WAVELET FILTERING APPLICATION FOR NONLINEAR SYSTEMS IDENTIFICATION BASED ON VOLTERRA MODEL IN FREQUENCY DOMAIN

Pavlenko V.D., Lomovoy V.I.

Odessa National Polytechnic University, Shevchenko av. 1, Odessa, 65044, Ukraine
+3(8-063)461-74-72, E-mail: pavlenko_vitalij@mail.ru

Natural objects in real world have nonlinear structure with different levels of nonlinearities. The used method allows building linear and nonlinear models for different types of nonlinear dynamical systems (NDS). Most of NDS are nonlinear stochastic inertial systems. The model in the form of integral Volterra series used for identification of such systems. The nonlinear and dynamic properties of them can be characterized completely by a sequence of multidimensional weighting functions – Volterra kernels.

Constructing of the model of NDS in the form of a Volterra series lays in the choice of the characteristics for the test signals. The presented algorithm allows determining the Volterra kernels and their Fourier-images for the received responses (multidimensional amplitude–frequency characteristics (AFC) and phase–frequency characteristics (PFC)) to simulate the NDS in the time or frequency domain, respectively.

An interpolation method of identification of the nonlinear dynamical system based on Volterra series is used for experimental tests [1].

The series of test researches showed the optimal for use the Coiflet and Daubechie wavelets due to its minimal distortion impact on form of filtered signal with optimal RMSE minimization. The wavelet filtering were applied to reduce the noise impact on final characteristics of the test system. The Coiflet-4 and Daubechie-3 of the 3^{rd} level were used for the AFC and PFC filtering respectively.

New values of test signals amplitudes were defined and tested. They are greatly raising the accuracy of identification in compare to amplitudes and coefficients in previous works. The accuracy error of identification of linear part of the tested system is no more than 1%. The same time the accuracy of identification of nonlinear part of the test system growth 2 times compared to previous works. The standard deviation is about 5%. Noise reduction procedures using wavelets are applied to increase the computing stability of identification. It is allowing to receive smoothed decisions and reduce identification error in 1,5–4 times.

References

1. *Pavlenko V., Massri M., Ilyin V.* Computing of the Volterra Kernels of a Nonlinear System Using Impulse Response Data // Proceedings of 9th International Middle Eastern Simulation Multiconference MESM'2008, August 26–28, 2008, Philadelphia University, Amman, Jordan, pp.131 – 138.