The advancement of decomposition techniques for data processing in scientific researches. Recent advances in singularity localization and fractal properties evaluation tools

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Short description of the lecture (up to 10 sentences):

The essence of processing of research data and engineering experiments is to distinguish useful information from all data array. The presence of stochastic component of experimental data requires to perform their analysis to implement previous decomposition of numerical series data (signal) in combination simpler series. If the processes described numerical row is stationary and linear, then the problem is solved on the basis of the classical methods of Fourier transform. If the conditions of linearity and stationarity studied processes are not met, the task of data analysis is much more complex.

In the proposed lectures will be considered methods of decomposition of signals (data series) based on various modifications of Fourier, Gabor, wavelet and Huang-Hilbert transformations. This will be discussed using examples of processing information signals from various sensors (in the fields of oil and gas, electrical, environment, measurement). Analysis of the limits of use specified methods of decomposition and their advantages and disadvantages will be performed for data processing tasks. For the purpose of localization of self-similar singularities that are present in the signals at various scales, we will consider recent tools for evaluating fractal parameters of these data with actual data examples. These tools allow to determine which signals scale or time series scale have a multifractal nature.

Syllabus of the lecture subjects (enlisted):

1. Obtaining a series of experimental data, as a result of sampling and quantization the analog sensor signals. Signal parameters and classification of information signals types.
2. Decomposition and processing of periodic data signals based on the various kinds of Fourier transform and Gabor transform.
3. Decomposition and processing of nonstationary signal based on wavelet transformation: the use of continuous and discrete wavelet transform (with examples in MATLAB's toolbox). Different types of wavelet basis functions and the rationale for their selection for a certain task.

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4. Processing information signals using basis functions decomposition derived from the samples of the same signals (based on the Huang-Hilbert transform). Advantages and problems of this transformation.
5. The concept of fractal and multifractal functions (numerical series). The calculation of the parameters that characterize the level of self-similarity data signals at different scales.
6. Multifractal detrended fluctuation analysis (MDFA)
7. Method of maximum wavelet transformation (MMWT).
8. Review of methodologies for the implementation of these methods using MATLAB (or R) and modern digital signal processors.

Terminy wykładów			
Data	**Dzień tyg.**	**Godzina**	**Sala**
2015-10-28	Śr	9.15-14.00	WEiA E28
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