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EXPERIMENTAL RESEARCHES AND SOFTWARE TOOLS FOR IDENTIFICATION COMMUNICATION CHANNELS IN FREQUENCY DOMAIN

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ABSTRACT. The engineering software tools used for nonlinear dynamical systems nonparametric identification based on Volterra models in frequency domain is presented. The wavelets application for filtering of measurement noises of received responses and characteristics of the identifiable system allowed enlarging computational stability of the identification method. The proposed methodology and the software tools applied for construction of the communication channel models.

Introduction. Infocommunication systems due to their complexity and lack of knowledge can be interpreted as a «black box» system. The nonparametric dynamic models based on integral power Volterra series are usually used for mathematical modeling of such systems. The models in the form of integral Volterra series [1, 2] are widely used to identify nonlinear dynamical systems. Herewith the nonlinear and dynamical properties of the system are fully characterized by sequence of multidimensional weighting functions – Volterra kernels. The known existing software (such as NI LabVIEW Signal or COMSOL Multiphysics) are very complex and doesn't allow constructing infocommunication system models, so the development of such engineering tools is an actual problem.

The aim of the work is the engineering software developing used for constructing the nonparametric models of nonlinear dynamical systems in a form of Volterra series in frequency domain using polyharmonic test signals. The efficiency of the developed software had to be tested in practical issue for building the nonlinear dynamical model of the communication channel.

Experimental researches methodology. Identification problem for modelling nonlinear dynamical system in a form of Volterra series consists in n-dimensional weighting functions determination $w_n(\tau_1,\ldots,\tau_n)$ for time domain or it's Fourier transforms $W_n(j\omega_1,\ldots,j\omega_n)$ – n–dimensional transfer functions for frequency domain. This based on data of experimental researches of the «input–output» system. Identification of nonlinear system in frequency domain coming to determination of absolute value $|W_n(j\omega_1,\ldots,j\omega_n)|$ and phase $\arg W_n(j\omega_1,\ldots,j\omega_n)$ of multidimensional transfer function at given frequencies – multidimensional amplitude–frequency characteristics (AFC) and phase-frequency characteristics (PFC) respectively.

The identification algorithm is based on nonlinear dynamical model constructing in a form of Volterra series and consists in selecting the form of the test signals. The identification methodology is implemented with approximation and interpolation methods [3]. The structured scheme of the computational process of the identification procedure is shown in the fig. 1.

The hardware platform of the experimental researches using developed software consists of IBM–PC compatible computer with two soundcards Creative Audigy 4 (signal to noise ratio less than 89 dB and distortions not higher than 0,003 %). This allows characterizing the final results as reliable ones. Onboard soundcards (motherboard built-in) has much worst characteristics and higher unevenness of its AFC. Thus it cannot be used in experimental researches.

Maximum allowed amplitude in the described experiment with use of sound card was A=0,25V (defined experimentally). The range of frequencies was defined by the sound card pass band (20…20000 Hz), and frequencies of the test signals has been chosen from this range, taking into account restrictions specified in [4]. Such parameters were chosen for the experiment: start frequency f_s =125 Hz; final frequency f_e =3125 Hz; a frequency change step F=125 Hz; to define AFC of the second order determination, an offset on frequency $F_1=f_2-f_1$ was increasingly growing from 201 to 3401 Hz with step 100 Hz.

The software is organized from two software parts and written in C++ and Matlab languages. The first part is assigned for test signals generation with minimal impact of the operation system of used PC. The experimental results processing is implemented in the second part.

