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Reconstruction of Controls and Parameters by the Tikhonov Method with Non-Smooth Stabilizers

M. A. Korotkii[1]*

[1] *Ural State University, pr. Lenina 51, Ekaterinburg, 620083 Russia*

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Abstract—We consider the problem of the reconstruction of an a priori unknown control in a dynamic system based on approximate a posteriori observations of the motion of this system. We propose to solve this problem by the Tikhonov method with a stabilizer which contains the total variation of the control. This provides the piecewise uniform convergence of regularized approximations and thus enables one to numerically reconstruct the fine structure of the desired solution.

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INTRODUCTION

We consider the problem of the reconstruction of a priori unknown controls (parameters) in a controlled dynamic system. The control actions in the dynamic system can be unknown beforehand. One should determine them by observing the object, in particular, by measuring approximately the current phase behavior of the system. The reconstructed controls can be applied then for estimating the characteristics of the controlled object, for prompt decision making, or for more accurate modeling. It is well known that the problem under consideration is ill-posed and its solution needs the application of regularization methods [1, 2]. Similar reconstruction problems for dynamic systems are studied in various statements in the control theory, the theory of differential games, the theory of estimation and identification [3]–[5].

We propose to solve the problem by the Tikhonov variational method. It consists in minimization of a certain appropriate functional (the discrepancy) on the set of admissible controls. From the point of view of the control theory, this technique is a static reconstruction method. The peculiarity of the static approach to the problem under consideration is connected with the fact that the data used for the calculation of controls are known a priori, the reconstruction algorithm does not take into account the possible alteration of the data during the calculation process. The latter, in general, is not one-time, if necessary, it can be repeated. For solving the problem we apply certain concepts and methods of the control theory and the theory of ill-posed problems [1]–[5].

In this paper we prove that stabilizers in the form of the sum of the classical variation and the norm of the space L_2 enable us to obtain the pointwise convergence, the convergence in L_2, the convergence of variations, and the uniform convergence on intervals of continuity of the desired reconstructed control.

* E-mail: m_korotkii@list.ru.