Tfy-99.3275 – Biosignal Processing

Exam 13.01.12 9:00-12:00

For each question a maximum of 6 points can be earned (thus: 5 * 6 = 30 points in total). Points you possible earned by doing exercise will be added.

You may answer the questions in English as well as in Finnish.

1.

a) Give two examples of *biomechanical* signals, for each of them state whether they are random (yes/no), transient (yes/no) and periodic (yes/no). (2p)
b) The sampling theorem is well-known by most engineers. Still, we see that sometimes it is violated in practice and an incorrect sampling rate is used. Give *two* reasons (in a biosignal processing application) why this might happen. (2p)
c) Describe what the terms *causality* and *stability* mean. (2p)

2.

a) Give one advantage and one disadvantage of a FIR filter when compared to an IIR filter (2p)
b) Give two possible reasons why we would like to process some (bio)signal in the frequency domain instead of in the time domain. (2p)
c) What do we mean with the Spectral Edge Frequency (SEF) of a signal? (1p), and what with the median frequency (1p)?

3.

a) A researcher designs an artefact-detection algorithm for EEG signals on the basis of a few publicly available EEG 'normal subject' data records that are known to be artefact-free. Using this data he derives as detection limits [mean-3*standard deviation, mean+3*standard deviation] employing the idea that in such case about 99.7% of artefact-free data will be accepted for further processing. However, upon trying out the algorithm in a 'real-life' situation in a hospital, the results are disappointing – many false alarms (false artefact detections) are generated. Give *three* possible reasons why this could happen. (3p)
b) Describe the principle of a *matched filter*: when do we use it, what does the impulse response of such a filter look like, and give a biosignal processing application example of such a filter. (3p)

4.

a) Measuring data over long-term during daily living has as typical problem that one has to deal with missing data. Describe one way to calculate the power spectral density of a signal that has missing data. (2p)
b) Describe how a return map (Poincaré plot) is constructed. Give a detailed example of its usage. (2p)
c) Explain what is meant with 'segmentation of a signal', and describe one example of a way to perform segmentation (2p).

5.

a) Give one reason why one would want to apply Principal Component Analysis (PCA) on a data set (1p). Describe one possible practical problem associated with the use of PCA (1p).
b) Explain the difference between *sensitivity* and *specificity* (2p)
c) Give an example of a feature selection method and describe how it works (2p)

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