IDENTIFICATION OF NONLINEAR SYSTEMS ON VOLTERRA KERNELS WITH USING IMPULSE RESPONSE DATA

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The use of the mathematical models based on the Volterra integro-power series for identification of nonlinear dynamic systems is one of the long-standing problems of the control theory [1]. In the general case the "input-output" relationship for a nonlinear dynamic object can be represented in terms of the Volterra series as

$$y[x(t)]=\sum_{n=1}^{\infty}y_n(t)=\sum_{n=1}^{\infty}\int_0^{\infty}\!\!\ldots\!\int w_n(\tau_1,\tau_2,\ldots,\tau_n)\prod_{i=1}^{n}x(t-\tau_i)d\tau_i, \qquad (1)$$

where $x(t)$ and $y[x(t)]$ are the input and output signals, respectively, $w_n(\tau_1,\tau_2,\ldots,\tau_n)$ is the Volterra kernel of the *n*-th order and $y_n(t)$ stands for the *n*-th partial component of the object response. When determining the multidimensional Volterra kernels, however, the problems arise in separating the *n*-th order partial components from the measured system response to a given perturbation and then in determining the *n*-dimensional Volterra kernel. Solving these problems is computationally unstable, and this leads to significant identification errors even at small deviations (measurement noises) of initial input data. We have investigated the errors of identification of a nonlinear system in the form of the Volterra series with the use of testing impulse signals, basing on the separation of the partial components by differentiation of the system response with respect to the parameter-amplitude [2]. Computer experiments MATLAB on the choice of the test signal amplitude are performed and the results of identification of the Volterra kernels of the 1st, 2nd and 3rd orders are presented..Application of the noise suppression procedure based on the wavelet transformation to estimations of the Volterra kernels allows us to obtain smooth solutions and to lower the identification error 1.5÷3 times. The presented dependences of identification errors on the area of testing actions in determining the diagonal sections of the Volterra kernels allow us to specify the range of optimal amplitudes of pulse actions for different levels of response measurement errors which correspond to the minimal errors of identification of the Volterra kernels.

References

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