Automated Road Safety Analysis and Data Collection Using Video Sensors

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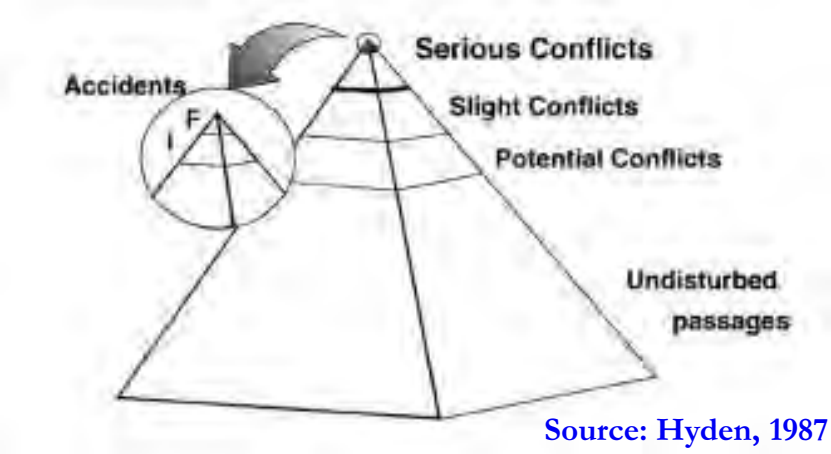
Engineering Approaches to Road Safety Management

- Reactive approach
  - Making improvements to existing unsafe road locations based on accident history
- Proactive approach
  - Prevent unsafe road conditions from occurring by including road safety as a priority at the planning/ design and early operation stages
  - The earlier that road safety is considered, the more cost-effectively it can be accommodated

Motivation

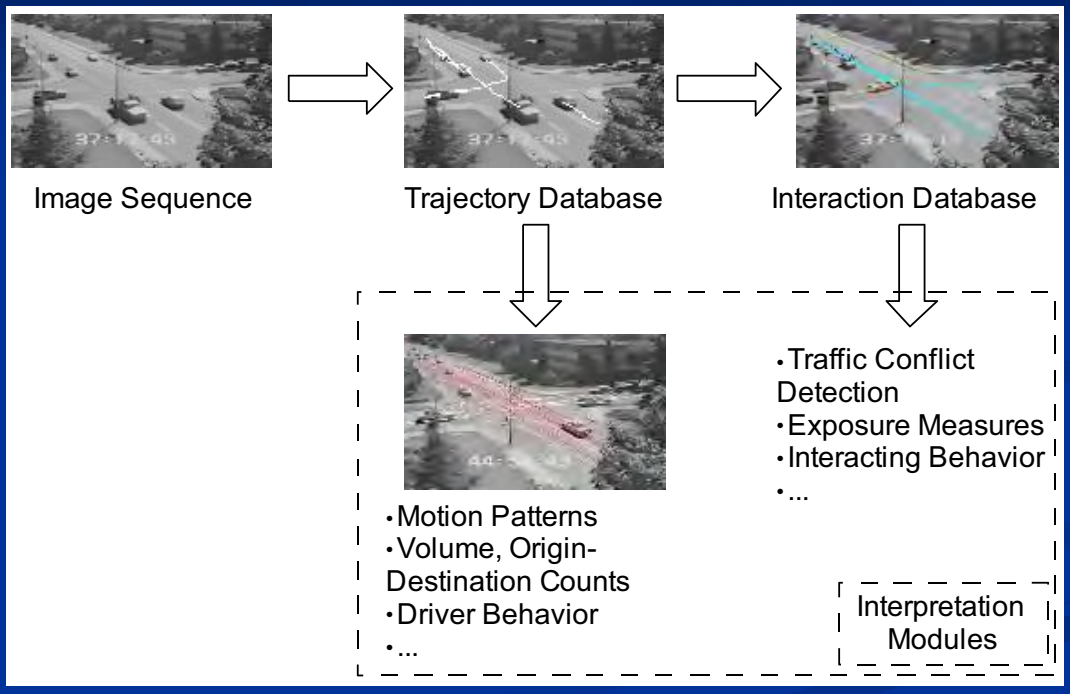
- Traditional road safety analysis is a reactive approach, based on historical collision data
  - There are well-recognized availability and quality problems associated with collision data
  - Less complete understanding of the complex interaction of collision factors and how safety measures work
  - A more proactive approach is needed which provides a better understanding of collision occurrence

Traffic Conflicts (near-misses)



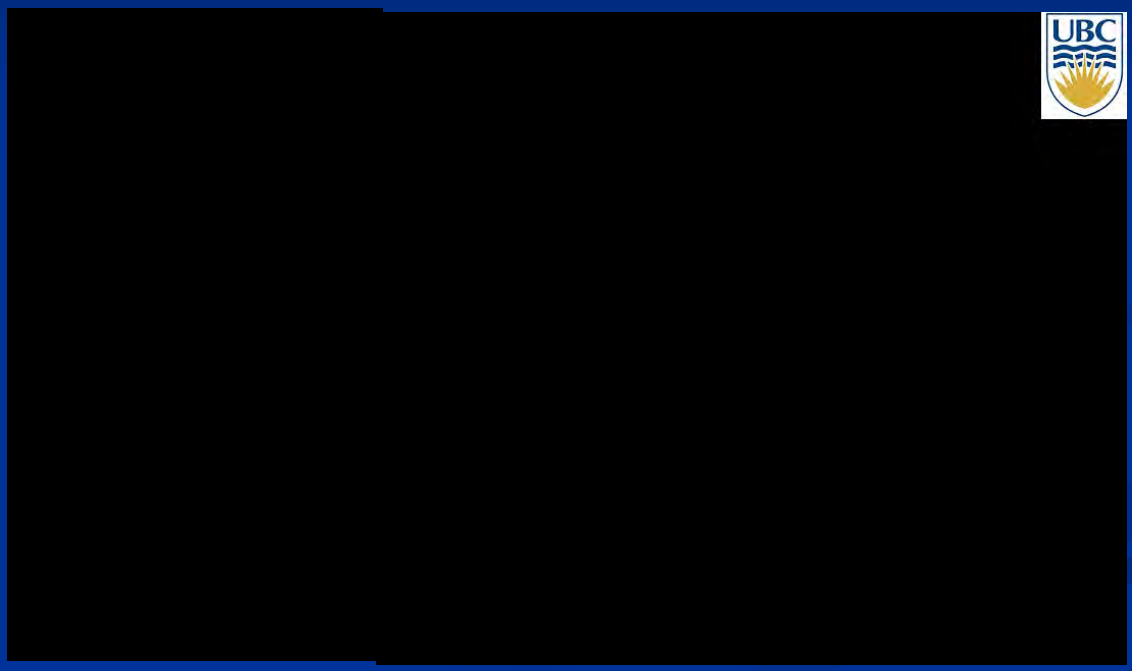
- Shortcomings
  - Cost of data collection
  - Issues related to the reliability and accuracy of human observers

