

Algorithm for Solving of Two-Level Hierarchical Minimax Program Control Problem in Discrete-Time Dynamical System with Incomplete Information

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Abstract. This article discusses the discrete-time dynamical system consisting from two controlled objects and described by a linear recurrent vector equations in the presence of uncertain perturbations. This dynamical system has two levels of a control: dominant level (the first level or the level *I*) and subordinate level (the second level or the level *II*) and both have different linear terminal criterions of functioning and united a priori by determined information and control connections. It is assumed that the sets constraining all a priori undefined parameters are known and they are a finite sets or convex, closed and bounded polyhedrons in the corresponding finite-dimensional vector spaces. For the dynamical system in question, we propose a mathematical formalization in the form of solving two-level hierarchical minimax program control problem with incomplete information. In this article for solving of the investigated problem is proposed the algorithm that has a form of a recurrent procedure of solving a linear programming and a finite optimization problems. The results obtained in this article can be used for computer simulation of an actual dynamical processes and for designing controlling and navigation systems.

INTRODUCTION

In this article we consider a discrete-time dynamical system consisting from two controllable objects. The motions of all objects are given by the corresponding vector linear discrete-time recurrent vector relations, and control system for its has two levels: dominating level (the first level or the level *I*) and subordinate level (the second level or the level *II*) and both have different linear criterions of functioning and united a priori by determined information and control connections. We assume that on a given integer-valued time interval the dynamics of the objects *I* and *II* in this system, controlled by the dominant player *P* and subordinate player *E*, respectively, are given by the corresponding vector linear discrete-time recurrent relations in the presence of uncertain perturbations. All controlling parameters of this system, and all parameters that have not been defined a priori restricted to given constraints which are a finite sets or convex, closed and bounded polyhedrons in the corresponding finite-dimensional vector spaces. For the dynamical system in question, we propose a mathematical formalization in the form of solving a multistep problem of two-level hierarchical minimax program control with incomplete information. In this article for solving of the investigated problem is proposed the algorithm that has the form of a recurrent procedure of solving a linear programming and finite optimization problems. Results obtained in this paper are based on the studies [1]–[7] and can be used for computer simulation and for designing of optimal digital controlling systems for actual technical, robotics, economic, and other multilevel control processes. Mathematical models of such systems are presented, for example, in [8]–[9].

Then from this assertion follows that a solution of the problem 3 for the discrete-time dynamical system (1)–(5) can be formed from a finite number procedures of solving the linear mathematical programming problems and the finite discrete optimization problems on the basis of construction of the set $\bar{V}^{(\epsilon)}(\bar{\tau}, \bar{T}, w^{(1)}(\tau), u^{(\epsilon)}(\cdot))$ and numbers $\bar{c}_\alpha^{(\epsilon)}(\bar{\tau}, \bar{T}, w(\tau))$ and $\bar{c}_\beta^{(\epsilon)}(\bar{\tau}, \bar{T}, w^{(1)}(\tau), u^{(\epsilon)}(\cdot))$.

Note, that on the basis of the above algorithms of solving the Problems 1–3 the procedure of the construction a solution of the main problem of two-level hierarchical minimax program control by the final states of the objects *I* and *II* for the discrete-time dynamical system (1)–(5) in the presence of perturbations can be formed from realization of a finite number procedures of solving the linear mathematical programming problems and the finite discrete optimization problems.

CONCLUSION

Thus, in this article we have presented the mathematical formalization of the main problem of two-level hierarchical minimax program control by the final states of the objects *I* and *II* for the discrete-time dynamical system (1)–(5) with incomplete information. This article proposes an algorithm for solving this problem, which is a realization of a finite sequence procedures of solving the linear mathematical programming problems and the finite discrete optimization problems.

Results obtained in this paper are based on the studies [1]–[7] and can be used for computer simulation, design and construction of multilevel control systems for actual technical and economic dynamical processes operating under deficit of information and uncertainty.

ACKNOWLEDGMENTS

This work was supported by the Russian Basic Research Foundation, project no. 15-01-02368, and by the Russian Science Foundation, project no. 15-18-10014 (In part of mathematical simulation of dynamical process with information uncertainty).

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