# Chapter 69
# Detecting Cognitive Distraction Using Random Forest by Considering Eye Movement Type

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## ABSTRACT

*Detecting distracted states can be applied to various problems such as danger prevention when driving a car. A cognitive distracted state is one example of a distracted state. It is known that eye movements express cognitive distraction. Eye movements can be classified into several types. In this paper, the authors detect a cognitive distraction using classified eye movement types when applying the Random Forest machine learning algorithm, which uses decision trees. They show the effectiveness of considering eye movement types for detecting cognitive distraction when applying Random Forest. The authors use visual experiments with still images for the detection.*

## 1. INTRODUCTION

Cognitive informatics (Wang, 2007) and cognitive computing (Wang, 2009) have been actively studied. We focus on cognitive distraction in relation to cognitive informatics and cognitive computing. A cognitive distracted state is one example of a distracted state. The detection of cognitive distraction is very useful. For example, it can help to prevent work-related accidents.

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Eye movement is the primary sign of life in neuropsychology and cognitive science (Wang, Y. 2014). It is well known that eye movements can express cognitive distraction. Therefore, it is possible to detect whether a person is in a cognitive distracted state by analyzing their eye movement data. Many studies have attempted to detect cognitive distraction from eye movements; these studies have been applied in various fields (Duchowski, 2002). In these studies, eye movements of people responding to car driving scenes were utilized to detect cognitive distraction (for example, Azman, Meng, & Edirisinghe, 2010; Hirayama, Sato, Mase, Miyajima, & Takeda, 2014; Katja, Christer, & Albert, 2009; Salvucci, 2006; Yoshizawa & Iwasaki, 2015).

There are two main types of distracted states: visual distracted states and cognitive distracted states. In previous studies, we evaluated cognitive distracted states using eye movements. In (Harada, Iwasaki, Mori, Yoshizawa, & Mizoguchi, 2014), we proposed a model that expresses a degree of cognitive distraction quantitatively using neural networks, and applied the model to eye movement data of a car driving scene. In (Harada, Mori, Yoshizawa, & Iwasaki, 2015), we proposed a cognitive process model for car driving considering quantitative representation for the degree of cognitive distraction.

Eye movements can be classified into various types, such as fixations and saccades (Holmqvist, Nyström, Andersson, Dewhurst, Jarodzka, & van de Weijer, 2011; Nyström, & Holmqvist, 2010; Salvucci, & Goldberg, 2000). The saccade which is one of the eye movement types indicate psychological conditions (Mizushina, Sakamoto, & Kaneko, 2011). Therefore, eye movement types are thought to be effective in evaluating cognitive distraction. In (Harada, Kawakami, Yoshizawa, Iwasaki, & Mizoguchi, 2015), we applied the distraction model we proposed (Harada, Iwasaki, Mori, Yoshizawa, & Mizoguchi, 2014) using classified eye movement types, and evaluated cognitive distracted states in a visual experiment.

In this paper, we use Random Forest (Breiman, 2001) to detect cognitive distraction. Random Forest is an identification-based machine learning algorithm. It is an ensemble learning algorithm that uses decision trees. It is robust to noise and has good learning precision. In this paper, we show the effectiveness of considering eye movement types when applying Random Forest to detect cognitive distraction. We used still images in the experiment.

## 2. RELATED STUDIES

Various research efforts have applied identification-based machine learning algorithms to detect cognitive distraction using eye movement data. In (Miyaji, Kawanaka, & Oguri, 2010), the Adaboost algorithm was applied to detect cognitive distraction in drivers using gaze angles and head rotation angles. In (Liu, Yang, Huang, & Lin, 2015) and (Liu, Yang, Huang, Yeo, & Lin, 2016), the Semi-Supervised Extreme Learning Machine algorithm was applied to detect distraction in drivers using eye and head movements. In (Liu, Yang, Huang, Lin, Klanner, Denk, & Rasshofer, 2015), the Cluster Regularized Extreme Learning Machine algorithm was applied to detect distraction in drivers using eye and head movements. However, classified eye movement types were not considered in these studies.

On the other hand, some studies detected cognitive distraction using classified eye movement types and identification-based machine learning algorithms (Liang, Reyes, & Lee, 2007; Liang, Lee, & Reyes, 2007; Liang, & Lee, 2014; Liao, Li, Wang, Wang, Li, & Cheng, 2016). (Liang, Reyes, & Lee, 2007) and (Liao, Li, Wang, Wang, Li, & Cheng, 2016) applied Support Vector Machines, (Liang, Lee, & Reyes, 2007) applied Bayesian Networks, and (Liang, & Lee, 2014) applied Dynamic Bayesian Networks and supervised clustering.