

Automated Analysis of Surrogate Safety Measures and Non-compliance Behavior of Road Users at Intersections

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Overview

- Introduction
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- Research Objective
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- Video Analytics AI Framework
- ✤ Safety Analysis
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Introduction

✤ According to the National Highway Traffic Safety

Administration (NHTSA), 14,711 fatal crashes occurred at or

near the intersection involving vehicles in 2018

Every year, over 2.5 million intersection or intersection related crashes are reported. However, numerous crashes at the intersections that did not result in major injuries or damage are sometimes not recorded.



(Source: FHWA, 2009)



Literature Review

Studies	Variables Analyzed	Study Location	Collection method
Chen et al. (2017)	PET; Relative Time to Collision (RTTC)	Intersection	Drone Video
Zangenehpour et al. (2015)	Traffic Volume; Speed; TTC; PET	Intersection	Fixed Camera Video
Fu et al. (2016)	PET; Vehicle approaching speed; Yielding compliances; Conflict rate	Intersection	Thermal Video
Zangenehpour et al. (2012)	PET; Red light violation	Intersection	Mobile video-camera
Ismail et al. (2010) 2 nd study (2009)	TTC; PET; Deceleration-to-safety (DST); Gap Time (GT)	Intersection	Fixed Camera Video
St-Aubin et al. (2015)	TTC; Gap time (GT)	Roundabout	CCTV
St-Aubin et al. (2013)	TTC; Predicted PET	Freeway	Highway traffic Surveillance Video camera unit
Mohamed and Saunier (2013)	TTC; Predicted PET; probability of unsuccessful evasive action	Intersection	Fixed Camera Video at the corner.
Laureshyn et al. (2017)	TTC	Intersection and roundabout	Fixed Camera Video at the corner.
Zhang et al. (2012)	Time difference to collision (TDTC)	Crosswalk near the intersection	Fixed Camera Video at the top of the building.
Xie et al. (2016)	TTC	Long street with 2 intersection	Video recording from a building. 70 hours



- Evaluate the traffic operations and safety of the transportation network
- Develop a machine learning algorithm to analyze video data that captures the traffic volume and traffic conflicts
- ✤ AI framework that works for different road user groups and calculate the surrogate safety

measures.



Data Collection

List of Potential Data Required for Safety Analysis

- Crash Data
- Conflict Points
- ✤ Speed
- ✤ Traffic Volume
- Road Users
- ✤ Signal Indicator







Video Analytics AI Framework



You Only Look Once (YOLO)

✤ Frame detection in YOLO is processed as a

regression problem, and does not require a complex

processing structure

✤ YOLO is very fast and quickly identifies the objects

in the frame

✤ It can process recorded videos and can also be useful

for real-time detection analysis



Traffic Count

- Classification of road user
- Total number of vehicles entering the

intersection

Total number of pedestrian crossing at

or near the intersection



Counts based on direction of traffic flow



Violation and Non-compliance Events

Counts of the vehicles violating running

red light signal

Count of pedestrian jaywalking events





Surrogate Safety Analysis

Time to Collision (TTC)

Post- Encroachment time (PET)

Travel path of the road users





Surrogate Safety Measure

***** Time to Collision (TTC):

TTC is defined as the time that remains

before two road users collide unless one of

them takes an avoiding manipulation such

as braking or changing lanes

(Threshold : 1.5 seconds)





Surrogate Safety Measure

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(Source: Ryan Louie, 2017)



Surrogate Safety Measure

***** Post-Encroachment Time (PET):

A time between the leaving of the encroaching

vehicle from the conflict point and the entering of the vehicle with an appropriate way at a conflict point.

(Threshold : 1.5 - 5 seconds)





Tool Output

📓 Safety Analysis Tool		– 0 X			
Safety Analysis Tool					
Analysis		Video			
Location Upload Run Analysis	 Pedestrian Volume Vehicle Volume Directional based Volume Pedestrian Violation Time to Collision Post Encroachment Time 	1.458151 Attent - Violents Object Counter: 0			
Results		<image/>			



Location





Results

Video Properties				
Video Length	30 minutes			
Video Resolution	640 X 480			
Frame Rate	10 FPS			

Analysis Results				
Total Vehicles	362			
Left Turning Vehicles	57			
Right Turning Vehicles	89			
Thru Moving Vehicles	216			
Red Light Running Vehicles	7			
Total Pedestrians	6			
Jaywalking Events	4			
Risky Behavior (TTC < 1.5 seconds)	12			
High Risky Behavior (PET < 1.5 Seconds)	16			
Risky Behaviors (PET < 5 Seconds)	59			





Conclusion

- The algorithm demonstrated more than 98 percent of detection accuracy for the tested videos.
- Safety analysis parameters can help in investigating the relationship between human driving behaviors and collision risk at an intersection.
- ✤ Overall, the developed tool would help the state department of transportation, and local

agencies evaluate intersections' safety with less effort.



* Sponsor

Region 2 University Transportation Center – Rutgers (CAIT)

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Thank You

