The inter-disciplinary analysis of complex systems (CS) is implemented from standpoint of enlarging their degrees of freedom that is shown to be the intrinsic feature of their functionating. The method of nonlinear analysis of data describing evolution of CS is developed. Using temporal localization along phase trajectories of the attractor, we achieve the essential reduction of computation time and required experimental data at computational analysis of the attractor's topological dynamics that allows the algorithm to be realized even for higher-dimensional cases (much more than a hundred degrees of freedom). The numerical simulations confirm reliability of the developed algorithm and its high efficiency. So, the algorithm is applicable for the sake of statistical characterization of CS under investigation. In particular, within tasks of modeling of turbulent flows the method can be applied for the automatic detection of appearance of turbulence in technical devices.

Time series (TS) obtained from CS are essentially nonlinear [1,2] and often lead to a multidimensional attractor in a relevant phase space [2]. Namely, it occurs at investigation of highly-developed turbulence where applying three-dimensional models (as in the model of Lorenz) is not enough for description of complex processes and higher-order modes become important for increasing reliability [1]. Multidimensional attractor also arises at modeling of nonlinear delayed feedback described by delay differential equations [2], those are widely applied for modeling of nonlinear processes in optics and laser physics, medicine and population dynamics, nonlinear vibrating systems and various self-sustained oscillations, in tasks of automatic control.

But it is worthy to note that the main problem of numerical analysis of TS in such high-dimensional cases is that the computation complexity of fractal-topological algorithms essentially increases with enlarging a dimension m, as well as a quantity of required experimental data N. Namely, the computation complexity increases exponentially for the box-count algorithm and almost linearly for the Grassberger - Procaccia algorithm (GPA) with growth of m at expense of growing a number of computation operations. Again, additional increase of computation complexity results from respective growth of N (N increases exponentially for the GPA with enlarging m). For this reason, implementation of such algorithms for multidimensional attractors is cumbersome and even impossible for high m. So, with comprehensive inter-disciplinary analysis of multidimensional systems, the main purpose of this work is to develop a method allowing reduction of N and computation time as well as being insensible to growing m on these characteristics.

This is attained by elaborating a topological method based on temporal localization in relation to points of the attractor. The most conventional methods of fractal-topological analysis imply just the spatial localization, i.e. investigation of distribution of points on the attractor basin based on estimating the quantity of hits into the m-dimensional cell with a size l. In particular, for the GPA this cell can be considered as a ball with a center in an attractor point. Similar approach of spatial localization (but with fixed number of nearest points) is used in a "nearest neighbor" method. In contrast to these methods, we show that temporal localization provides more convenient realization of topological analysis with essential reduction of required experimental data and computation time and makes these characteristics practically independent on dimensionality within some restricted range of changing m, that is the development of the approach couched in [3].

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