Effects of a Preventive Warning Light System for Near-Miss Incidents

Akira Yoshizawa, Denso IT Laboratory, Inc., Shibuya-ku, Japan
Hirotoshi Iwasaki, Denso IT Laboratory, Inc., Shibuya-ku, Japan

ABSTRACT

This article describes how the number of fatal traffic accidents has been decreasing in Japan because of recent safety technologies of vehicles, such as stiff cabins, antilock braking systems, and seat belts. Automated vehicles and advanced driver assistance systems can advance the trend. However, many traffic accidents occur on narrow streets in residential sections, where it is difficult for even advanced vehicles to drive safely. In this research, this paper utilizes a near-miss incident database to analyze driver gazing. The result showed that preventive warning systems are useful for avoiding traffic accidents.

KEYWORDS

Attention, Driver Distraction, Eye Tracking, Pedestrian Detection, Near-Miss Incidents, Preventive Warning, Saccade

INTRODUCTION

Even though the number of transport fatalities in Japan is steadily decreasing, we still have many traffic accidents. For those promoting safety systems, such as antilock braking systems and airbags, drivers and passengers are becoming relatively safer. However, pedestrians, cyclists, and motorcyclists still face dangerous situations. Statistics showed that 83% of such accidents occurred on straight roads, and 35% of them were caused by aimless driving (ITARDA, 2012).

Driver-monitoring systems have been marketed to prevent such situations. For example, the Driver Status Monitor (Denso, 2014) developed by Denso detects drivers’ head angles. If the driver looks away for a certain time, it alerts the driver with beeping sounds to get the driver’s eyes back on the road. Of course, the system can be effective, but some dangerous situations still remain. For example, the driver may gaze off the road without turning his/her head. We thus need to develop a new system with an eye-tracking device.

There is research analyzing driver gazing. Most of this research has been conducted with driving simulators or with real vehicles but in a very simplified scenario of a planned procedure in advance in a test field (Fletcher & Zelinsky, 2009; Harada, Iwasaki, Mori, Yoshizawa, & Mizoguchi, 2013; Harada, Yoshizawa, Mori & Iwasaki, 2014; Harada, Iwasaki, Mori, Yoshizawa & Mizoguchi, 2014; Harada, Mori, Yoshizawa & Iwasaki, 2015; Kircher, Ahlstrom & Kircher, 2009; Mizoguchi, Ohwada, Nishiyama, Yoshizawa & Iwasaki, 2015; Nishiyama, Yoshizawa, Iwasaki & Mizoguchi, 2015; Yamashiro, Deguchi, Takahashi, Ide, Murase, Higuchi & Naito, 2010; Yonetani, Kawashima, Hirayama & Matsuyama, 2012; Yoshizawa & Iwasaki, 2014; Yoshizawa & Iwasaki, 2015; Yoshizawa, Nishiyama, Iwasaki & Mizoguchi, 2016; Yoshizawa, Nishiyama, Iwasaki & Mizoguchi, 2017).

DOI: 10.4018/IJSSCI.2018010105
Starting with a simple scenario is a reasonable to try to understand how traffic accidents occur. However, there is no guaranty of reaching the goal of explaining sufficiently all traffic accidents by summing up the knowledge we acquire from this research. Real road scenes are far more complicated than experiment scenes. There are many objects, such as vehicles, bikes, pedestrians, traffic signals, shops, buildings, mountains, and blind corners, and they change dynamically. Sometimes they change interactively with changes made by the driver. Weather and sunshine change as well, changing the appearance of all the objects. The real world is so complicated that the exact same situation never recurs.

There is also research to create driver models. Itti et al. proposed a saliency map, a fundamental model of eye fixation (Itti, Koch & Niebur, 1998). It shows that different appearances of objects lead to different gazing behavior. The saliency map is a bottom-up model of human visual attention. There is also a top-down aspect (Oliva, Torralba, Castelhano & Henderson, 2003). The top-down mechanism drives change of gazing direction based on the meaning of each object, prediction, driving custom, or searching action, in which the driver looks back and forth when he/she wants to turn left/right for example, independently of the saliency map, considering total risk. Attention is a core feature of human intelligence (Wang, Patel & Patel, 2012). And it is considered that the feature controls the top-down and the bottom-up process. It works so flexible that

Computer driving simulators and simplified road experiments thus cannot possibly cover the true reasons for traffic accidents. Furthermore, there is little literature on analysis of gazing behavior using real incidents, though some researches focus on estimation of driver’s cognitive status by using real driving log data (Sega, Iwasaki, Hiraishi & Mizoguchi, 2011). J-SAI, the Society of Automotive Engineers of Japan, started collecting near-miss incident data (including incidents) in 2006 (Matui, Hitosugi, Doi, Oikawa, Takahashi & Ando, 2013). All data included in the database are real incidents captured by hundreds of taxis. We investigated gazing behavior using real near-incident images.

**METHOD**

**Near-Miss Incident Database**

A near-miss or close-call incident database has been developed and is currently managed by The Smart Mobility Research Center of Tokyo University of Agriculture and Technology. It collects driving information from driving recorders mounted on taxis in Japan (Smart Mobility Research Center). The device records critical scenes based on acceleration. The data includes front view camera images and basic vehicle data such as speed, braking, and acceleration. The stored images are recorded 10 seconds prior to the strong deceleration point and 5 seconds after it. Figure 1 presents the user interface of the database. The movie and vehicle data can be checked simultaneously.

All incidents in the database were real situations, and it is useful to reproduce near-miss experiences for subjects. We therefore had all subjects watch the movies and recorded their gazing and braking.

**Experiment System**

Our experiment system consists of a personal computer and an eye tracker (Figure 2). The experiment program presents movies on a computer display and checks the timing of keyboard entry. We asked the subjects to press a key if they wanted to push the brake pedal to avoid collision with pedestrians, vehicles, or other objects.

We use an EyeTribe system (Eye Tribe) as an eye-tracking device. It records movement at 30 frames per second. Figure 3 presents our system. The display is 27 inches and has 2560 x 1440 pixel resolution. The EyeTribe device was located under the display.

**Subjects**

Four subjects participated in this experiment. All of them were male and had a driver’s license. Three of them were in their 40s and one was in his 20s.
Role-Based Autonomic Systems
[www.igi-global.com/article/role-based-autonomic-systems/46145?camid=4v1a](www.igi-global.com/article/role-based-autonomic-systems/46145?camid=4v1a)

Multi-Fractal Analysis for Feature Extraction from DNA Sequences
[www.igi-global.com/article/multi-fractal-analysis-feature-extraction/43895?camid=4v1a](www.igi-global.com/article/multi-fractal-analysis-feature-extraction/43895?camid=4v1a)