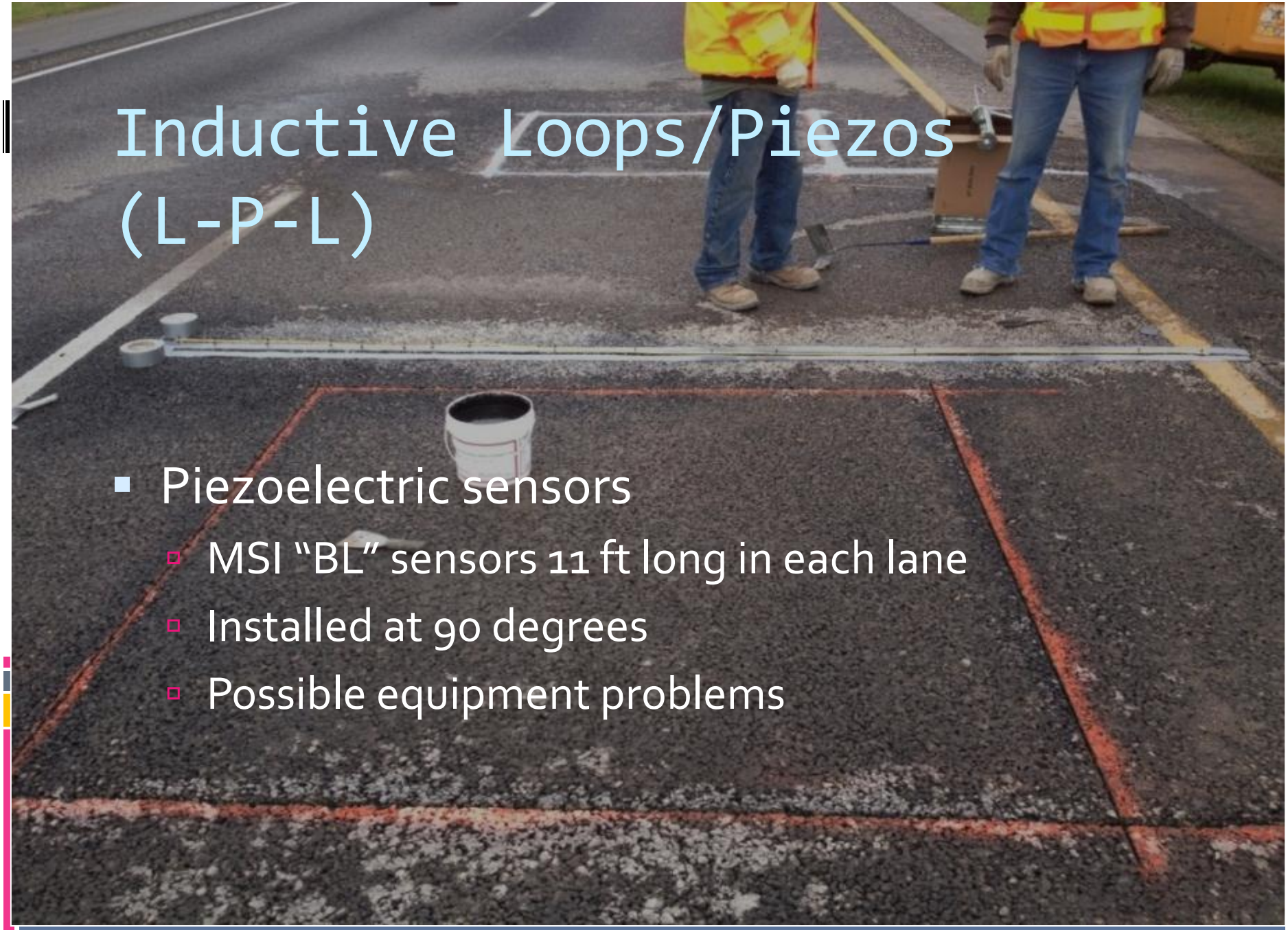
Field Data Collection and Analysis

- Inductive loops/piezoelectric sensors
- Magnetometers by Sensys Networks
- Multi-technology system by Migma
- Tracking video by TrafficVision
- Transportable Infrared Traffic Logger (TIRTL)

Test Locations

S.H. 6 Test Facility





Inductive Loops/Piezos (L-P-L)

- Piezoelectric sensors
  - MSI "BL" sensors 11 ft long in each lane
  - Installed at 90 degrees
  - Possible equipment problems

