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FRACTAL ANALYSIS IN PROBLEMS OF THE APPLIED PHYSICS

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For the researchers, a review of the existing mono-fractal analysis methods applied in different branches of modern applied physics is proposed. For each mono-fractal analysis method, some actual references allowing to study the method and to develope corresponding numerical realization are given.

Introduction

According to the non-linear and the system paradigms, many processes generated in open, non-linear, dynamical systems under influence of a powerful source of energy release are appeared to be short-time, ultra-wideband, non-linear and fractal. In applied physics problems, there are a lot of such processes and such systems. To investigate their fractal properties, the mono-fractal analysis methods can be applied. Suddenly, but these methods are often appeared to be quite unknown for the most part of researchers. The purpose of this work is to present the mono-fractal analysis methods to the researchers. Due to volume limitations of this paper, the number of references for each method is strictly limited.

Mono-Fractal Analysis Methods

Mono-fractal analysis of the signals and processes is based on calculation of different fractal dimensions. Now there are over sixty methods, which are regularly applied, in particular, in the applied physics. All these fractal dimensions are based on geometric or on statistical properties of the signal investigated. Mono-fractal analysis methods are divided on simple (only one fractal dimension is used) and complex (the set of fractal dimensions is calculated) ones. Today there are the Fourier dimension based method [1], the Lomb's periodogram method [2], the coarse graining spectral analysis method [3], the box-counting method [4], the real box-counting method [5], the differential box-counting method, the extended counting method, the multiresolution box-counting method [6], the Hall's and Wood's method [7], the Minkowski sausages method, the variation method [5], the Burlaga's and Klein's method [8], the Higuchi's method [9], the Katz method [9], the Petrosian's method [9], the Mandelbrot's method [6], the multiresolution length method [6], the Sevcik's method [10], the consecutive differences method [11], the normalized length density method [12], the critical exponent method [13], the average normalized autocorrelation method [14], the Maragos-Sun's method, the Renyi generalized dimensions method, the variational dimension method [15], the zero-crossing method [16], the Korcak's method, the Chens' method, the R/S-method [1], the Mandelbrot's and Wallis' method [17], the autocorrelation analysis method [18], the detrended fluctuation analysis [18], the adaptive fractal analysis [19], the detrended moving average method [20], the second moment method [16], the Peltier – Levi-Vehel's method [21], the variance plot method [22], the variogram method [1], the generalized variogram method [7], the aggregated dispersion method, the aggregated signal absolute values method, the periodogram method [23], the wavelet analysis based method [18], the empirical mode decomposition method, the dispersion analysis method [18], the scaled windowed variance method [18], the signal summation conversion method [18], the regularization dimension method, the diffusion entropy analysis [24] and other. As the complex fractal analysis methods, in particular, the generalized fractal analysis [25] and the dynamical fractal analysis [26] proposed by the authors of this paper can be considered. On our opinion, the correcting function method created this year by the same authors is appeared to be a useful addition to the all mono-fractal analysis methods. This method is an attempt to improve the accuracy of the fractal dimension estimations.

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