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An analysis of the impact of driving time on the driver's behavior using probe car data

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Abstract

Driver's fatigue is an important factor of traffic accidents. Therefore, a fatigue detection system which achieves a small burden on a driver is expected to be developed, which stimulates drivers after long hour driving to take a rest at an appropriate timing when the driver's fatigue is detected. In order to give warning at an appropriate timing, knowledge about the impact of continuous driving hours on driver's behavior should be obtained. Recently, a rapid spread of ITS technologies enables us to analyze driving behavior in detail by using a large quantity of probe car data. This study analyses the impact of continuous driving hours on driving behavior when a vehicle is traveling on an expressway based on the probe car data. It is shown that the continuous driving hour affects driving behavior significantly. From the results, it can be concluded that driver had better take a rest every 5,000 [s] approximately.

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Keywords: "the driver's behavior, continuous driving hour"

1. Introduction

Detection of driver condition is a major concern in road safety. In particular, professional drivers have been characterized as experiencing heavy fatigue resulting from long distance or long hour driving in their work. Therefore, an alert system is expected to be developed, which stimulates drivers after long hours driving to take a rest at an appropriate timing. In order to give a warning at an appropriate timing, the knowledge about the impact of driving time on driver's behavior should be obtained.

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This study aimed at developing a methodology to evaluate the relationship driver condition (such as driver fatigue, loss of alertness etc.) indices and driver behavior indices when a car is traveling on an expressway.

There are many factors that may cause the driver to be fatigued. It results from the effect of monotony on alertness, vigilance and so on. For example, if you drive a car for a long time, it might cause physical and psychological changes such as the reaction time delay and delay in responding to traffic situation.

Several methods of driver performance have been used to perform real time driver's condition detection using field experiment or driving simulators. These methods are divided into the vehicle based methods and the driver based methods.

The vehicle based methods based on monitor vehicle operational indices. The vehicle based methods observe the vehicle operating parameters such as change in the steering, acceleration, speed of the vehicle, braking and lane tracking and so on. For example, Apostoloff and Zelinsky (2003) represented the development and application of a novel multiple-cue visual lane tracking system. Moreover, Jagannath and Balasubramanian (2014) used seat pressure distribution and other measures of physical index like blood pressure such as heart rate, oxygen saturation level to quantify driver fatigue during monotonous simulated driving.

On the other hand, the driver based methods based on devices that directly monitor driver condition. the driver based methods are physical movement parameters such as eye closure and blink rates, tracking of facial expression by using video imaging techniques (Zhu and Ji, 2004). For example, Nillson et al,(1997) demonstrated average fatigue scores of experiment subjects increased rapidly during the first 80 minutes of driving. In addition to, Iwakura et al. (2001) investigated the possibility of a quantitative assessment of stress to measure the stress with long- distance driving which wearing heart rate interval RRI. This survey asks in seven ranks from "not tired at all" to "exhaustion", as an overall investigation. As the result, although it is not clear trend because it changes periodically during the day, as the driving time increase, RRI to be long, and this survey result agree with rate of the RRI change. So, it is supported that stress occurs by long distance or hour driving. Furthermore, Warita et al. (2012) conducted the driving survey to investigate the correlation between the driver's psychological condition and road structures, traffic conditions using a biosensor and an eye mark recorder and drive a car equipped with a drive recorder for these car experiments. And, Wu et al. (2013) conducted to examine the changes in driver's eye movements, driver performance and heart rate. Those analyses have been performed to analyze sings of driver's condition through the driving car experiments or driving simulators.

However, these have never been tested in practice or realistic traffic environment. In addition to, the limitation data obtained by these vehicles may not represent the whole population. Furthermore, it need to reduce the experiment burden on a driver.

On the other hand, a rapid spread of ITS technologies enables us to analyze driving behavior in detail by using a large quantity of probe car data. These data are the identification of the location of car using the global positioning system (GPS). The advantage of probe data analysis is that we direct observe the travel time. Therefore, the driving history is included in these data. It seems to easily trace driver behavior or performance and obtain realistic environment driving data. Therefore, it is expected that detailed driver's behavior analysis could be carried out using these data.

In this study, the methods are proposed to investigate the relationship the continuous driving hours and driver's behavior using probe car data. Specifically, we will propose an index that can be used to evaluate driver's behavior based on the probe car data using piece wise liner regression model.

2. Concept of this study

2.1. Methods

The study purpose was to understand the relationship the continuous driving hours and driver's behavior indices. In general, the driving behavior is regulated by drivers' functions of recognition, judgment, and operation. Therefore, the changes of psychological and physiological responses occurring as driving fatigue would be reflected in the changes of the driving functions. If a driver feels tired while driving, we were difficult to keep a proper driving operation such as adjusting velocity. Such changes of driving conditions are affected by the changes of conditions of