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Methods for Automatic Detection of Artifacts in Microelectrode Recordings

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Abstract

Background: Extracellular microelectrode recording (MER) is a prominent technique for studies of extracellular single-unit neuronal activity. In order to achieve robust results in more complex analysis pipelines, it is necessary to have high quality input data with a low amount of artifacts. We show that noise (mainly electromagnetic interference and motion artifacts) may affect more than 25% of the recording length in a clinical MER database.

New Method: We present several methods for automatic detection of noise in MER signals, based on i) unsupervised detection of stationary segments, ii) large peaks in the power spectral density, and iii) a classifier based on multiple time- and frequency-domain features. We evaluate the proposed methods on a manually annotated database of 5735 ten-second MER signals from 58 Parkinson's disease patients.

Comparison with Existing Methods: The existing methods for artifact detection in single-channel MER that have been rigorously tested, are based on unsupervised change-point detection. We show on an extensive real MER database that the presented techniques are better suited for the task of artifact identification and achieve much better results.

Results: The best-performing classifiers (bagging and decision tree) achieved artifact classification accuracy of up to 89% on an unseen test set and outperformed the unsupervised techniques by 5-10%. This was close to the level of agreement among raters using manual annotation (93.5%).

Conclusion: We conclude that the proposed methods are suitable for automatic MER denoising and may help in the efficient elimination of undesirable signal artifacts.

Keywords: microelectrode recordings, artifact detection, external noise, supervised classification

Highlights

- Artifacts are common in intra-operative micro electrode recordings (MER) - up to 25%.
- We propose a set of classifiers for automatic artifact detection.
- The methods are evaluated on a database of 5735 manually labeled MER signals.
- The best-performing classifiers achieved up to 89% test-set accuracy.
- Matlab source codes and sample data are available in the supplement.

1. Introduction

Extracellular microelectrode recording (MER) using electrodes with a tip size around 1 μm [1] is a basic technique for acquiring extracellular electric activity at the level of individual neurons (*single-unit activity*). Due to the small electrode size and the low voltage of the source signal, MER is susceptible to mechanical shifts and electromagnetic interference, resulting in signal artifacts [2]. While some components of the external noise can be filtered easily (e.g. 50 Hz or 60 Hz mains noise

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