Automated neuromagnetic examination of epilepsy using deep learning

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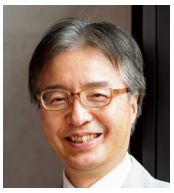
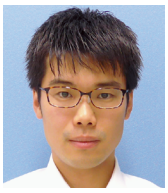




Abstract

Magnetoencephalography (MEG) of epilepsy can accurately and non-invasively locate epileptic activity. This is one of important examinations for pre-surgical evaluation in epilepsy treatment. However, detection of epileptic waveforms is complex, requiring hours of analysis by specialists. MEG has not been widely adopted despite its high performance. In this study, we developed a new method for detecting epileptic waveforms using deep learning. This system learned epileptic waveforms detected by medical doctors. We were able to fully automate MEG analyses. This system eliminates the need for long hours of analysis and achieves performance comparable to medical doctors.

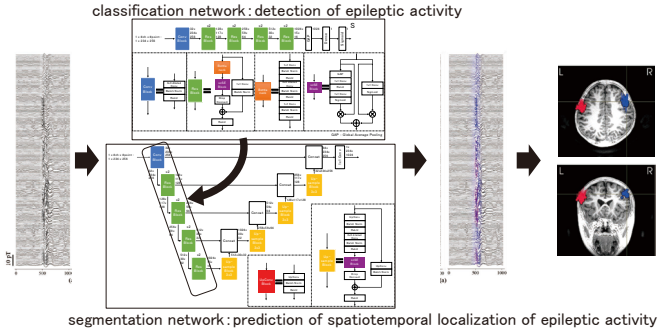
Background & Results

MEG can measure brain activity more accurately than EEG by measuring the magnetism generated by electrical activity in the brain, and is used for clinical eaminations to evaluate epileptic activity. MEG can non-invasively and more accurately investigate localization of epileptic activity in the brain. It is also important as a pre-surgical examination for epilepsy treatment, especially when accurate diagnosis of the location of epilepsy is required. However, interpreting epileptic waveforms is complex, so until now, medical doctors had to spend hours analyzing them. Therefore, despite its high performance, MEG has only been installed in university hospitals and has not been widely adopted. In addition, an previous study reported that it takes an average of 8 hours for analyses, which has been a major burden for medical doctors. In this study, we developed a system that can fully automatically analyze the localization of epileptic activity by not only accurately detecting epileptic waves but also their time using two types of deep learning. We used two types of deep learning methods and made them learn more than 400 test results analyzed by medical doctors. As a result, we were able to achieve analytical performance equivalent to that of medical doctors. Furthermore, by using the test results from multiple facilities, we were able to improve the generalization performance. Until now, medical doctors had to spend hours for analyses, but this analysis time is no longer required, and it is expected that the burden on doctors will be greatly reduced. The detection of epileptic waves is complex, and there is an issue that the interpretation differs depending on doctors, but this method offers an advantage that the quality of the test results can be homogenized.

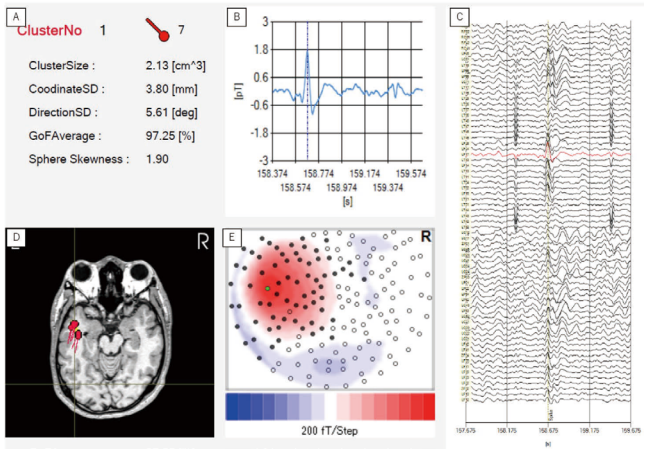
Significance of the research and Future perspective

This research is expected to popularize epilepsy MEG, which used to take time to analyze, and enable accurate epilepsy diagnosis non-invasively. This method is also expected to be applied to the automation of EEG analyses. Furthermore, it has recently been found that a certain proportion of cognitive decline in the elderly is due to epileptic seizures, and applications to screening epilepsy are also expected.

Automated MEG analysis of epileptic activity using deep learning



A report by automated examination



Patent	Japan Patent Application No. 2019-197953, JP2021069930, JP2021069929, Japan Patent Application No.2023-083473
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