POST-PROCESSING OF EEG RECORDINGS DURING CLINICAL RESEARCH OF EPILEPSY IN MULTIPLE SCLEROSIS PATIENTS

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Abstract

Data recorded with modules for processing of EEG signals for diagnostics of multiple sclerosis needs to be further post processed since its highly susceptibility to various forms and sources of noise. Investigation of the EEG with different filters and software tools is done in order. to handle the noise effectively. Aim is the evaluation of the noise artifacts of EEG data by employing separate benchmark software with highly universal capabilities benefiting from the rapid prototyping environment for developing, testing and processing biosignals

1. INTRODUCTION

EEG recording has a major drawback when considering the environment built, as interferences from adjacent electrical equipment can easily compromise measurements. It often happens that in evaluating symptomatic epilepsy induced seizures on time measurement is of utmost importance in patients with multiple sclerosis [1]. Very often patients cannot be transferred to a better shielded location. Measurements in intensive care units have the disadvantage of the low preparation time and overexposure to a large variety of electrical equipment [2]. Having so there are many sources of noise, to most of which the available EEG equipment is highly susceptible. Biological, electrical and environmental artifacts are seen more frequently. In [3] strategies for signal decomposition and filtering are investigated recommending and outlining changes in classical filtering approaches due to the inadequacy of previously used ones. Dealing with the issue of noise in EEG is a task significantly labored by the stochastic character of the recorded signal. A wide range of adaptive filtering methods of some of the major sources of interference are presented in [4], showing a significant reduction in unwanted artifacts. Thus employing separate software for a simultaneous processing increases the probability of a high signal-to-noise ratio of the recorded signal.

2. METHODS AND MATERIALS

2.1. Clinical basis

Multiple sclerosis (MS) is a chronic inflammatory disease of the immune system that affects the central nervous system, including the brain, spinal cord and optic nerves. An observed symptom is epilepsy seizures. Although not very frequently manifested, they can be observed more than in the general population [5], with the average 2-2.5% [6]. EEG helps determine seizure type and epilepsy syndrome in patients with epilepsy, and thereby choice of antiepileptic medication and prediction of prognosis. EEG findings contribute to the multi-axial diagnosis of epilepsy [7][8], in terms of whether the seizure disorder is focal or generalised, idiopathic or symptomatic, or part of a specific epilepsy syndrome.

2.2. EEG recording processing

Having the above mentioned we have used as part of our investigation a universal analog to digital converter jointly with LabView software and the add on Biomedical Workbench Toolkit. This an efficient and cost effective solution that assists in the communication with specialists and the consecutive signal processing. The Biomedical Toolkit includes – file management, biosignal calibrator, viewer, logger and player. A time saving feature is the file format converter, which diminishes the need for additional processing for the conversion of recorded data. This helps for the simultaneous comparison of EEG files from Neurowerk EEG, Nihon Kohden EEG 9100 and the independent National Instruments DAQ 6211. The file conversion utility imports many widely used biomedical data logger formats into NI Technical Data Management Streaming (TDMS) format including Biopac .ACQ, iWorx, .MAT, EDF, and HL7. Another important feature is

the EEG signal simulation which could help in noise evaluation.

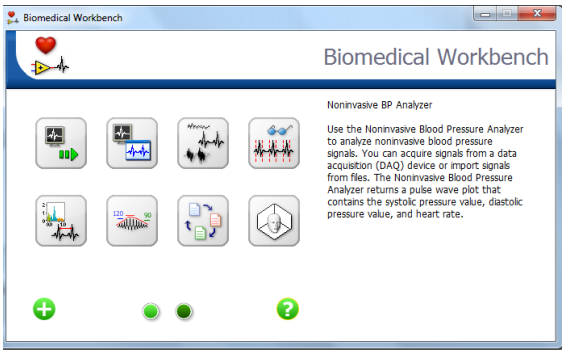

Figure 1. Biomedical Toolkit Workbench initial screen

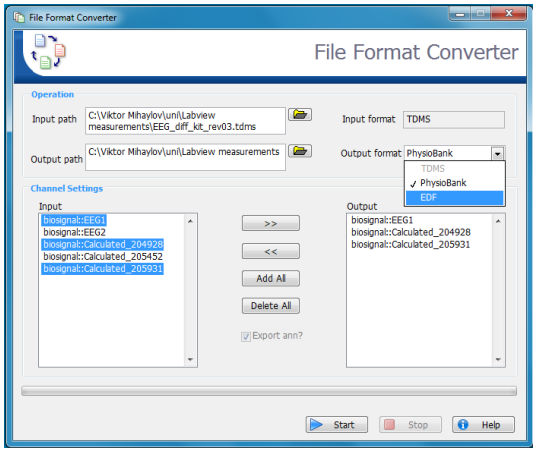

Figure 2. Biomedical Toolkit File Format converter

2.3. Acquisition methodology

As a basis for the measurement evaluation algorithm it is assumed the ANOVA statistical hypothesis measurement.