A Modular System for Vision-based Automated Road Safety Analysis

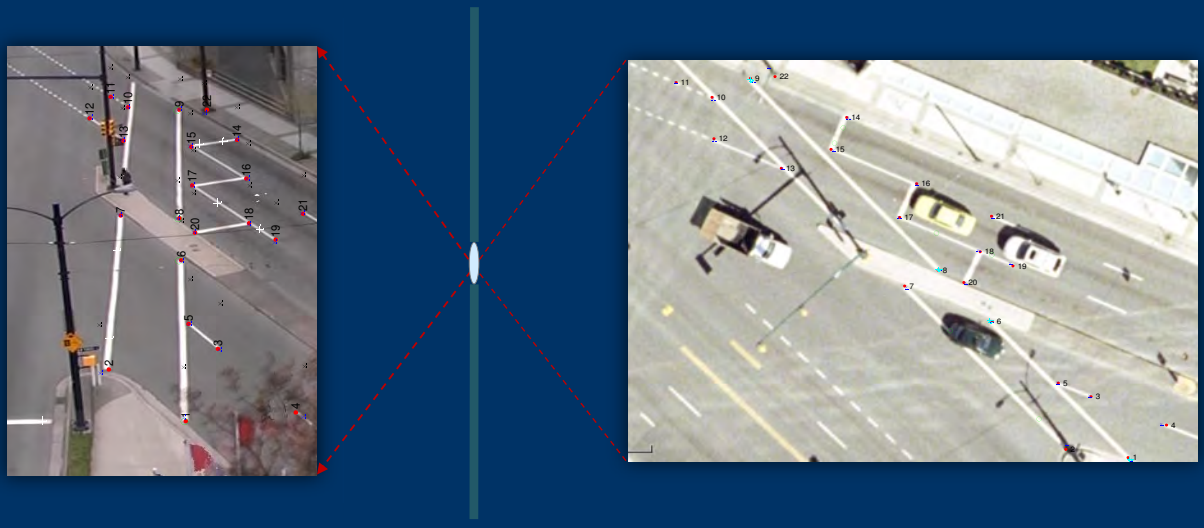


(Saunier and Sayed, 2006)

Video Analysis



Real-world Coordinates Recovery

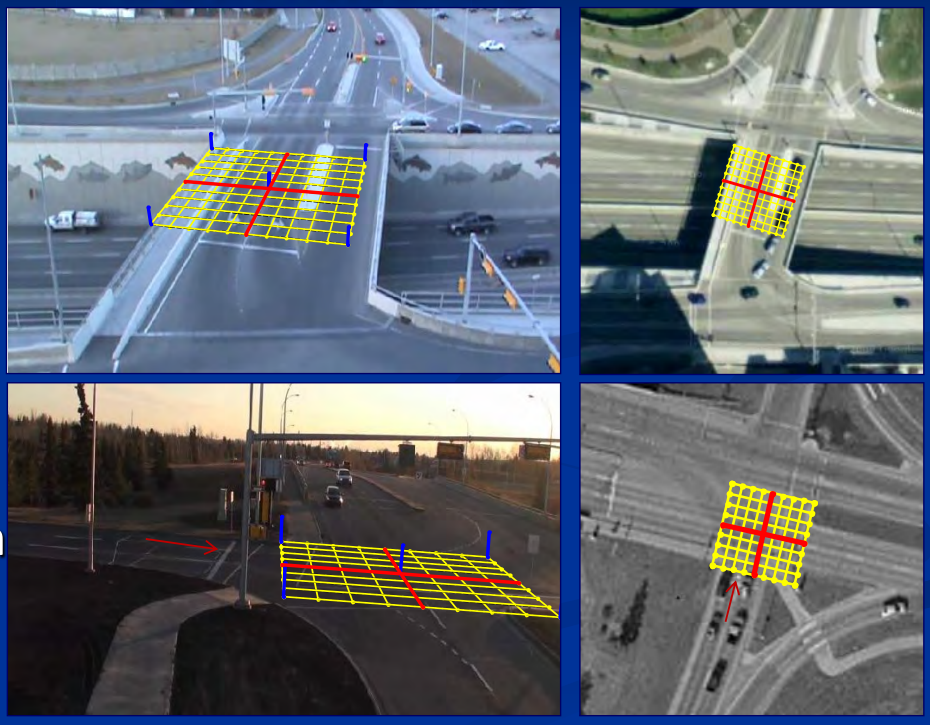


(Ismail, Sayed and Saunier, 2009)

