

SUMMARY OF Ph.D. DISSERTATION

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Title An Accurate Removal of Eyeblink Artifact from Single-channel Electroencephalogram by Supervised Tensor Factorization		
Abstract <p>Technologies using electroencephalogram (EEG) signals have been penetrated into public by the appearance of specialized EEG devices. Such devices can capture oscillating neuronal discharge with only an electrode. Although the aspect of entertainment or amusement associated with the usage of the system is emphasized, many applications based on specialized EEG device will be beneficial owing to its usability and portability for signal measurement. Therefore, single-channel EEG analysis has been attracted attention since nearly five years. Eyeblink artifacts disguise themselves as EEG components and make EEG signal processing difficult in all respects because the frequency components of the artifacts and EEG could be overlapped. The main objective of this research is to propose an accurate eyeblink artifact removal scheme for single-channel EEG by supervised tensor factorization.</p> <p>Chapter 1 presents the background and objective of this research. During EEG system operation, EEG signals should be observed with his/her eyes open for practical use in the real-world. That allows eyeblink artifact contamination into observed EEG signals.</p> <p>Chapter 2 describes the fundamental awareness of the brain, eyeball, and eyelid which are sources of EEG and eyeblink artifacts.</p> <p>Chapter 3 describes the basics of the source separation and the concepts of the conventional eyeblink artifact removal schemes as a signal processing module. Nevertheless, a signal separation algorithm has to be applied to an observed EEG signal to avoid the serious problem, the separation performance of conventional schemes has still been wrong and they need many manual operations for signal separation when there is only single-channel data. Thus, proposing an accurate and automatic eyeblink artifact removal scheme for single-channel EEG signal is a major challenge in EEG signal processing for the widespread use of systems with specialized EEG devices.</p> <p>Chapter 4 presents the effect of eyeblinks contributing to EEG signals for creating templates of eyeblink artifact removal from observed EEG signals with a signal-channel electrode. The extracted eyeblink features using wavelet-enhanced blind source separation found new characteristics of the eyeblink effects: (i) voluntary and involuntary eyeblink features obtained from all channels present significant differences; (ii) distorting effects have continued influence for 3.0-4.0 s; and (iii) eyeblink effects cease to exist after the zero-crossing four times. The results are collected in templates as prior information for supervised learning algorithm.</p> <p>Chapter 5 proposes a section-based eyeblink artifact removal scheme by using supervised tensor factorization for single-channel EEG signals. Conventional schemes require additional information or technique to complete automatic eyeblink artifact rejection. In contrast, the proposed scheme can automatically remove eyeblink artifacts using supervised learning algorithm. For the experimental results, the proposed scheme showed best performance for eyeblink artifact removal in the nine schemes.</p> <p>Chapter 6 indicates the effectiveness of the proposed eyeblink artifact removal scheme using single-channel EEG data. The proposed scheme improved the classification accuracy to more than 30%. For the result, the efficiency of proposed scheme for actual single-channel EEG analysis has been shown.</p> <p>Finally, chapter 7 summarizes thesis, and describes the future works of this study.</p>		