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Review of the Book "Non-Traditional Dynamics: Theory and Practice"

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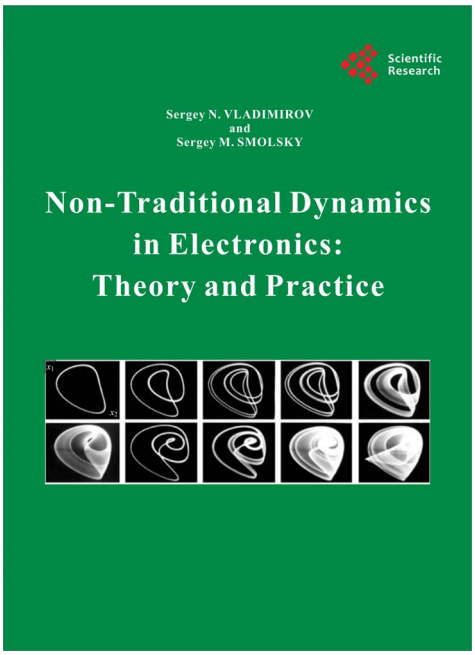

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The offered book is devoted to theoretical and applied problems of nonlinear dynamics of radio physical systems. The main goal of this book is theoretical and experimental investigations of key principles and laws of radio physical system's functioning with continuous and discrete time, in which both regular and chaotic oscillation types may occur.

Modern radio physics and radio engineering, as it follows from scientific publications, feels the increased necessity in the sources of wide-band noise-like oscillations. This necessity is caused by possibility to create on this basis the systems of electronic counter measures and radio masking, the noise-like radar technology and confidential communications, ultra-fast radio communications, cryptographic structures, devices for non-traditional interaction on biologic objects, various devices of special applications. All this is evidence of the fact that investigations directed to examination of dynamic instabilities and the determined chaos are quite relevant. Therefore, the urgency of this book and its practical significance cannot present any doubts.

The book consists of six chapters. The first chapter is devoted to the mathematical model of non-autonomous oscillating system contained the nonlinear capacitor and having the four-dimension phase space. Numerical investigation is conducted for bifurcation phenomena and processes occurring at variations of amplitude and frequency of the external force. It is proved that in the phase space of the system under investigation both strange chaotic attractors and the strange non-chaotic attractors exist. Numerical results are confirmed by the full-scale experiments.

The typical features of transition from regular types of oscillations to chaotic ones in the self-oscillating systems of oscillator and relaxation types are discussed in the second chapter. It is proved that for definite type of these systems non-linearity the chaotization of motions happens according to one auto-parametric scenario. Numerical results are confirmed by experimental results fulfilled on the basis of radio physical oscillating systems.

The new spectral-temporal method for the analysis of oscillating systems is discussed in the third chapter. Peculiarities of construction of the mathematical model suitable for physical analysis are discussed, which describe motions in the discrete and distributed dynamical systems. It is shown that if such systems are physically realizable, the processes in them can be described by identical systems of spectral-time equations. The comparative analysis is executed for natural fluctuations of oscillating systems with delay and Thomson-type. The direct approach of spectrum calculation of Lyapunov characteristic exponents for systems with delayed feedback.

Boundaries and the attraction basin of the time series attractor caused by modified logistic map are determined in the fourth chapter. Values of the control parameter, which divide regular chaotic types of oscillations and strictly-chaotic ones are found out. It is shown that at arising of the chaotic motion the control parameter behavior corresponds to the phase transition of the second

kind. The connection between considered map with the physical system with delayed feedback, which has the infinite dimension of the phase space, is proved. Properties of modified logistic map are investigated analytically and numerically.

A series of algorithms of noisy sequence generation with accurately predicted statistical characteristics is suggested. The nonlinear dynamics of two coupled modified logistic maps is examined. Bifurcation phenomena and processes are studied in detail. Two unknown earlier phenomena are described. The first one is arising the "intermittent synchronization" of two chaotic processes. The second one is formation in the phase space the geometrically ordered structures at strictly positive value of the Kolmogorov-Sinay entropy.

Promising directions of UHF generating structures having high and uniform spectral density in the wide frequency range are investigated in the fifth chapter. The possible methods of such system constructions are analyzed. On the basis of the last achievements of nonlinear chaotic dynamics, the variant of creation the source of the determined chaotic oscillations is offered intended for angular modulation of quasi-sinusoidal oscillator of UHF range. Numerical modeling results as well as results of physical experiments are discussed. A series of issues of robust systems for confidential communication with the chaotic carrier frequency is examined. New principles of double-channel systems with active and passive synchronization are described. The investigation results fort frequency-modulated systems of chaotic communication are given.

Some problems, in which the mutual understanding of experts working in the field of nonlinear dynamics is absent, are investigated in the sixth chapter. To eliminate a series of ambiguities, authors offer the classification of physical systems, objects and processes based on attraction the concept of an openness degree and the reproduced motion type. The influence of the white noise with normal and uniform distribution laws upon dynamics of the quasi-periodic excited system is determined. The unambiguous correspondence between the sign of Lyapunov characteristic exponent and essential dependence of phase trajectory behavior upon initial conditions. Impossibility of generation of Poisson pulse flows and the dynamic chaos by signing correlator of two sinusoidal processes with irrationally coupled frequencies is shown theoretically and experimentally.

Scientific novelty of this book's results consists in the following.

1) For the first time the mathematical model adequately describing processes in oscillating system with four-dimension phase space and the nonlinear capacitor, which is under influence the external harmonic force; this model allows determination of complicated dynamic modes, transitions into chaotic states, to prove the existence of rough attractors having fractal geometrical structures at the absence of positive Lyapunov exponents.

2) Requirements to frequency responses of linear circuits and to a form of non-linearity are formed, which are the necessary conditions of autoparametric scenario of motion chaotization in the oscillating systems, the physical sense of the scenario is stated.

3) Conditions are formulated, at which motions in linear and nonlinear discrete and continuous systems may be described by a system of spectral-temporal equations.

4) The direct algorithm of calculation of the complete spectrum of characteristic Lyapunov exponents is offered for dynamic systems with delay.

5) Bifurcation phenomena and processes typical for a system of two coupled modified logistic maps are examined. The new phenomena of synchronization of chaotic motions, of intermittent synchronization and arising of geometrically ordered structures in the phase space with the positive value of the Kolmogorov-Sinay entropy are discovered and investigated.

6) The white noise influence on dynamics of the nonlinear dynamic systems with quasi-periodic excitation is examined.

Practical significance of the book is determined by the fact that results obtained can be the basis of designing of microprocessor systems, digital automatons, combined circuits, which in combination with digital-analog converters and frequency (phase) modulators permit to solve the problem of creation of wide-band noise-type oscillation sources. Results allow creation of generation algorithms of the white noise with normal and uniform distribution laws and chaotic sequences with necessary value of metric entropy.

The book has the internal unity caused by it contents, structure and statement logic. Scientific issues and conclusions are reasonable. Book materials are expounded clearly and correctly. My opinion is: this book is accomplished scientific investigation and its results may be evaluated as new large-scale scientific achievement in the field of nonlinear dynamics of electronic systems.

REFERENCES

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