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

- Image Sequence
- Trajectory Database
- Interaction Database
- Motion Patterns
- Volume, Origin-Destination Counts
- Driver Behavior
- Traffic Conflict Detection
- Exposure Measures
- Interacting Behavior

(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
  Daruaza
  15th Apr 09 05:52:3
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

Receiver operating characteristic curve for three classification schemes:

- Max speed classifier
- Smoothed max speed classifier
- Prototype classifier

Ismail, Sayed and Saunier (2010)

Video Analysis

Validation
“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

Conflict Indicators calculated for traffic event 1.

- DST: Deceleration
- t
- Safety Time
- GT: Gap Time
- TTC: Time to Collision
- PET: Post Encroachment Time

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
## Conflict Examples (After Data)

<table>
<thead>
<tr>
<th>CONFLICT TYPE</th>
<th>BEFORE TREATMENT</th>
<th>AFTER TREATMENT</th>
<th>B/A RATIO</th>
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## Results
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