*Proceedings of Engineering and Technology Innovation, vol. 7, 2017, pp. 37 - 40*

# Traffic Safety Evaluation Based on Vision and Signal Timing Data

Won-Ho Suh*, Jin-Woo Park, Jung-Ryul Kim

Department of Transportation and Logistics Engineering, Hanyang University, Ansan, Korea.

Received 18 July 2017; received in revised form 11 August 2017; accepted 30 August 2017

## Abstract

With the advancement of recent image processing technologies numerous imaging applications have been developed to collect traffic information. In this study, image processing technology is applied to roadway safety to detect and measure the conflict between pedestrians and vehicular traffic and investigate the correlations between the conflict and signal timing data. By using an image processing technique, pedestrian and vehicular movements are detected and the distance between these two are calculated to detect conflicts between them. In this study, Machine Learning techniques are utilized to facilitate more accurate and efficient detection. It is assumed that the intersection is accident-prone if conflicts between pedestrian and vehicular traffic appear more frequently than other intersections and correlations exist depending on the status of signal timing, for example at the end of green signal for a particular movement. This approach is expected to identify accident-prone intersections without actually experiencing crashes; therefore, this would potentially reduce social costs associated with traffic accidents.

**Keywords:** image processing, vehicle detecting, traffic safety, pedestrian safety

## 1. Introduction

Pedestrians are vulnerable road users. When they are involved in collisions with vehicles, there are considerably higher chances of being severely or fatally injured, while a large number of collisions between vehicles are property damage only. Surrogate safety measures has been developed as a complementary method to improve pedestrian safety and offer more in depth analysis than relying on historic accident data alone. There is a growing effort to use recent image processing technologies for a conflict analysis between vehicles and pedestrians. In this study, vehicle tracking and pedestrian tracking technologies currently developed and used are reviewed.

## 2. Vehicle Tracking

Model-based tracking utilizes a priori knowledge of typical objects. For a vehicle tracking, vehicles in an image captured from a video are tracked. These methods recognize vehicles. However, this method tends to fail when there is an occlusion for the target object. Also, this tracking method is limited in recognizing all the vehicle types on the roadway.

Region-based tracking method is to identify connected regions of the image associated with each target vehicle. Regions are usually acquired from background subtraction. Also, this method utilizes Kalman filters to process available information from the image including motion, size, color, shape, texture, and centroid. It is known that this tracking method is

* Corresponding author. E-mail address: wonhosuh@hanyang.ac.kr

Tel.: +82-31-400-5154; Fax: +82-31-436-8147

computationally efficient and the detection accuracy is generally good in free-flowing traffic conditions. However, if traffic is congested – when background images do not change over a short period of time and vehicles partially occlude one another, this method tends to have problems, since separating individual vehicles are becoming challenging. Sometimes, such vehicles are identified as one vehicle, resulting in low detection rates.

Contour-based tracking method uses the boundary curves of the moving object. For example, this method tracks pedestrians by identifying the contour of a pedestrian's head. This method is known to have more efficient description of objects than region-based methods. However, this method still shares the weakness of region-based tracking when traffic condition is congested.

Feature-based tracking does not track object as a whole in image processing. Instead, this method tracks unique features. There features can be points or lines of the object which are distinct from other objects. When the target object is partially occluded, some of the distinctive features of the moving object remain visible and detectable, resulting in successful tracking. The advantage of this method over other tracking methods is that the same algorithm can be applied for tracking in different lighting or traffic conditions. For example, this method utilizes window corners or bumper edges during the day when the entire object is visible. During the night, this method uses tail lights, since other features are not detectable in night time lighting conditions. Currently, this method is advanced and computational efficient allowing this method to be used in real time processing. An example of vehicle tracking is provided in Fig. 1.

Fig. 1 Vehicle tracking [1]

## 3. Pedestrian Tracking

To identify conflicts between vehicles and pedestrians, all movements of vehicular and pedestrian traffic need to be tracked from video frames. Especially, this is challenging since pedestrians sometimes move in group and change directions, while vehicular movements are somewhat predictable. To overcome the issues and increase the accuracy of tracking, there are three tracking methods which are currently popular; tracking by detection, tracking using flow, and tracking with probability.

Tracking by detection method detects objects using background modeling and subtraction with the current image or deformable templates. Tracking using flow is similar to feature based tracking. This method is popular in traffic monitoring and pedestrian counting. Tracking with probability uses a Bayesian tracking framework. This method also utilizes other filers and methods, such as particle filters, Markov chain, and Monte Carlo methods. An example of pedestrian tracking is provided in Fig. 2. Also, Fig. 3 presents an example of vehicle and pedestrian tracking in an intersection.

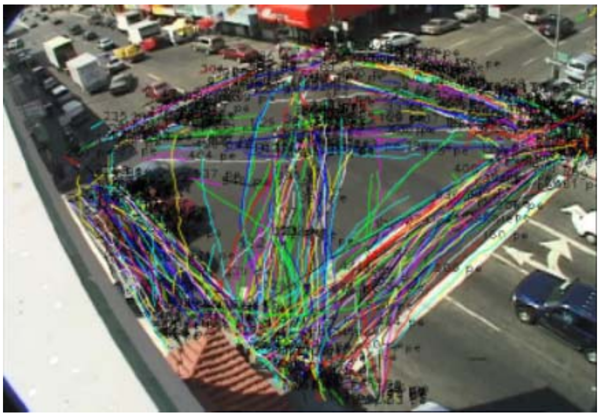

Fig. 2 Pedestrian tracking [1]

Fig. 3 Vehicle and pedestrian tracking [2]

## 4. Calculating Conflicts

To calculate conflicts between vehicular and pedestrian traffic, potential accident-prone conditions need to be identified. These conditions are illustrated in Fig. 4 and Fig. 5. Based on the calculated time gap between the vehicle and pedestrian, conflict data can be obtained.

