(様式 5)

2021 年 3 月 8 日
Year Month Day

学位（博士）論文要旨

(Doctoral thesis abstract)

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論 文 題 目 (Title)	Real-time EEG Oscillatory Phase Prediction and Phase-Informed Visual Stimulation Using a Least Mean Square-based AR Model

論文要旨 (2000 字程度)
(Abstract(400 words))
※欧文・和文どちらでもよい。但し、和文の場合は英訳を付すこと。
(in English or in Japanese)

Neural oscillations are vital features for the functioning of a central nervous system. The rapidly changing brain state measured by EEG can be computed using the instantaneous phase and amplitude; however, estimation of the brain state in a real-time setup is technically challenging because the prediction of future signals is required to define the current state. Alpha oscillations are thought to depict idling or inhibition of task-irrelevant cortical activities. However, recent studies on the phase of alpha oscillation hypothesize that they have a direct and active role in the mechanisms of working memory and attention. To understand the role of alpha oscillations, accurate phase estimation is required. An adaptive approach for time-series forward prediction and using it in the brain state-dependent real-time implementation of a closed-loop system has not yet been explored. The primary objectives were; to evaluate the performance of an adaptive least mean square (LMS) based AR model and a conventional YW based AR model for time-series forward prediction in an offline study; to check the implementability of a time-series forward prediction employing an adaptive LMS-based AR model in a real-time closed-loop system. For the offline time-series forward prediction, EEG data from 21 healthy participants was recorded for 3 minutes in an eyes-closed resting state. While for the real-time closed-loop system, State-dependent EEG-triggered visual stimulation synchronized with the EEG peaks and troughs of alpha oscillations in both visual task and open eyes resting state from 9 participants. Two different prediction lengths of 128 ms and 256 ms were tested for both methods in the offline study. For the real-time closed-loop implementation prediction length of 170 ms was tested. The results of the offline study show that for a shorter prediction length (128 ms), YW surpasses the LMS, whereas, for longer prediction lengths of 256 ms, the LMS outperforms the YW. In the real-time closed-loop system, resting peak condition, both methods showed statistically significant results in 100% of participants (five out of five participants). While for the trough condition, LMS showed statistically significant results in 100%, and YW

showed 80% of participants. In the visual task, all participants in both methods and both conditions showed significant results. The findings indicated that the LMS-based AR model with a low computational load was effectively applied in a real-time closed-loop system aiming at particular alpha oscillation phases and could be utilized as an adaptive substitute to the machine-learning and conventional methods.

（英訳）※和文要旨の場合(400 words)