Influence of Nonvisual Secondary Tasks on Driver’s Pedestrian Detection

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ABSTRACT

The most frequent type of fatal traffic accident is caused by “aimless driving” in Japan. In many cases the victims are pedestrians on straight roads, where there are usually fewer objects drivers need to pay attention to than at intersections. In this study, the authors investigate driver gazing for detecting pedestrians in such situations. To make subjects seem “aimless,” they gave them nonvisual secondary tasks of four difficulty levels while they tried to watch pedestrians and press a key to answer their moving direction. The result indicated that even nonvisual tasks influence eye movement and the subjects fail to react properly.

Keywords: Attention, Driver Distraction, Eye Tracking, Pedestrian Detection

1. INTRODUCTION

Trends in the number of fatalities in Japan indicate that the number of fatalities of vehicle drivers and passengers has decreased steadily over the past ten years. One reason may be increased safety systems, such as antilock braking systems and airbags. However, the number of fatalities of pedestrians hit by vehicles has become the most frequent cause of deaths on the road. Statistics indicate that 83% of such accidents occurred on straight roads. Among these accidents, 35% of drivers’ engaged in aimless driving, and another 35% engaged in “distracted driving (ITARDA, 2012).

Appropriate attention allocation is a key to safe driving (Fisher, D.L. & Pollatsek, A., 2007). And the internal information processing mechanisms and process of the brain, including attention mechanisms, have been investigated as Cognitive Informatics (Wang, Y., G. Baciu, Y. Yao, W. Kinsner, K. Chan, B. Zhang, S. Hameroff, N. Zhong, C.-R. Hunag, B. Goertzel, D. Miao, K. Sugawara, G. Wang, J. You, D. Zhang, & H. Zhu, 2010). Attention and eye movement are strongly linked in the brain, and fixation is the most effective mechanism (Victor, T. W., Engström, J., & Harbluk, J. L., 2009; Wickens, C. D., 1984). Studies have been conducted in an effort to create models of drivers’ attention and distraction using gazing behavior (Harada, T., Iwasaki,
H., Mori, K., Yoshizawa, A. & Mizoguchi, F., 2014). However, the spatial direction of attention is not always the same as the gazing direction (Posner, M.I., 1980). Even covert attention mechanisms do not involve explicit eye movement (Geisler, W.S. & Cormack, L.K., 2011).


The purpose of this study is to investigate inattentive drivers’ gazing behavior especially at pedestrians. We hypothesize that even nonvisual secondary tasks cause inattention for the driver and affect eye movement.

2. METHOD

2.1. Measurement Equipment

We use a driving simulator with three 50in plasma displays (Figure 1). Computer-generated images of pedestrians appear on the displays. The pedestrians move randomly in the walking area, set by testers beforehand (Figure 2).

Figure 3 depicts our system configuration. The subject wears a cap with a reflector for the head-tracking system. For the head tracker, we use TrackIR5 (NaturalPoint, Inc.), which emits infrared light towards the reflector and captures the reflection pattern to estimate head motion with six degrees of freedom in 3D space.

The cap also has two eye cameras and a single front camera for the eye tracking system (NAC Image Technology). Its Eye Mark Recorder 9 can capture eye direction at a 60Hz sampling rate.

Gaze direction calculation software in Computer 2 combines head-motion data from the head-tracker and eye-motion data from the eye tracker to estimate gazing direction. The calculation result is logged into a file every 31ms.

The subject also wears a headphone for the secondary task, which we will explain later. The secondary task generator software in Computer 3 generates tasks, and the speech synthesizer software changes it to voice data and sends it to the headphone.

In front of the subject is a numeric keypad to collect attention data. The keypad is connected to the target control software in Computer 1; it draws and controls pedestrian images on the plasma displays. The software saves pedestrian motion data and key input data in a log file.

Through the calibration of the eye tracker and the head tracker, the gaze direction calculation software and the target control software output pitch and yaw angles based on the same origin of the coordinate axes.

2.2. Secondary Task

Four levels of difficulty were prepared to cause subjects to be inattentive. “No secondary task” means the subjects can concentrate on the main task. “Level 1” to “Level 3” tasks are addition tasks of different difficulty levels (see Table 1). The subjects listen to the questions the second-
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