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PARAMETRIC IDENTIFICATION OF STATE-SPACE DYNAMIC SYSTEMS: A TIME-DOMAIN PERSPECTIVE

Oleksandr M. Nazarenko and Dmytro V. Filchenko

Department of Complex Systems Modeling
Sumy State University
2, Rimsky-Korsakov St., Sumy, 40007, Ukraine
dm.filchenko@yahoo.com

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Abstract. *In this paper we have presented a time-domain approach to parametric identification of state-space dynamic models comprised both an equation of motion and a system potential (a performance measure). The proposed techniques have been elaborated in order to obtain high simulation and forecast properties and applied to systems of non-stationary accelerator, gradient systems, and linear-quadratic stationary systems. We have also demonstrated a new concept of system potential specification in case of linear-quadratic stationary systems. It is based on the principle of its basis decomposition as an element of energy space. All models and algorithms have been approbated using real statistical data for models of macroeconomic dynamics.*
Keywords: Parametric identification, Performance measure, Non-stationary accelerator, Gradient system, Macroeconomic dynamics

1. **Introduction.** Dynamic systems design is one of the most urgent and difficult issues in different branches of science. Basically, it has three essential practical implications: simulation, forecast, and optimization. The first one is purely retrospective, while the others allow anticipating system dynamics. It is especially useful for analysts. This paper deals with techniques aimed at simulation and forecast. Thus, the quality of applied methodology will be considered in terms of simulation or forecast properties inherent in the resulted models.

The core issue of dynamic systems design is identification methodology and its practical efficiency. Basically, two types of concepts are common in the field of system identification [12]. The first one assumes full or partial specification of the relationship between systems inputs, states and outputs, while a number of unknown parameters should be estimated. Such an approach is called a grey box model. It uses parametric identification techniques (lest squares, general method of moments, maximum likelihood technique) [5, 1]. The other concept is a black box model, which assumes no prior specification and uses both parametric and non-parametric identification techniques (transient response analysis, Fourier analysis EFTE) [4, 21]. System identification can also be carried out in either the time (applying Markov Parameters [8], subspace system identification method [13]) or frequency domain (using singular value decomposition of Hankel matrix of Markov parameters [8]). This paper pertains only the time-domain identification within grey box model framework.

The main problems which arise in this area are computational difficulties connected with numerical realization of optimization algorithms; bias, inefficiency or inconsistency of estimators caused by failure to meet all preconditions of classical estimation techniques; insufficient precision and inadequacy of models. That results in low simulation