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Optimal experiment design for identification of ARX models with constrained output in non-Gaussian noise

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ABSTRACT

The identification of ARX models with constrained output variance in the presence of non-Gaussian distribution of measurements is proposed in this paper. In the presence of non-Gaussian noise, the Masreliez–Martin filter (robust Kalman filter) is the natural frame for identification of model parameters. For the purpose of increasing the practical value of the filter, a heuristic modification is performed. Also, an optimal input is obtained by a minimum variance controller with a Gaussian reference signal. A fundamental issue in experiment design is that the optimal input in general depends on system parameters to be estimated. In order to realize obtained optimal input, authors have proposed a two-stage adaptive procedure, where one iterates between parameter estimation, on the one side, and experiment design using the current parameter estimates, on the other. The practical behavior of new approach to optimal input design for robust identification of ARX models is shown by intensive simulations.

1. Introduction

A controller design is mostly based on the theory and findings of system identification [1–4]. Obtaining mathematical models of the systems represents very topical research area as shown by recent research [5–10]. An extraction of maximum information from available measurements is the key task of system identification, which is realized by optimal experiment design [11,12].

The main issue in the optimal input design for dynamic systems is that the optimal input depends on true system parameters which are estimated. It is known that Fisher information matrix depends on true (unknown) parameters of the system. This issue has been solved by two basic approaches. The first approach is based on robust experiment design which is slightly sensitive to the uncertainty of a priori information about the system [13,14]. A nonparametric frequency method [15,16] can be used to obtain a priori knowledge of the system, in which a finite number of parameters as well as a large number of measurements can be considered. An adaptive experiment design is the second approach. Two-stage adaptive procedure was considered in [17] where one iterates between parameter estimation, on the one hand, and experiment design using the current parameter estimates, on the other. Identification of ARX models applying the adaptive input design has been considered in [18].

In many practical cases, there are significant constraints on the system input and/or system output [19,20]. In an industrial process, the quality of product output usually has to be regulated within certain prescribed tolerance limits. Further,

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