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論文 / 著書情報
Article / Book Information

題目(和文)	脳波を用いた眼球運動を基にしたリアルタイムブレイン・マシン・インタフェース
Title(English)	Real-Time Brain Computer Interface Based on Eye Movements Using Electroencephalographic Signals
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種別(和文)	論文要旨
Type(English)	Summary

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（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	Information Processing 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of (Philosophy)
学生氏名： Student's Name	Abdelkader Nasreddine Belkacem	指導教員（主）： Academic Advisor(main)	Prof. Yasuharu Koike
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要旨（英文 800 語程度）
Thesis Summary (approx.800 English Words)

Some people with disabilities lack control of their voluntary muscles. They are unable to do even a simple task. For these people, brain activity gives them another chance to improve their quality of life. Several diseases can make people lose their abilities to control or communicate with the environment such as: locked-in syndrome, Amyotrophic Lateral Sclerosis (ALS), Lou Gehrig's disease, and muscular dystrophy. Fortunately, brain-computer interface (BCI) can be a new means to help these people to operate a lot of machines and applications such as: control computer cursor, wheelchair or robot arms with their neural activities.

There is a huge opportunity for advancement in BCI field by combining brain activity and eye movements by using both of electroencephalogram (EEG) and electrooculogram (EOG) data. This approach could help not only the disabled, but also regular consumers through the development of BCI systems for intelligent cars or playing video games.

Many classification algorithms have been presented in the literature to distinguish brain activity states during different mental tasks using invasive and non-invasive techniques. However, although these algorithms achieve good results, they require many training loops to make a decision or an expensive equipment to recode brain activity. As the complexity of an algorithm grows, and number of sensors increases, it becomes more and more difficult to execute commands in real time or make portable applications. In this thesis, we present a new approach of communication and device control for disabled and healthy people. We present real-time control of video game (eye-controlled gaming) with six commands of eye movements for asynchronous and non-invasive communication system using two temporal EEG singles. Real-time classification of eye movements offers an effective mode for human-machine interaction. BCI-controlled gaming applications range widely from strictly medical to completely nonmedical applications. Games can provide strong motivation for practicing, and thereby achieving, better control with BCI system.

The main objective of this dissertation is to evaluate the usability of EEG signals as new means for detecting and classifying eye movements. More precisely, real-time algorithm was proposed for distinguish among different classes of eye movements from EEG signal using two temporal EEG sensors. This algorithm was tested real-time in controlling video game. The contributions of this dissertation are: (1) demonstrate that EEG technique is more preferable than EOG technique for detection and classification of eye movements, (2) real-time algorithm proposed based on continuous wavelet transform for online detection of eye movements and some discriminable time-series features were extracted as relevant characteristics for classification phase, and (3) new position proposed for more practical and useful BCIs based on two electroencephalography sensors positioned over the temporal areas to perform real-time classification of eye movements.

The first Chapter performs a thorough review of brain-computer interface based on the electrophysiological activity within the brain. The chapter describes in detail the origin, acquisition, characterization and applications of EEG recorded signals. The purpose of this chapter is to familiarize the reader with BCI applications, eye-movement-based communication systems and some EEG characteristics that will be exploited and referred to in second chapter. A large portion of this chapter is devoted to performing a state-of-the-art review of BCI technology and describing the approaches of various different BCI research groups around the globe. The second chapter begins by introducing the idea and purpose of using biomedical signals recording from the scalp. The essential components of EEG signals are described and some of the signal-processing methodologies behind them are reviewed in detail. The chapter concludes by reviewing necessary standardized performance metrics and discusses the challenges for future progression of using both of brain activity and eye movements. The third chapter discusses the possibility

to use EEG recording instead of EOG as an alternative technique to measure eye movements. We present a simple algorithm for offline recognition of four directions of eye movements from electroencephalographic signals. The fourth chapter describes online detection and classification of six classes of eye movements using two temporal EEG sensors. We explain in details all steps of the proposed algorithm from electrodes position to classification results. The biggest challenges would be reducing the number of sensors used and extracting appropriate features of eye movements from EEG signal. The fifth chapter presents a real-time BCI controlled video game with eye movements using our proposed algorithm. The chapter describes the EEG signals associated with eye movements and the methodologies that are exploited in this study to offer real-time control. The real-time deployment of this system and the associated performance results are reviewed. Finally, a discussion reviews the success and future work of this type of communication-system implementation. Conclusion provides a conclusion on the issues addressed by this research and on the future of non-invasive, asynchronous, and hybrid BCIs based on brain EEG and EOG signals.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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