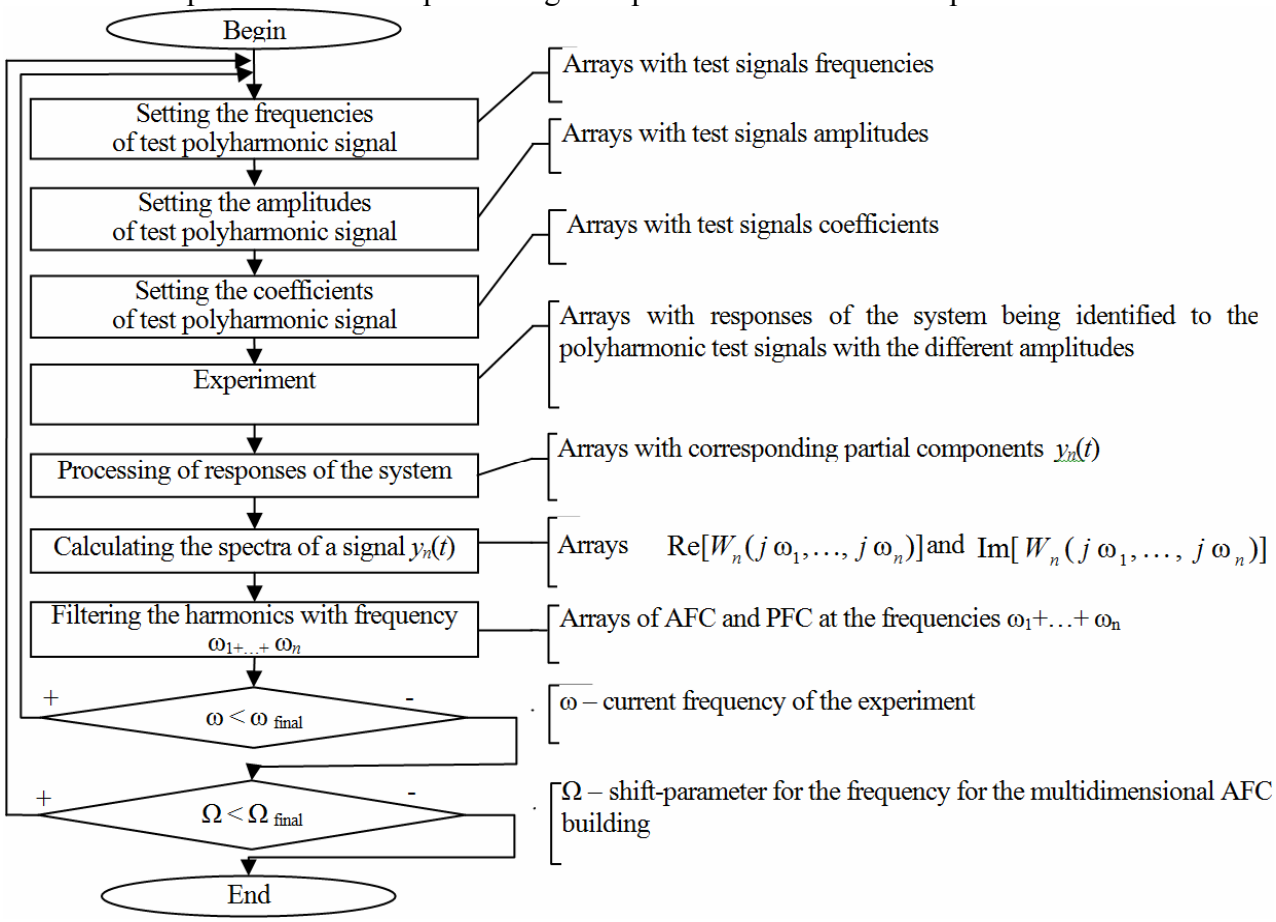

Fig. 1. Structured scheme of the computational process of the identification procedure

Conclusion. The engineering software development and performed researches presented. This software allow identifying and constructing the models of the system with unknown structure using the Volterra series models and polyharmonic signals in frequency domain. Using the developed software for obtaining characteristics of the nonlinear systems in future will allow correcting its characteristics. Current software was applied for constructing the nonparametric models of the communication channel. Results of identification of the linear and nonlinear communication channels models were presented in [3, 4]. The significant nonlinearities of the identified systems have been showed. Thus, it is necessary to take into consideration the characteristics of the system to obtain its high efficient and reliable operating modes.

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