Magnetometers

- Communicates wirelessly
- Battery life in the sensor node 10 yrs
- Improvements since early MC tests
  - Requires two stations for speed and length
  - Sensitivity settings
  - Place three per station



Multi-Technology System

- Designed specifically for MCs
- Initially designed as pedestrian detector
  - Infrared camera
  - Visible light stereo camera
  - Acoustic sensor
- 2d phase SBIR underway

Hybrid Sensor

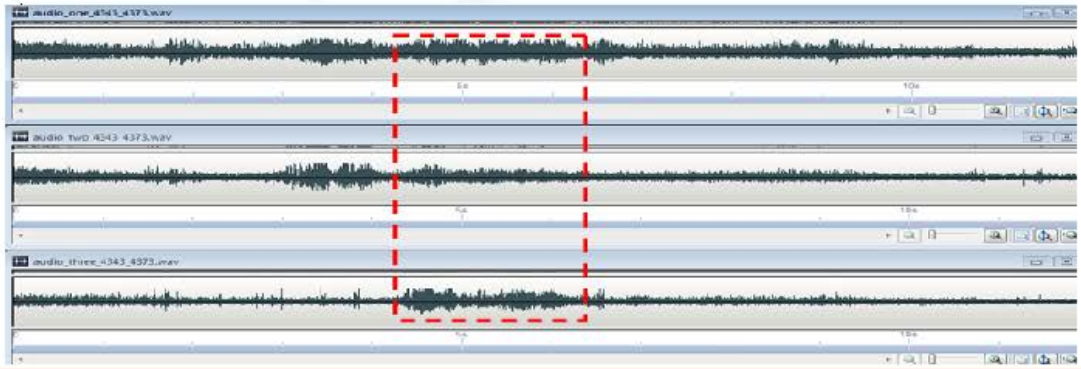
Source: Migma Systems, Inc.

Sensor Signals

Stereo Images

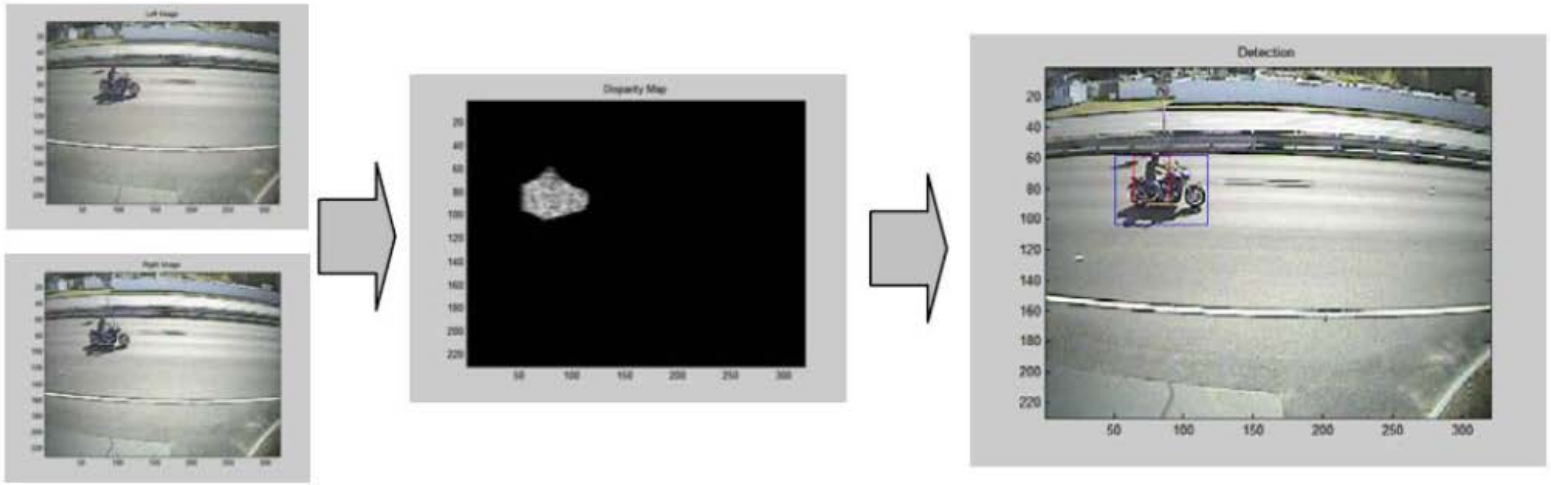
Thermal Image

Acoustic Signal



Source: Migma Systems, Inc.

