Tfy-99.3275 – Biosignal Processing

Exam 24.11.09 16:00-19:00

For each question a maximum of 6 points can be earned (thus: 5 * 6 = 30 points in total). Possible points you gained from the exercises will be added to these points.

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) Explain what we mean with *discretization* of a signal, and what with *quantization* (2p)

c) Describe (visually, or in text) what aliasing is and when it may occur. (2p)

2.

a) Give two possible reasons why we would like to process some (bio)signal in the frequency domain instead of in the time domain. (2p)

b) What do we mean with the phase response of a filter? (1p) What does it mean in practice for a (bio)signal processing task when we state that a filter we use has a 'linear phase response'? (1p)

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 home health monitoring system consists of a weight scale, a noninvasive blood pressure meter and a beat-to-beat heart rate meter. The subjects are instructed to measure their weight every morning, blood pressure every morning and evening, and heart rate continuously during daytime. The data are recorded for one year. The data are stored and transferred automatically to a database. Your task is to analyze the data to identify possible regular rhythms, such as a weekly or yearly rhythm, in the signals. When starting the analysis, you notice that there is a lot of 'missing data' in all signals (days when no data was stored).

a) The system has been functioning without any technical problems all the time. Give *two* reasons why the amount of data that we were actually able to collect is less than planned (despite that there were no technical problems). (2p)
b) Describe a possible method for estimating the power spectral density of the blood pressure signal in this example application. (2 p)
c) Give an alternative method that you can use instead frequency analysis if you want to investigate whether there is for example a weekly or yearly rhythm in the data. (2p)

5.

a) Explain the difference between sensitivity and specificity (2p)
b) Draw an example of a ROC curve (with clear indication of what the axes represent) and give 2 applications where we can use it for. (3p)
c) What is an essential difference between the functioning of an expert system (using 'programmed computing') and an artificial neural network (using 'neurocomputing') (1p)

[END]