Recovery of Real-world Coordinates

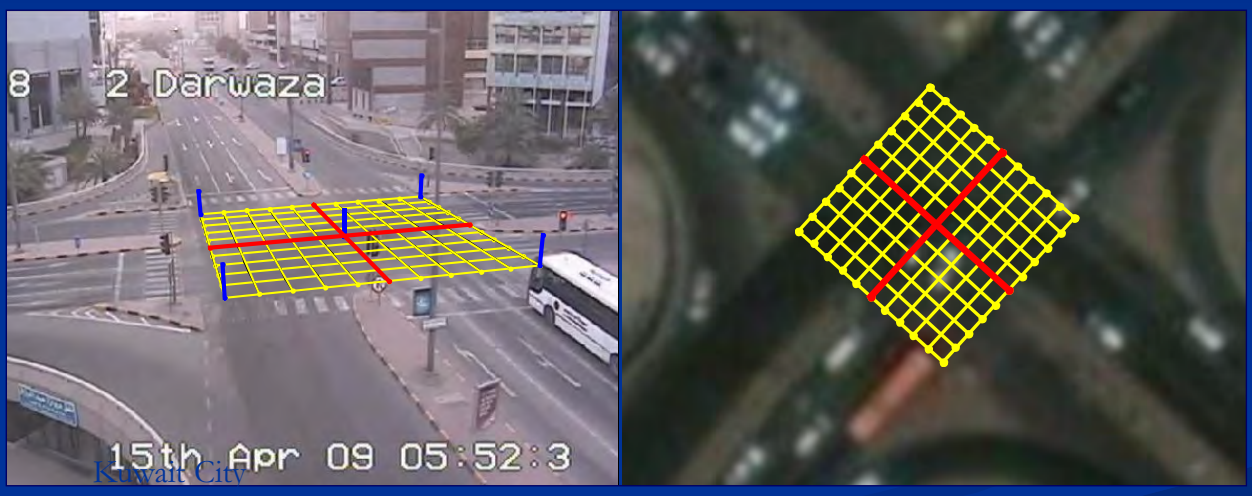
- Calgary

Glenmore Trail & 5 Street



- Edmonton

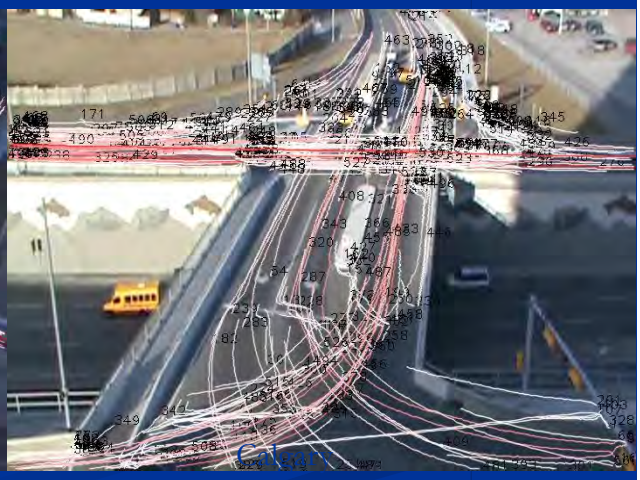
Recovery of Real-world Coordinates…2



Kuwait City

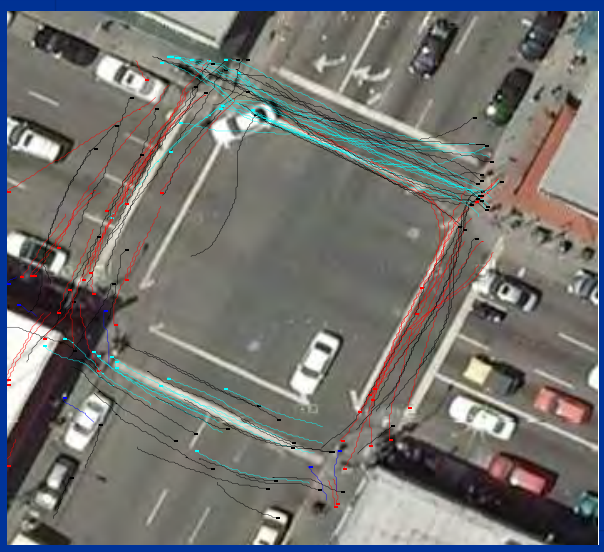
Video Analysis

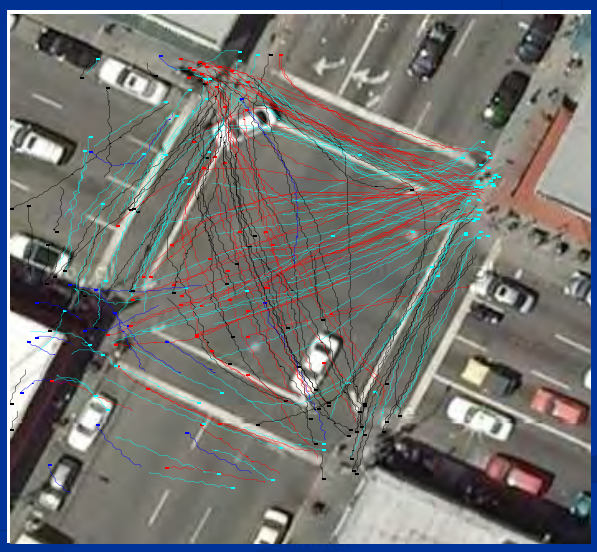
Example of Motion Patterns (Calgary)



