CONTINUOUS WAVELET TRANSFORM FOR THE DETECTION AND CLASSIFICATION OF EPILEPTIFORM ACTIVITY IN THE EEG

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Abstract - This paper outlines a novel approach to wavelet based detection of epileptiform activity in the EEG. A special complex-valued wavelet filter is used in a continuous wavelet transform (CWT). The response of wavelet coefficients (WCs) to epileptiform discharges (EDs) is measured with respect to artifact-free background activity (BG). A detector based on the WCs of a single scale could operate at 45% sensitivity without false alarms or at 99% sensitivity with 19 false alarms per minute on an artifact-free recording.

Key Words – continuous wavelet transform, spike detection, epileptiform discharge, epileptiform transient

I. INTRODUCTION

EDs appear as epileptiform transients (ETs) in one or more channels of the EEG. Efforts to automate the detection of EDs have made it clear that both spatial and temporal contextual information are crucial to the decision making process of EEGers [1]. Several approaches have been made to apply wavelet analysis to ED detection based on the discrete wavelet transform (DWT) [2] and CWT [3]. While there are advantages favouring the DWT (fast decomposition algorithm and inverse transform), detection based on the DWT can only fully respond to a target pattern if that pattern occurs at some dyadic translation coinciding with the temporal alignment of the DWT.

II. METHODS

Data: Data comprised 11 16-channel EEG recordings (bipolar, total 278 min) containing 298 definite EDs (as determined by three independent EEGers) sampled at 200 Hz.

Wavelet Filter: Because optimal detection is achieved with a wavelet that correlates well with the target transients, we chose the 'psi' wavelet [4] for our analysis. This wavelet is complex-valued and has a real part which correlates strongly with the Mexican hat wavelet.

Evaluation: Each channel of the EEG was convolved with the wavelet filter (1 scale, centre frequency: 25 Hz) to obtain the corresponding WCs. Local magnitude maxima were chosen for further analysis. At least two artifact-free 2000 ms periods were used to assess the distribution of the BG's log WCs. The mean log magnitude of the BG's WCs was subtracted to measure the strength of EDs with respect to a common reference. The channel showing the largest WC in response to an ED was chosen and two histograms were generated for log WCs of BG and EDs, respectively.

III. RESULTS

Figure 1 shows the histograms for BG and ED log WCs for a centre frequency of 25 Hz. A reasonable separation of artifact-free background and definite EDs is achieved. A detector based on the WCs of this scale could operate at 45% sensitivity without false alarms, or at 99% sensitivity with 19 false alarms per minute. Similar distributions were obtained for two other scales (centre frequencies 12.5 and 50 Hz, respectively).

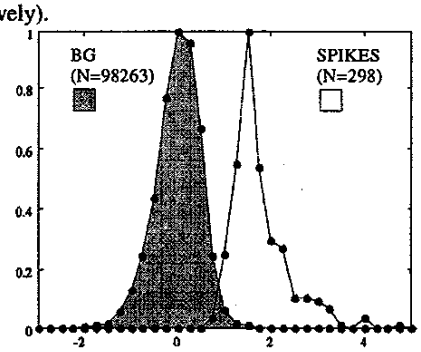

Figure 1: Distribution of log magnitude of wavelet coefficients for artifact-free background activity (BG) and definite epileptiform discharges (SPIKES).

IV. DISCUSSION

The single scale detector outlined in this paper will be implemented as initial stage in a multistage detector. Classification of a detected transient will be based on concurrent exploration of three domains: time, scale and space.

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