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Original Research Paper

An analysis on possibility of intelligent speed adaptation in terms of drivers' consciousness

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ARTICLE INFO

Article history:
Available online 28 March 2015

Keywords:
Intelligent transportation systems
Intelligent speed adaptation
Advisory ISA
Driving simulator
Zone 30
Speed management

ABSTRACT

Intelligent speed adaptation (ISA) is considered as an effective measure to reduce number of traffic accidents in the field of intelligent transportation systems (ITS). On the other hand, its effects for traffic safety are still doubted by many people. To make the possibility analysis, an experiment is conducted by using driving simulator. Regarding ISA approaches, there are three modes: mandatory, voluntary and advisory. Among them, the advisory type seems to be the easiest one to introduce. Therefore, we focus on the advisory mode in this study by considering ISA just at the beginning stage in Japan. The experiment consists of four steps: without ISA, ISA using pictures, ISA using voices and again without ISA. The outputs obtained from the driving simulator are analyzed combined with the consciousness of the participants. The experiment shows that the ISA can improve recognition of speed limitation especially for people who have random rambling or looking aside tendency. Furthermore, the ISA especially when using voices can contribute in changing the consciousness of people who are aggressive in driving. Their driving speeds can reduce so that positive effects on traffic safety can be concluded.

1. Introduction

In 2011, the 9th Fundamental Traffic Safety Program of Japan was finally decided and released (Cabinet Office, 2011). One of the three important viewpoints is focusing on the community road traffic safety measurements. One concrete measure is to introduce the speed limit zone widely all over Japan. Instead of the current line speed limits, the area speed limit system was emphasized as an effective approach in the coming years. This is the so-called Zone 30 (speed limit is 30 km/h) system being promoted into the community roads. As a famous worldwide guideline, WHO (2008) published a manual. Furthermore, in order to make the speed limit regulation work well, the studies on intelligent speed adaptation (ISA) have been undertaken mainly in Europe, e.g. Warner and Åberg (2008), Carsten (2012) and Van der Pas et al. (2012). However, there are few studies regarding ISA in Japan. Therefore, we conducted an experiment by using the driving simulator on the effects of

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Peer review under responsibility of Periodical Offices of Chang'an University.
http://dx.doi.org/10.1016/j.jtte.2015.03.002

ISA. The effects can be discussed from many different viewpoints. In this paper, in order to answer whether ISA can make the traffic safer, we make an analysis from the viewpoint of the drivers' consciousness. In the discussion, the contribution to the traffic safety is expressed by the change of drivers' consciousness and the reduction of speeds.

2. Outline of experiment

The experiment was carried out during Nov. 2011 to Feb. 2012. The experiment was made by using a driving simulator instead of driving a car on public road. One reason is to avoid traffic accidents on the public road. Another and the most important reason is that, the driving simulator can simulate many road environments and traffic scenarios. Same road environment and traffic scenarios allow comparison on the differences among the monitors. Furthermore, different road environments and traffic scenarios manifest their individual influence.

Driving simulator "D^3sim" developed and provided by Mitsubishi Precision Co., Ltd. is used. The driving simulation system consists of an operation stage, three simulation computers, and four projectors. The screen is 1.5 m high and 2 m wide. Four screens are located in the front, left front, right front and right side.

In the world, Japan is one representative aging country. The traffic safety countermeasures for the elder people become very important. Comparing fatalities number caused by the traffic accidents in 2013 and 2012 in Japan, the elderly people being 60 years old and over increased to 2644 from 2601 although the total number has decreased to 4373 from 4411 (Japan Research Center for Transport Policy, 2014). Therefore, our analysis concerns these elder drivers but not limits to them (Fig. 1). The monitors gathered from all ages including 17 younger drivers being under 30 years old and 30 elder drivers being 60 years old and over.

By considering this study as the beginning stage on ISA in Japan, we take the advisory mode as the objective. Regarding the advisory mode, both picture information and voice information can be applied. Thus, the experiments are divided into four parts: usual driving, driving with picture information, driving with voice information and again usual driving. Here, the usual driving is programmed as the first drive to record the usual behavior of the monitors, and fourth drive to know how they behave after having experienced the information provision. For comparison, in between the 1st and the 4th drives, the drives with the information provision are performed twice: the picture information and the voice information. However, the orders of these two drives are randomly programed to exclude the influence of the drive order. Additionally, one test run is made at the beginning in order to let the monitors get used to the driving simulator. Because some monitors experience kinetosis while using driving simulator, resulting to only 15 young drivers and 16 elder drivers to complete the drive plan.

As stated above, the advisory mode is considered in two ways: picture and voice. The voice information is an audible short phrase, i.e. "speed limit is 30 km/h"; such voice information lasted three seconds that was prior recorded and played during the experiment. The picture information is shown in the screen as depicted in Fig. 2.

The drive route and space design are summarized in Fig. 3. The route includes three different speed limit sections: a four-lane section about 640 m long with the speed limit 50 km/h (A–B section), a two-lane section about 480 m long with the speed limit 40 km/h (B–C section) and a 5.5 m wide section about 1.12 km long with the speed limit 30 km/h (C–D–E section). Fig. 3 also depicts the road environment, in C–D–E section, there are two kinds of space design: one looks narrow because houses are located very close to the

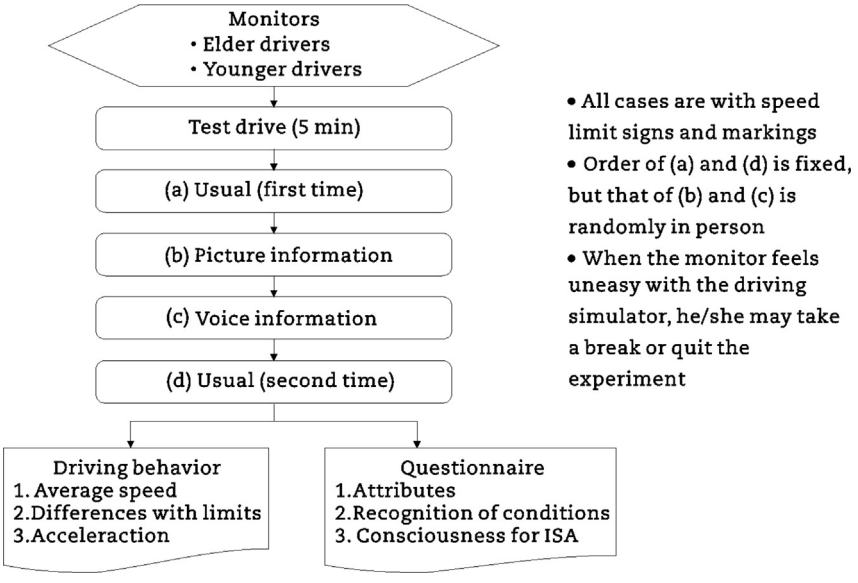

Fig. 1 – Experimental procedure.