Biomedical Signal Processing

Data Engineering Program, spring 2018

Exercise Sheet 3

April 24, 2018

Submission until May 10th, 24.00 to f.hadaeghi@jacobs-university.de

Exercise 1) EEG signal analysis/Processing

Download the EEG data, EEG.mat. The complete data consists of five sets (A, B, C, D, and E), each one containing 100 single-channel EEG segments of 23.6 s duration. Artifacts caused by eye and muscle movements were removed from the signals (signal is segmented to 100 segments such that each segment can be considered as a stationary signal). Sets A (eyes open) and B (eyes closed) were extracranially taken from five healthy subjects. Sets C, D, and E were intracranially taken from five epilepsy patients. While sets D and C contained the EEG activity measured in seizure-free intervals from epileptic hemisphere and the opposite hemisphere of the brain, respectively, set E only contained the seizure activity. The sampling rate is 173.61 Hz. We only work on the first segment of each recording.

1-1. Write a m-file to plot the first 23 seconds of all 5 classes in 5 subplots. Horizontal axis would be time (ms). hint: you have 4097 samples for each x[n] and the sampling rate was also given. Now, generate a time vector and plot each x[n] vs this vector.

1-2. Write a m-file which receives a signal and "signal to noise ratio" (snr), adds a Gaussian noise to the signal and returns a noisy EEG signal. Try it with snr = 1, 10, 20 and plot the pure and the noisy signals for the first 23 s of all classes in five subplots.

1-3. Design a suitable filter and remove the added noise with snr = 10 from the 5 signals. Plot pure, noisy and de-noised signals in 5 subplots. Hint: filters might be averaging, median filter, butterworth filter or adaptive filters.

1-4. Write a m-file which receives a signal and the order of AR model and estimates the AR parameters. For classes A and B, simulate the signal by using AR model. Find the order of the model, p, based on trial and error and compare it in two cases of closed and opened eyes.

1-5. Write three m-files to estimate the PSD of a given signal by means of Blackman-Tukey, periodogram and welch methods. Try different windows, number of FFT points and number of zero padding samples to get accurate and discriminative power spectrums. You can either write your own codes from scratch or use the MATLAB built-in functions.