Automated Annotation of EEG in a Mouse Model of Epilepsy

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ABSTRACT

The detection of epileptic seizure activity in EEG is important for the analysis and classification of epileptic seizures. However, as EEG is typically a dynamic and non-stationary process, it is time-consuming for researchers to annotated manually. In this study, an automated system for the annotation of abnormal events in the EEGs from a mouse model of epilepsy is proposed. This will assist research groups to analyze abnormal events accurately and more efficiently.

1 INTRODUCTION

Two channels of adult male C57BL/6 mouse EEG were recorded, ipsilateral (C1) and contralateral (C2). The first 20 minutes are baseline C57BL/6 mouse EEG, then Kainic acid (KA) was injected. KA is an epileptic evoking agent widely used in the rodent model of temporal lobe epilepsy (TLE), which can cause hippocampal-specific damage similar to that of human TLE patients [1, 3]. Seizures typically begin within 5 to 10 minutes and continued with increasing severity until becoming continuous after approximately 30 minutes [2]. Lorazepam is injected 40 minutes after KA injection to reduce morbidity and mortality and restrict the extent of hippocampal damage. Following the injection of lorazepam there is a silent period, 3-5 days later seizures start to develop. EEG is recorded for a two-week period. Many research groups use this mouse model of epilepsy. Researchers must count the number and duration of seizures manually, it is time-consuming and requires expert training. An automatic detection algorithm was created in this study to support researchers who use this mouse model of epilepsy to examine abnormal events.

2 METHOD

Spontaneous seizures were defined as high amplitude (greater than 2 times baseline) polyspike discharges of greater than 5 seconds duration. The algorithm searches time periods of 0.07 seconds with an overlap of 0.02 seconds of raw amplitude, from start to end of the baseline of channel C2. The max and the min values for each time period are extracted, then the mean of the max and min values for all time period are calculated. The threshold is identified as two-fold of max-mean and min-mean. For the abnormal events, if the event is greater than the max threshold or smaller than the min threshold, the EEG is marked as a probable seizure. Otherwise, we identify this part as normal. In addition, the duration of each abnormal period is checked, if the duration less than 5 seconds then we relabel it as a normal event.

Conference'19, ACM Celebration of Women in Computing womENcourage 2019, September 16-18, 2019, Rome, Italy
2019.

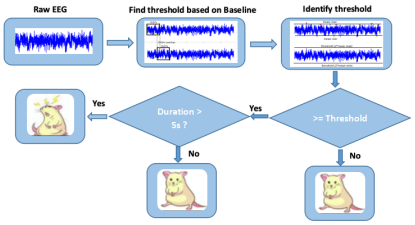

Figure 1: Proposed System diagram.

3 RESULTS

Our automatic detection algorithm identified 56 abnormal events in four mice, of which 49 were manually detected. Compared with manual detection our automated algorithm showed an overall sensitivity of 92.05%, specificity of 96.40% and Matthew's correlation coefficient of 0.8142.

Table 1: Performance of Proposed Algorithm

Mouse	ACC	Sens	Spec	MCC
M19	96.27%	97.58%	96.18%	0.7717
M21	95.05%	72.16%	96.75%	0.6437
M23	99.06%	98.46%	99.08%	0.8858
M25	98.22%	100%	93.59%	0.9557
AVG	**97.15%**	**92.05%**	**96.40%**	**0.8142**

4 DISCUSSION

According to these results, a reliable seizure detection algorithm is presented, this algorithm is useful for marking the epileptic EEG activities. It reduces the time required for manual annotation of the abnormal wave patterns in long-term EEG recordings. Moreover, this method can improve reliability and consistancy between different researchers by having the same standard for checking seizures and counting the number of seizures in different mice. Also, other research groups, who use the same type of mouse model of epilepsy, can use this algorithm to identify and count the abnormal events automatically.

5 ACKNOWLEDGEMENTS

This publication has emanated from research supported in part by a research grant from Science Foundation Ireland (SFI) under Grant Number 16/RC/3948 and co-funded under the European Regional Development Fund and by FutureNeuro industry partners.

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