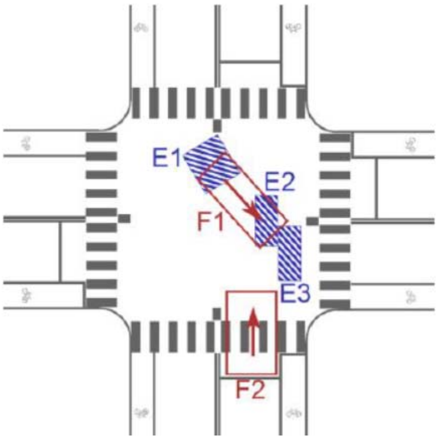


Fig. 4 Left turning vehicle conflict example [3]

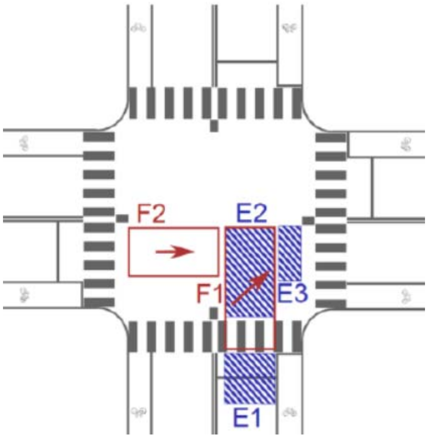


Fig. 5 Thru moving vehicle conflict example [3]

## 5. Preliminary Results and Future Works

The research team is in a process of developing vehicle and pedestrian tracking method. The team was successfully tracked vehicles in a video collected from an intersection in Seoul, Korea (Fig. 6). The team is planning to continue to develop the tracking algorithm and calculate the conflicts between vehicular and pedestrian traffic. The team is utilizing Machine Learning techniques to reduce the detection error and increase the efficiency of the program. The output of this research is expected to improve traffic analysis [4] by detecting pedestrian and vehicular movements and facilitate more accurate and efficient detection. It is assumed that the intersection is accident-prone if conflicts between pedestrian and vehicular traffic appear more frequently than other intersections and correlations exist depending on the status of signal timing, for example at the end of green signal for a particular movement. This approach is expected to identify accident-prone intersections without actually experiencing crashes; therefore, this would potentially reduce social costs associated with traffic accidents.

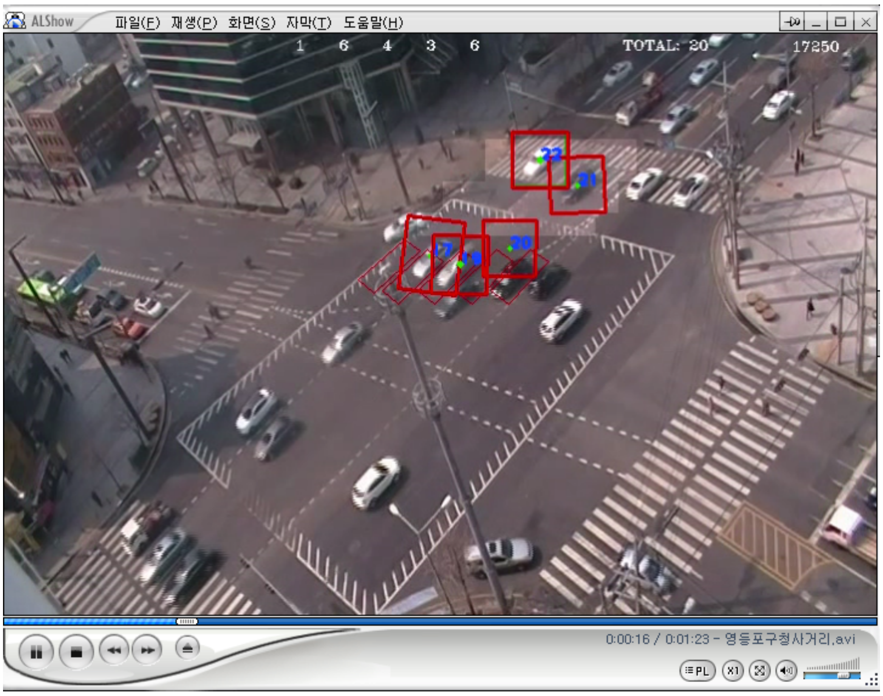


Fig. 6 Vehicle tracking program snapshot

## Acknowledgment

This work was sponsored by NRF-2017R1D1A1A09000606 and Transportation & Logistics Research Program ID-97344 of the Korean government.

## References

[1] K. Ismail, T. Sayed, and N. Saunier, “Automated analysis of pedestrian-vehicle: conflicts context for before-and-after studies,” Transportation Research Record: Journal of the Transportation Research Board, vol. 2198, pp. 52-64, 2010.

[2] A. Laureshyn, “Superpixel based road user tracker,” Workshop on the Comparison of Surrogate Measures of Safety Extracted from Video Data, Transportation Research Board 93rd Annual Meeting, January 2014.

[3] T. Madsen, “Automatic detection of conflicts at signalized intersections,” Workshop on the Comparison of Surrogate Measures of Safety Extracted from Video Data, Transportation Research Board 93rd Annual Meeting, January 2014.

[4] W. Suh, “Mitigating initialization bias in transportation modeling applications,” Proceedings of Engineering and Technology Innovation, vol. 3 pp. 34-36, 2016.