Video Analysis

Road User Classification



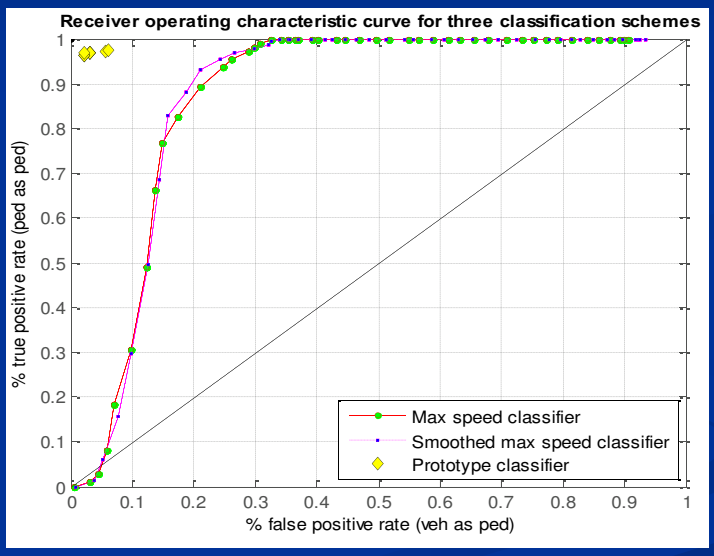


Oakland, CA
Chinatown

(Ismail, Sayed and Saunier, 2009)

Video Analysis

Road User Classification

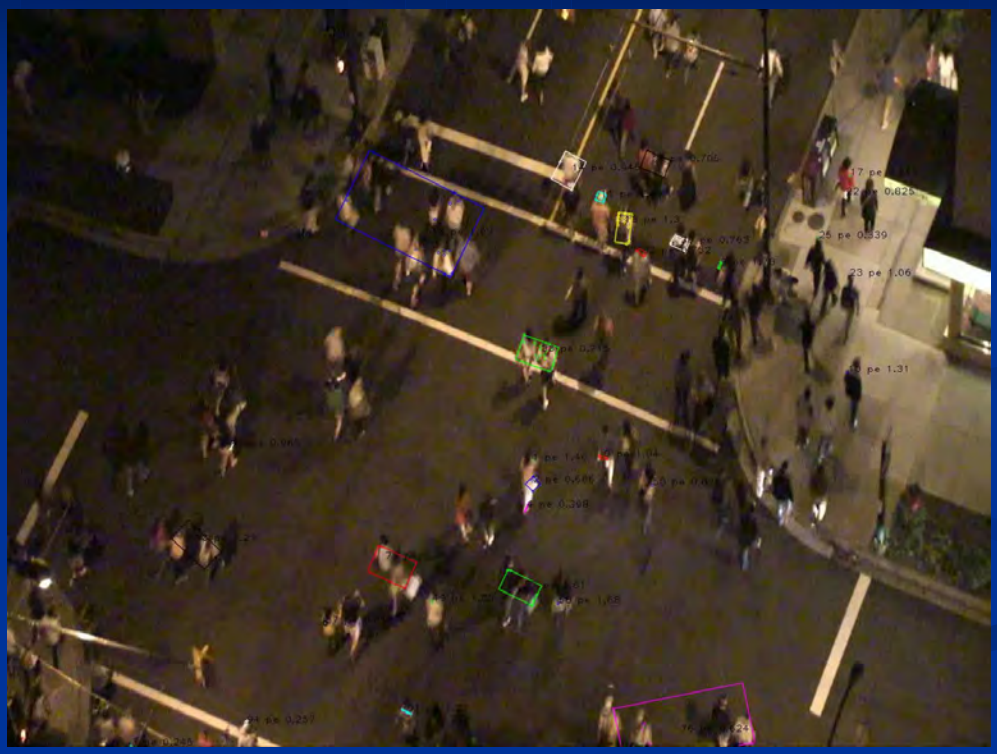


Ismail, Sayed and Saunier (2010)