Motorcycle Detection Using Stereo Camera



- Disparity map is estimated from a pair of stereo images. Motorcyclist is windowed out and detected through human body 3D features. Motorcycle is detected if motorcyclist is detected.

Source: Migma Systems, Inc.

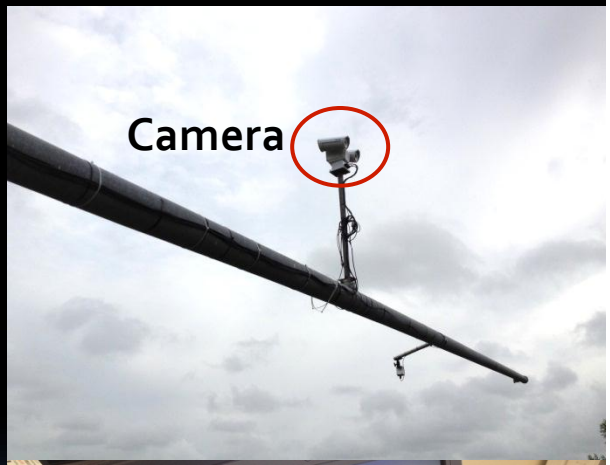
Motorcycle Detection Using IR Camera

- Thermal signatures of motorcycles and vehicles are different and can be used for their discrimination.

Source: Migma Systems, Inc.

Video Detection

- Can provide image of roadway
- Accuracy compromised
  - Inclement weather
  - Shadows
  - Artifacts on lens
  - Camera motion
  - Vehicle occlusion
- Light transition periods




TIRTL
Accurate for MC (& non-MC) detection
Classifies all 13 FHWA classes
Non-intrusive
Low power consumption
Portable or fixed
Cost competitive

Equipment Results Summary

Technology	MC Accuracy	Non MC Accuracy	Cost per lane		Portability
			Two-lane	Four-lane	
Loop/piezo	45% [a]	95%	$16,500	$15,250	Low
Magnetometer	75%	95%	$10,204	$15,964	Med
Multi-technology	50%	N/A	$3,000	$6,000	High
TrafficVision	75%	95%	$15,000	$15,000 [b]	High
TIRTL	95%	98%	$13,425	$13,425 [c]	High

[a] Low accuracy might be due to equipment problem.

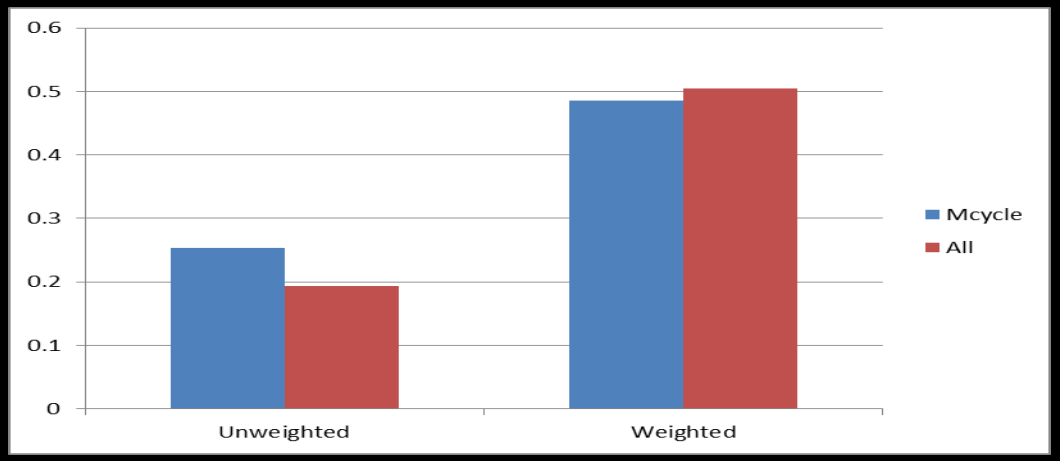
[b] Assumes one system can cover four lanes.

