

國立交通大學

多媒體工程研究所

碩 士 論 文

利用虛擬實境模擬系統偵測駕駛員從清醒
至打瞌睡過程之腦波變化



**EEG-Based Subject- and Session-Independent Drowsiness
Detection: An Unsupervised Approach**

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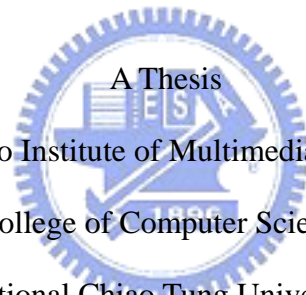
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中文摘要

打瞌睡是造成意外事故的主因之一，因此於各種工作環境中，一套可靠、即時的非侵入式打瞌睡警示系統的建立是有其必要性的。本論文的目標在於利用360度虛擬實境(Virtual-Reality: VR)模擬駕駛系統，藉由一小時將維持車輛在車道中心位置的長時駕駛工作，偵測駕駛員由清醒到打瞌睡的連續腦波(Electroencephalogram: EEG)變化現象。十三位年齡在18到28歲間的受測者參與此駕駛模擬實驗，並以250Hz取樣頻率同步量測其28通道腦電波與駕駛行為資料。所量測的腦電波利用 unsupervised 演算法來偵測人類從清醒到打瞌睡認知狀態的改變。此應用可作為未來發展即時瞌睡警示系統的基礎。實驗結果顯示，我們不需要事先資料的回饋並且使用更簡潔的運算即可準確的偵測出受測者從清醒到打瞌睡的腦波狀態。並發現人類在不同打瞌睡的程度之下其腦電波的變化情形也不相同。精神狀態從清醒至極輕度和輕度瞌睡過程中，有些的受測者可能使用 α 波來做特徵值抽取會有比較好的表現結果，而有些受測者則可能使用 θ 波會有比較好的表現結果 所以我們結合 α 波和 θ 波來做為一個瞌睡指標的依據，以期能偵測出受測者從清醒到打瞌睡的變化來防止一些因打瞌睡而導致的意外產生。

關鍵字：打瞌睡、虛擬實境、腦電波、認知狀態、瞌睡警示，特徵值抽取

EEG-Based Subject- and Session-Independent Drowsiness Detection: An Unsupervised Approach

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Abstract

Monitoring and prediction of changes in the human cognitive stages, such as alertness, drowsiness, using physiological signals such as Electroencephalogram (EEG) are very important for driver's safety. Typically, psychophysiological studies on real time detection of drowsiness based on EEG data use the same model for all subjects.

However, the relatively large individual variability in EEG dynamics relating to loss of alertness implies that for many subjects, group statistics may not be useful to accurately predict changes in cognitive states. Researchers have attempted to build subject-dependent models based on his/her pilot data to account for individual variability. Such approaches cannot account for the cross-session variability in EEG dynamics, which may cause problems due to various reasons including electrode displacements, environmental noises, and skin-electrode impedance. Here we propose an unsupervised subject and session independent approach for detection departure

from alertness. We first demonstrate that the EEG power in the alpha band (as well as in the theta band) is correlated with changes in the subject's cognitive state with respect to drowsiness as reflected through his driving performance. We then make a few mild and realistic assumptions to derive models for the alert state of the driver using the EEG power in the alpha and theta bands. The deviations of the EEG power in the alpha and theta bands from the corresponding alert models are found to be correlated with the changes in the driving performance. Although, the alert state models derived using alpha band power and theta band power are quite effective in detecting drowsiness, for an improved performance, we also use a linear combination of deviations of the EEG power in the alpha band and theta band from the respective alert models. This approach being an unsupervised and session independent one could be used to develop a useful system for noninvasive monitoring of the cognitive state of human operators in attention-critical settings.

Keyword: human cognition, Electroencephalogram (EEG), Alertness, Drowsiness, unsupervised, alpha band, theta band.

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