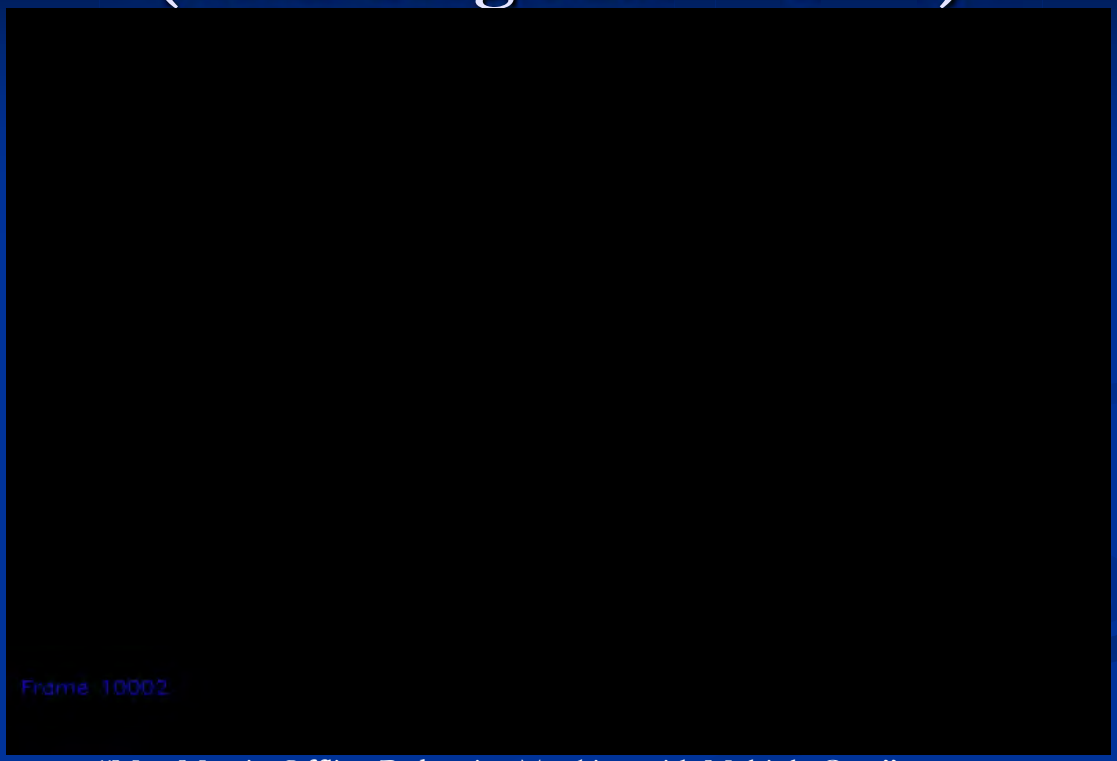
Video Analysis

Validation

Vancouver – Fire Works



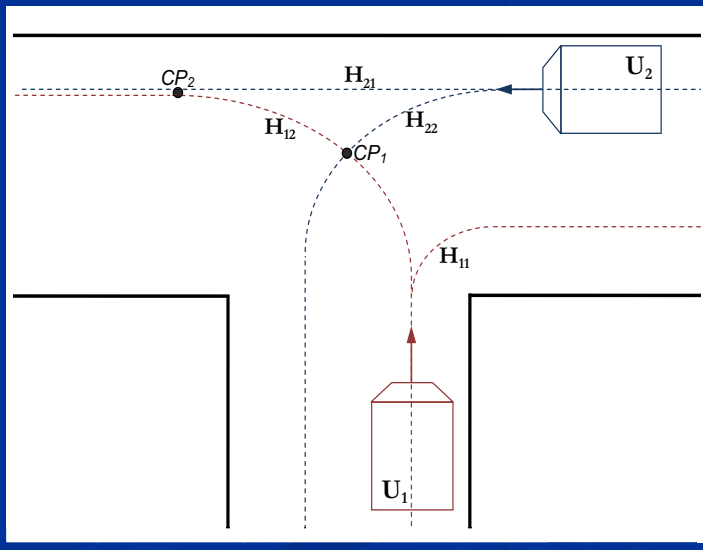
Vancouver – Fire Works (with Greg Mori – SFU)



"Max-Margin Offline Pedestrian Tracking with Multiple Cues" - Canadian Conference on Computer and Robot Vision (CRV 2010)

Objective Conflict Indicator

Vehicle-vehicle Interactions

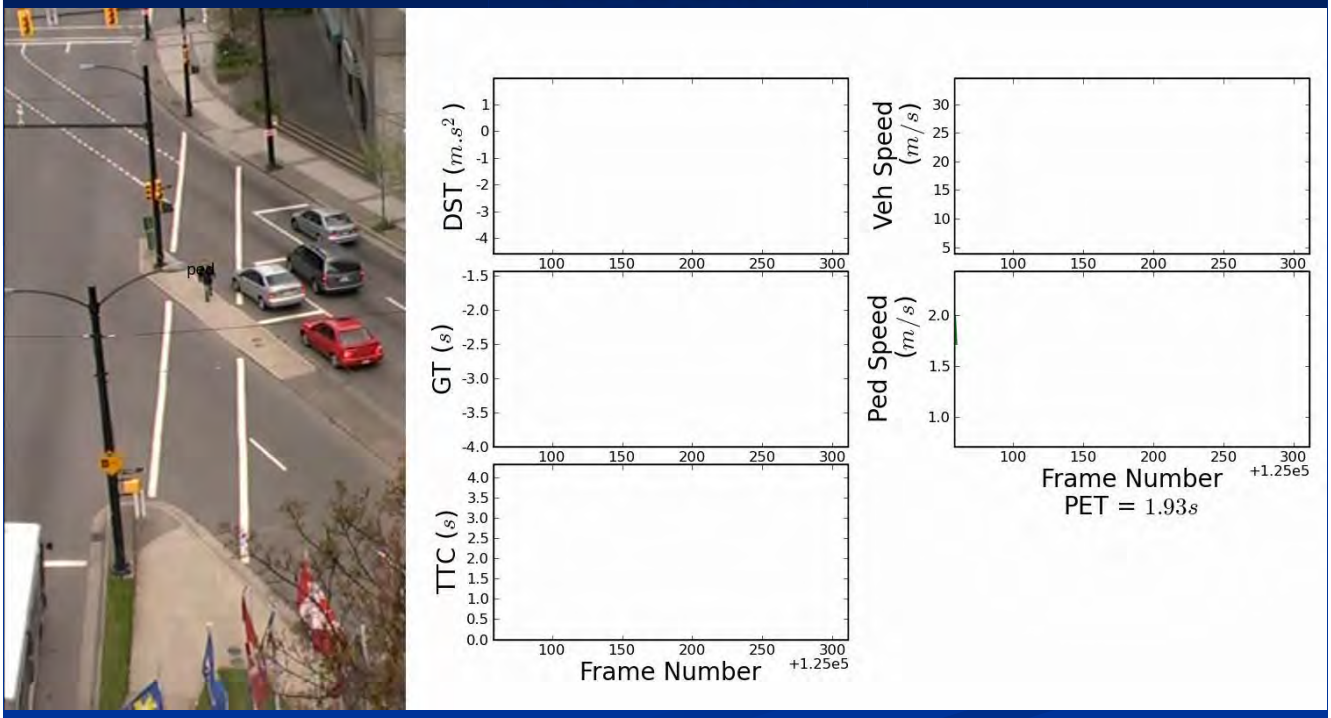


U_x is current track
H_{xy} is extrapolation hypothesis
CP_x is collision point

(Saunier and Sayed, 2008)

Results (Old Training Video)