Data Collection Protocols - Results

- Objective
  - Confirm hypothesis that crashes are reasonable predictor of count sites
- Method
  - Use ArcGIS to develop map of crash locations and current count sites
- Findings
  - Spatial distribution of MC crashes is associated with spatial distribution of MC traffic

Data Collection Protocols

- Correlation of MC crashes with MC counts
  - Texas results

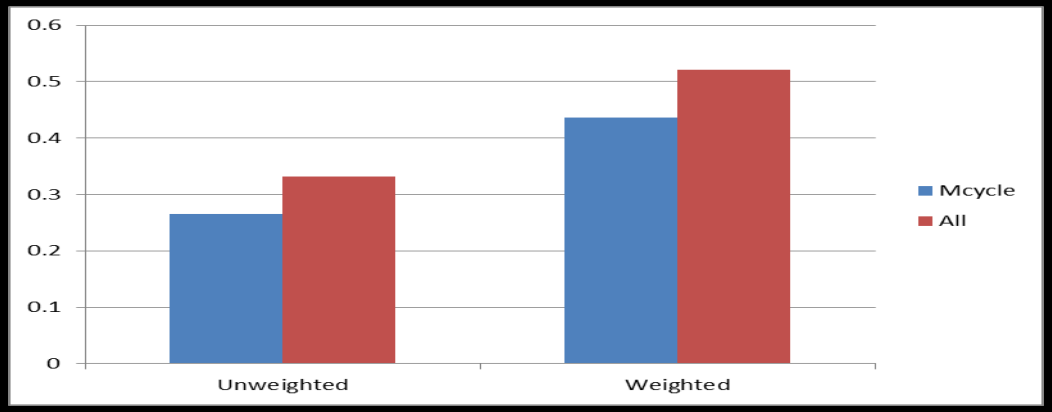


Vehicle Type	Motorcycle Crash Frequency	
	Unweighted	Weighted
Motorcycle	0.253*	0.485*
All vehicles	0.193*	0.505*

* N = 545; $p<0.001$

Data Collection Protocols

- Correlation of MC crashes with MC counts
  - Michigan results



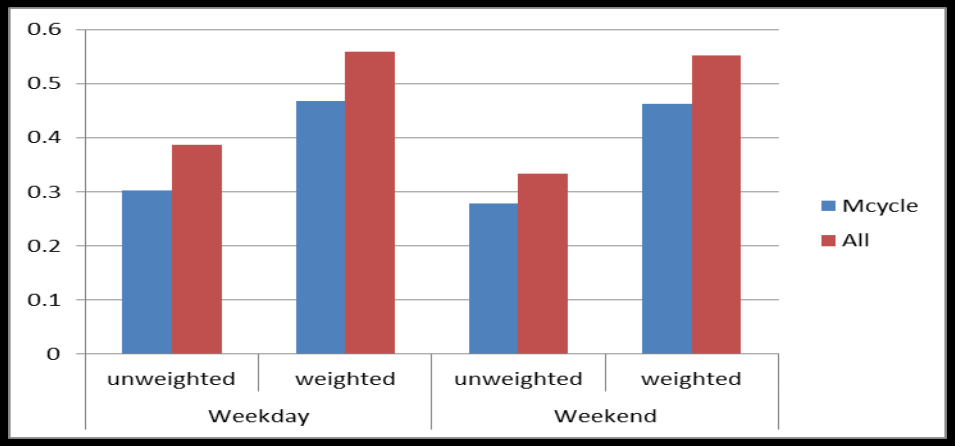
Vehicle Type	Motorcycle Crash Frequency	
	Unweighted	Weighted
Motorcycle	0.266*	0.436**
All	0.332**	0.521**

*N=101; $p<0.005$

**N=101; $p<0.001$

Data Collection Protocols

- Michigan results: weekday vs weekend



Time Period	Crash Frequency	Traffic Volume Counts	
		Motorcycle	All
Weekday	Unweighted	0.302*	0.387*
	Weighted	0.467**	0.559**
Weekend	Unweighted	0.279*	0.333*
	Weighted	0.462**	0.552**

*N=51 (weekday); N=50 (weekend), $p<0.05$

**N=51 (weekday); N=50 (weekend), $p<0.001$

Conclusions

- Conclusions
  - Improving motorcycle VMT accuracy
    - Selecting appropriate locations
    - Choosing the best technology

Recommendations

- TIRTL results
  - Classifies according to FHWA Scheme F
  - Can be portable or fixed
  - Cost per lane is competitive
  - Modifications make it even better
- Supplemental research
  - Verify accuracy of TrafficVision, Migma, and TIRTL in inclement weather
  - Loop/piezo equipment problems
  - Magnetometers require three nodes per station

Recommendations

- Based on four states:
  - Crash sites are reasonable representation of count sites
  - Need count data weekend vs. weekday
  - Use weighting factor based on distance measured along count roadway
  - Needs further testing in other states

Contact Information

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Issues Involved in MC Detection

- Motorcycle definition
- Spatial and temporal factors
- Lane discipline
- Vehicle size
- Vehicle occlusion

