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AUTOMATIC CLASSIFICATION OF DRIVING MENTAL FATIGUE WITH EEG BY WAVELET PACKET ENERGY AND KPCA-SVM

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Abstract. *Driving mental fatigue is a main cause of some serious transportation accident and it has drawn increasing attention in recent years. In this study, an automatic measurement of driving mental fatigue based on the Electroencephalographic (EEG) is presented. Fifteen healthy subjects who performed continuous simulated driving task for 90 minutes with EEG monitoring are included in this study. The feature vectors of ten-channel EEG signal on prefrontal, frontal, central, parietal and occipital regions are extracted by wavelet packet transform. Kernel principal component analysis (KPCA) and support vector machines (SVM) are jointly applied to identify two driving mental fatigue states. The results show that wavelet packet energy (WPE) of EEG is strongly correlated with mental fatigue level on prefrontal frontal central and occipital regions. Moreover, the KPCA method is able to effectively reduce the dimensionality of the feature vectors, speed up the convergence in the training of SVM and achieve higher recognition accuracy (98.7%). The KPCA-SVM could be a promising candidate for developing robust automatic mental fatigue detection systems for driving safety.*
Keywords: EEG, Driving mental fatigue, WPE, KPCA, SVM

1. **Introduction.** Mental fatigue is one of the major causes of serious accidents, especially in transportation and aviation area and it is believed to account for 20 – 30% of all traffic accidents [1]. Experts agree that the actual contributions of driver mental fatigue to road accidents may be much higher [2]. Developing and establishing an accurate and non-invasive real-time system for monitoring driver's mental fatigue is quiet important to reduce the number of fatigue-related crash and to lower social cost in traffic safety. Driving simulator studies have dominated these types of studies, mainly because of safety, low cost, well-controlled conditions and easiness of data collection [3].

To data, many methods have been developed for detecting the driver's mental fatigue in the recent few years, including the measurements of physiological features like EEG, event related potential (ERP), heart rate and pulse rate, heart rate variability (HRV), electrooculographic (EOG), eyelid movement, gaze, head movement, facial tone and behaviors of the vehicle, such as lane deviations and steering movements, etc. Among those different physiological parameters, the EEG is quite promising for monitoring driving mental fatigue [4].

Recently, the theory of machine learning has developed a wide variety of novel learning and classification algorithms, which provides an opportunity to develop a non-intrusive