Results



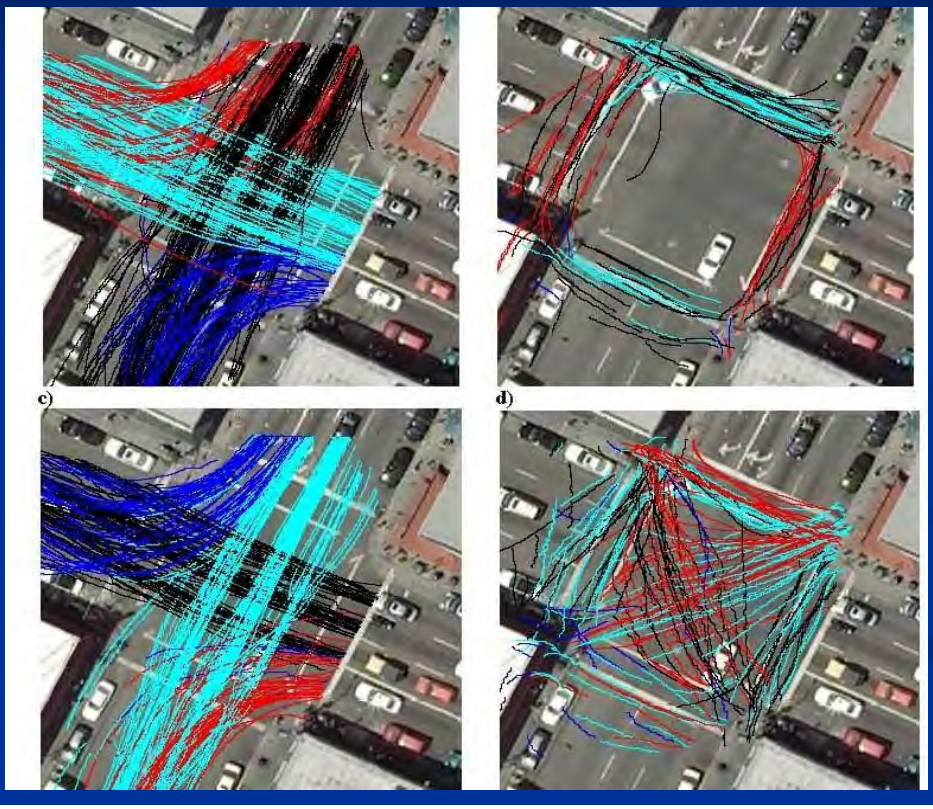
(Ismail, Sayed and Saunier, 2010)

Automated Before-and-After Safety Projects

1. Before/After Evaluation of Pedestrian Scramble (California)
2. Before/After Analysis for the Treatment at Yellowhead / Victoria Trail

Before/After Evaluation of Pedestrian Scramble (Ismail, Sayed and Saunier, 2010)

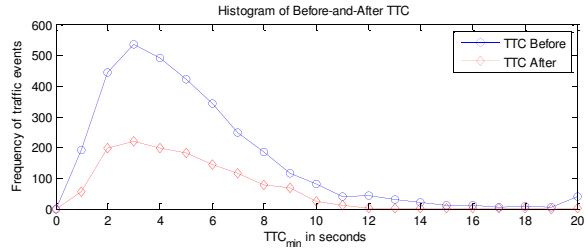
Motion Patterns

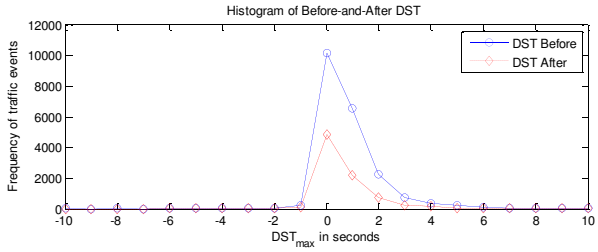


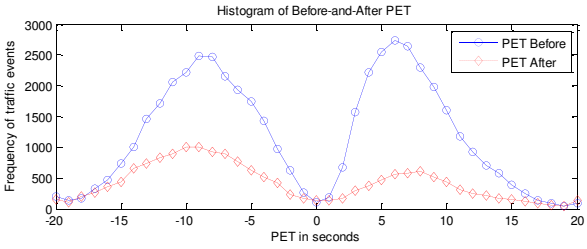
Results

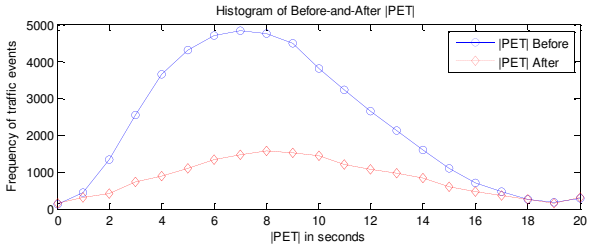
Ismail, Sayed and Saunier (2010)