Motorcycle Definition

- FHWA uses two categories
  - Large motorcycles with 2 or 3 wheels
  - Mopeds and scooters (requiring registration)
- Some states define in other ways
  - 2 or 3 wheels in contact with the ground
  - A seat or saddle with sidecar/trailer
  - A handlebar
  - No enclosure for operator
  - By size: engine HP or wheel diameter

Spatial & Temporal Factors

- State methods might not be valid
- Investigate spatial/temporal differences
  - Weekdays
  - Weekends

Lane Discipline

- Detector must cover the entire lane width
- Shoulder detection
- Between rows of cars (lanes)

Vehicle Size

- Current Harley-Davison WB: 63-66 in
- Subcompact Smart ForTwo WB: 73.5 in
- Other subcompacts WB: 2-3 ft longer
- Conclusion
  - Easier to distinguish by magnetic length
  - MCs have magnetic length 3 ft shorter than physical length

Vehicle Occlusion

- MCs are often occluded by tall vehicles

RESEARCH APPROACH

Data Collection Protocols

$$C_w = \frac{100{,}000 * C_r}{D_a}$$

- Where:
- C_w = Weighted crashes.
- C_r = Raw crash frequency.
- $D_a = \{\sum_1^n d\}/n$ = Average distance from crashes to nearest count station.

Inductive Loop/Piezo Results

Date	Time Span	Ground Truth	Detected MC/Actual	Detection Accuracy		Bin
				Simple	Overall	
June 30, 2012	11:00-12:00 09:00-10:00	Video/ ADR-6000	5/6 2/3	88.3% 66.7%	- -	Hourly
July 1, 2012	11:00-12:00 09:00-10:00	Video/ ADR-6000	0/3 0/4	0% 0%	- -	Hourly
July 3, 2012	11:00-12:00 11:00-12:00	Video/ ADR-6000	4/24 10/20	16.7% 50.0%	- -	Hourly
July 21, 2012	00:00-24:00	ADR-6000	104/191	54.45%	99.76%	Hourly
July 22, 2012	00:00-24:00	ADR-6000	76/154	49.35%	99.76%	Hourly
July 23, 2012	00:00-24:00	ADR-6000	41/73	56.16%	99.82%	Hourly
Feb. 8, 2013	13:00-15:00	Video/ADR	20/102	21.05%	98.46%	PV[a]

[a] PV: per-vehicle.

Magnetometer Results

Date	Time Span	Ground Truth	Detected MC/Actual	Detect. Acc.		Bin
				Simple	Overall	
June 30, 2012	--	ADR-6000	TBD/TBD	TBD	TBD	TBD
July 1, 2012	--	ADR-6000	TBD/TBD	TBD	TBD	TBD
Feb 22, 2013	15:00-16:00	Rec. Video	11/18	61.0%	--	PV[a]

[a] Per vehicle.

Migma Results

Date	Time Span	Ground Truth	Detected MC/Actual	Detection Accuracy		Bin
				Simple	Overall	
May 19, 2012	09:00-12:00	Video	143/206	69.42%	77.94%	PV
Sept. 5, 2012	09:20-10:30	ADR-6000	26/45	57.80%	--	PV
Sept. 21, 2012	17:00-22:00	ADR-6000	21/46	45.65%	--	PV
Sept. 22, 2012	17:00-20:00	Video	13/22	59.09%	--	PV
Sept 23, 2012	17:00-20:00	Video	6/21	28.57%	--	PV

TrafficVision Results

Date	Time Span	Ground Truth	Detected MC/Actual	Detection Accuracy		Bin
				Simple	Overall	
May 18 (day)	15:00-20:40	Video	111/168	66.07%	93.77%	PV
May 18 (night)	20:40-21:00	Video	9/12	75.00%	--	
May 19, 2012	09:00-12:00	Video	98/233	42.06%	92.58%	PV
June 30, 2012	10:00-12:00	Video	14/18	77.78%	99.96%	PV
July 1, 2012	11:00-12:00	Video	2/3	66.67%	99.92%	PV
July 3, 2012	09:00-12:00	Video	46/50	92.00%	99.90%	PV

TIRTL Results

Date	Time Span	Ground Truth	Detected MC/Actual	Detection Accuracy		Bin
				Simple	Overall	
May 18, 2012	13:00-18:46	Video	129/134	96.27%	87.95%	PV
Oct. 20, 2012	07:30-09:30	Video	709/744	95.30%	98.16%	PV

CONCLUSIONS AND RECOMMENDATIONS