EMARO Signal Processing – Assignment 2 subjects

1. Filter quality analyzer

Create an automatic (or semi-automatic) system for analyzing quality of the digital filter provided. Filter evaluation should comprise factors such as step response speed and overshoot, phase (linear, non-linear), roll-off speed, passband ripple and stopband attenuation.

2. Signal deconvolution

Create a simple system for performing deconvolution of two signals. Assume that one of the signals is known (by the frequency spectrum or in the form of impulse response). Use division of Fourier coefficients or cepstrum. Reduce an impact of non-linear operation on the long resulting signal. Test the algorithm one of the typical problems eg. echo removal, resonance suppression.

3. Recursive filters

Create a system for designing recursive filters. Implement filtering using low-pass, high-pass and narrow-pass filters and multi-stage filters. Provide a possibility to define custom filters and implement a functionality of staging filters in cascade and parallel. Compare filtering results and efficiency of different recursive and corresponding FIR filters.

4. Recursive filters design in the *z*-domain

Create an application for designing recursive filters in the *z*-domain. The application enables to graphically define poles and zeros of the transformation in the *z*-domain and automatically generates recursion coefficients for the filter. Visualize the frequency response of the filter designed.

5. Chebyshev filters

Create an application for designing Chebyshev filters for a specified filter type, number of poles, cutoff frequency and allowed passband ripple. Visualize impulse, frequency and step response of the filter designed.

6. FFT convolution

Implement a method of FFT convolution for long signals. Compare results with standard convolution in terms of efficiency for signals and kernels of different length.

7. Pattern recognition in images using FFT correlation

Use correlation-by-convolution technique to localize a specified pattern in the image. Compare the method with a naive pattern matching algorithm. Visualize correlation results. Propose methods for image preprocessing for improved pattern positioning.

8. Noise reduction

Design a system for reduction of white and colored noise. Choose the best filter for each operation (eg. band-pass (reject), moving average or Wiener filter). Demonstrate filtering results on selected audio samples as well as on artificial signals.