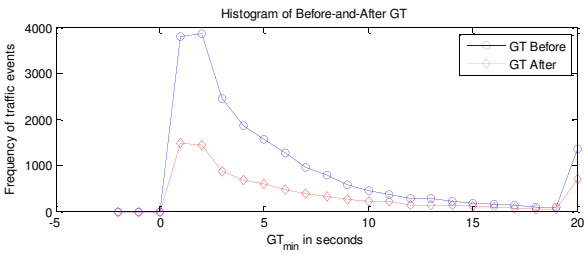
Before-and-After Conflict Indicators

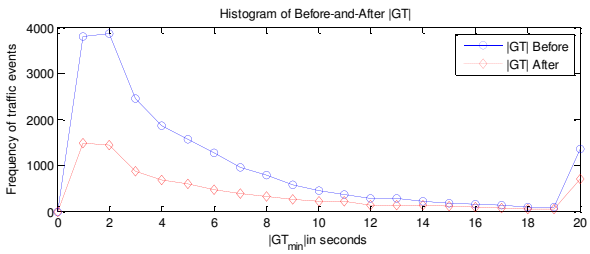






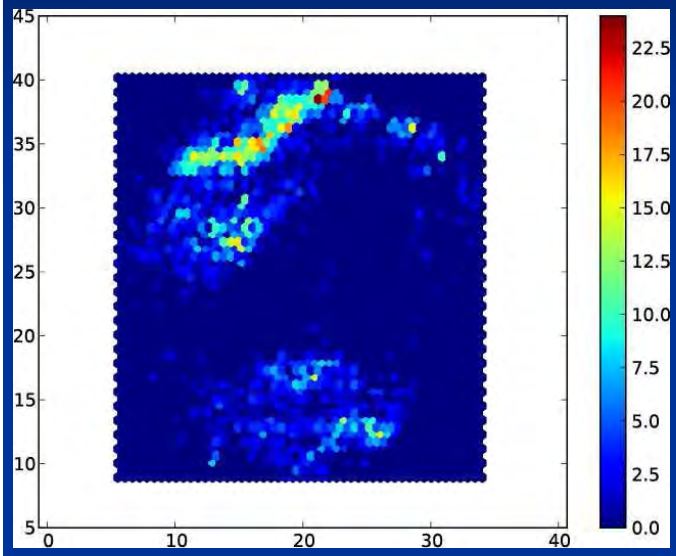


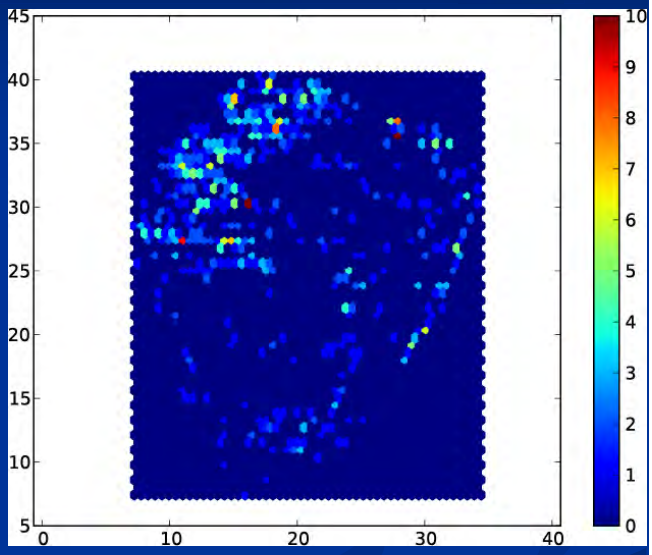




Ismail, Sayed and Saunier (2010)

B/A Studies (Scramble Phase)





Before

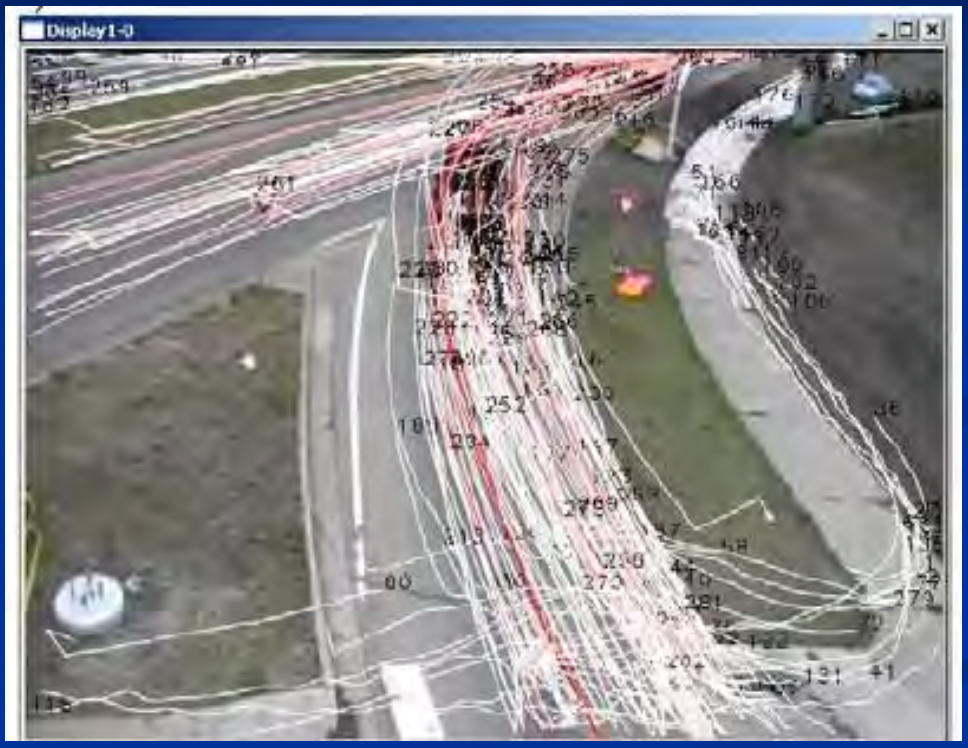
After

Ismail, Sayed and Saunier (2010)

