ISSN 0735-2727, Radioelectronics and Communications Systems, 2009, Vol. 52, No. 1, pp. 38–44. © Allerton Press, Inc., 2009.
Original Russian Text © P.A. Kucherenko, 2009, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2009, Vol. 52, No. 1, pp. 56–65.

A Criterion of Minimum of Estimation Error Probability in a Problem of Nonlinear Parametric Identification

P. A. Kucherenko

Rostov State University of Transport Communication, Rostov, Russia

Received in final form September 21, 2007

Abstract—Solution of stochastic nonlinear identification problem is proposed. An algorithm of discrete observer parameter identification, based on utilization of criterion of minimal estimation error probability, is synthesized. To illustrate proposed approach efficiency we consider a model example.

DOI: 10.3103/S0735272709010063

INTRODUCTION

Solution of a problem of stochastic parametrical identification, appearing in many fields of communication, control and measuring, using existing methods, requires assumption of definite simplification restrictions, for example, linearity of model of measurer relatively to its parameters, necessity of normal form of additive noise of observed signals distribution, etc. In the most real cases it impacts negatively on identification procedure, hence, it reduce potential accuracy of obtained estimations of parameters [1–4]. Researches of methods and algorithms synthesis, allowing to eliminate traditional approach drawbacks, are actual now in point of view of theory and practice.

We consider an approach for given problem solution, which allows to remove existing restrictions of developed methods, and to increase potential accuracy of identification procedure due to application of generalized probability criteria, nonlinearly depending in general cases on a posteriori probability density distribution of state vector.

We consider more detail a case of scalar equations, defining in general case nonlinear model of researched object and its observer structure (general conclusion in vector case, as it will be shown, has no particular features).

PARAMETRICAL IDENTIFICATION PROBLEM STATEMENT

Let we have a discrete object, which is described by nonlinear difference equation:

$$x_k = f(x_{k-1}, n), \tag{1}$$

where n is object noise with known probability density distribution $q(n)$; x_k is state variable in kth time point; f is known nonlinear function, which can be inverted.

Observation of variables of state in discrete time is realized by measuring device, which can be described in general case by nonlinear equation (observation equation) of following form:

$$z_k = \chi(c_k, x_k, w), \tag{2}$$

where c_k is unknown desired observer parameter, in general case it is not stationary; w is observation noise with known probability density $g(w)$; χ is known nonlinear observation function, z_k is discrete sample of observation signal.

We assume a set of discrete samples z_i ($i = 1, \ldots, k$) is z_1^k with purpose to reduce of further writing.

In considered general nonlinear stochastic case a problem of unknown parameter c_k identification can be stated as a problem of its value obtaining, which satisfies definite optimal criterion J.