Two types of recordings are made with differentiation in the electrode to electrode comparison and filtering of the system is done. Initial spectral analysis is made in order to have a rough estimate on the noise levels in the signal. Lead connection is done in NRSE (detect the ground voltage provided by the signal for all EEG leads) and differential voltage between the electrodes. 3 to four leads are chosen for the measurement – Z (for ground), Cz, C4, T4. For recoding of the signal the Biomedical toolkit Logger is used, with three preset filters. A low pass Butterworth filter, a band stop Butterworth filter, and a Chebyshev low pass. Both band stop filters target a frequency of 50 Hz.

3. EXPERIMENTS

3.1. Equipment

For the purpose of the benchmark measurement device we have chosen National Instruments USB-6211 bus-powered USB M Series multifunction data acquisition (DAQ) module. All post processing is done with LabView and Biomedical Toolkit Logger.

3.2. Compatibility of the system components

Test were made in order to evaluate the compatibility of the module and software.

3.3. Evaluation of signals

The measurements in Figure 3 are a differential recording of two scalp electrodes, and the 3rd, 4th and 5th graphs represent low pass and two band stop filter applied to the C4 – T4 couple.

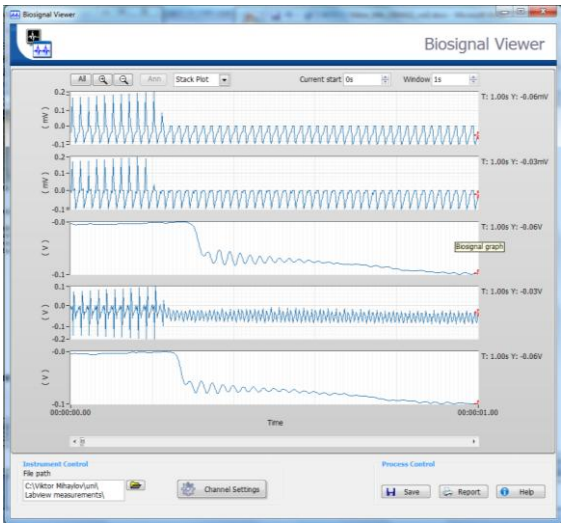

Figure 3. Differential measurement between Z-Cz, and C4-T4

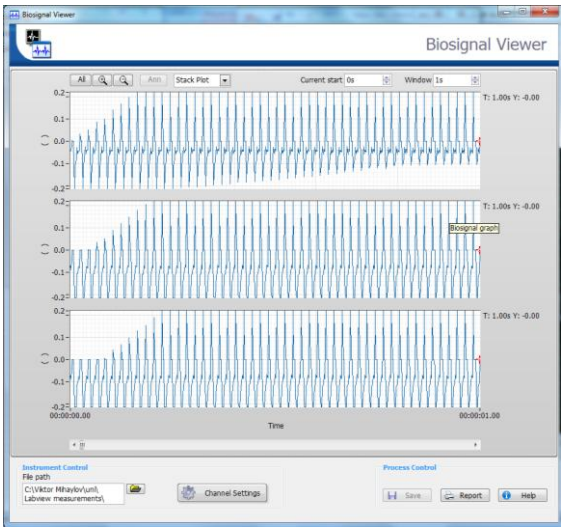

Figure 3. Non-referenced single-ended mode NRSE measurement between Z-Cz, and C4-T4

4. ANALYSIS AND CONCLUSION

Visible from the graphics is the large amount of noise in both in NRSE and Differential setup. After basic processing with the Biomedical Toolkit we strip the differential signal from the 50Hz component and its harmonics. Thus the signal can be prepared for future examination.

The NRSE on the other hand is more prone to noise artifacts, and its removal should be base on similar feature extraction from the adjacent electrodes, as share common noise source. As an extension the experiment increasing the number of patient subjects, leads measured and inclusion independent component analysis should be applied.

5. APPENDIX AND ACKNOWLEDGMENTS

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