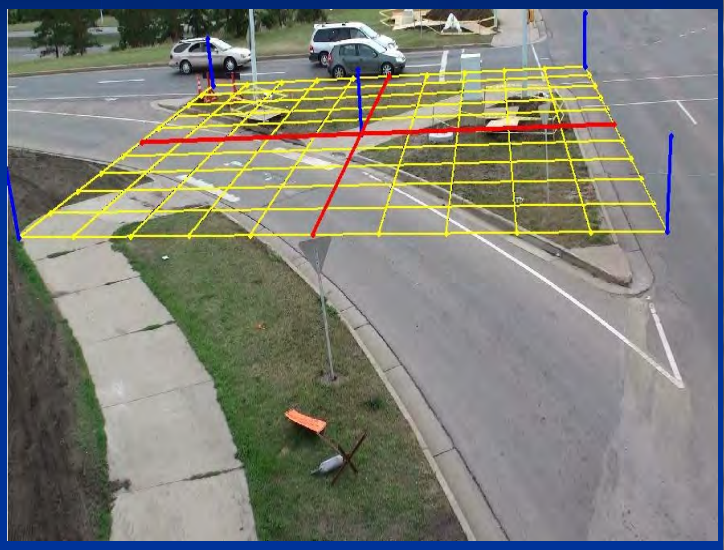
EDMONTON – B/A YELLOWHEAD / VICTORIA TRAIL RAMP

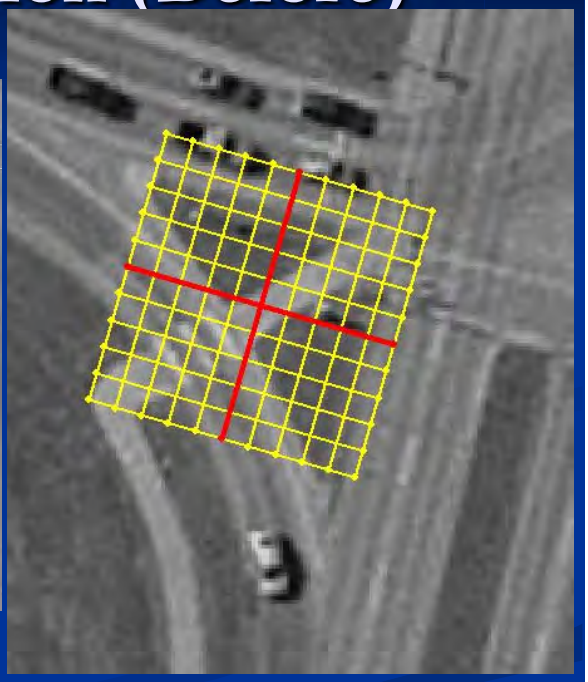
Motion Patterns

Motion Patterns

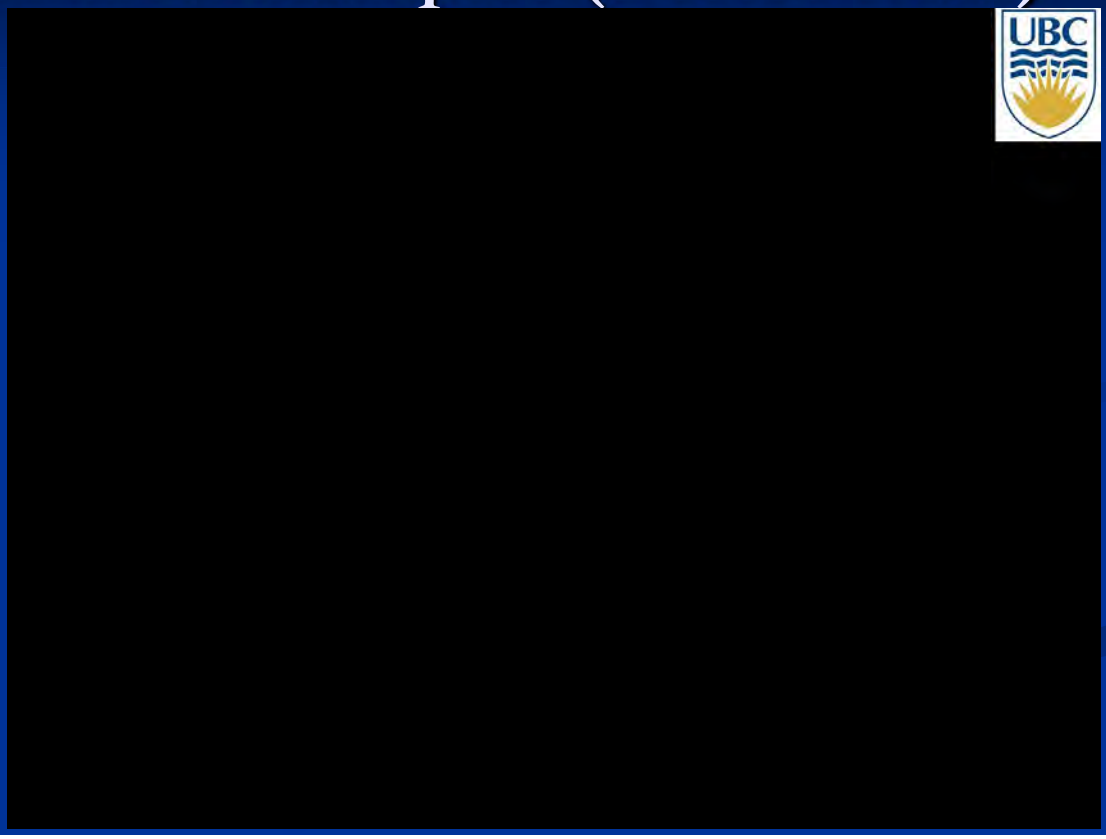


Camera Calibration (Before)





Conflict Examples (Before Data)



Conflict Examples (Before Data)

After Analysis

Conflict Examples (After Data)

Results

CONFLCIT TYPE	BEFORE TREATMENT	AFTER TREATMENT	B/A RATIO
Merging	1.3151e-004	4.5799e-006	**28.71**
	1.1399e-004	4.1768e-006	**27.29**
	9.1363e-005	3.4317e-006	**26.62**
Rear-end	2.8288e-005	2.6896e-005	**1.05**
	2.8716e-005	2.3093e-005	**1.24**
	2.4232e-005	1.6991e-005	**1.43**
All Types	9.1685e-005	7.6311e-006	**12.01**
	8.1091e-005	6.7632e-006	**11.99**
	6.5463e-005	5.2856e-006	**12.39**

Penticton, BC - Before/After Analysis of Right-turn Treatment

Evaluating the Reliability of Red-Light Cameras

Evaluating the Reliability of Speed Cameras

Automated Safety Analysis - Conclusion

- A **new** approach to road safety analysis
  - Proactive, generic and low cost approach
  - Provides better understanding of driver behavior especially collision avoidance mechanisms
  - Diagnostic approach
  - Overcomes the problems with the traffic conflict technique (high cost and reliability of observers)
  - It is time to take safety analysis in a new direction

Ongoing Studies /Future Work

- Automatic detection of traffic violation events (TRB, 2011)
- Several B/A studies using conflicts
- Aggregation of conflict indicators (TRB, 2011)
- Safety diagnosis of collision prone locations (roundabout)
- Conflict/Collision models