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

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## Overview

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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.


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## 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 <br> compliances; Conflict rate | Intersection | Thermal Video |
| Zangenehpour et al. (2012) | PET; Red light violation | Intersection | Mobile video-camera |
| Ismail et al. (2010) <br> 2nd study (2009) | TTC; PET; Deceleration-to-safety (DST); Gap <br> 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 <br> Video camera unit |
| Mohamed and Saunier (2013) | TTC; Predicted PET; probability of <br> unsuccessful evasive action | Fintersection | Intersection and <br> roundabout |
| Laureshyn et al. (2017) | TTC | Crosswalk near the <br> intersection | Fixed Camera Video at the top of <br> the building. |
| Zhang et al. (2012) | Time difference to collision (TDTC) | Long street with 2 <br> intersection | Video recording from a building. <br> 70 hours |
| Xie et al. (2016) | TTC |  |  |

## Research Objective

* 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.

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## Data Collection

## List of Potential Data Required for Safety Analysis

* Crash Data
* Conflict Points
* Speed
* Traffic Volume
* Road Users
* Signal Indicator


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## 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


## Safety 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


## Safety Analysis

## Violation and Non-compliance Events

* Counts of the vehicles violating running
red light signal
* Count of pedestrian jaywalking events


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## Safety Analysis

## Surrogate Safety Analysis

* Time to Collision (TTC)
* Post- Encroachment time (PET)
* Travel path of the road users


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## Safety Analysis

## Surrogate Safety Measure

## $\not \approx$ 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)


## Safety Analysis

## 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)

## Safety Analysis

## 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



## 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.


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