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FAILURE OF CONTROL DEVICES UNDER CONFLICT CONDITIONS

Abstract. The authors consider a nonstationary game problem of control of moving objects in the case of violations in their dynamics caused by a breakdown or failure of the control devices. A game situation is analyzed where the moment of failure of control devices is a priori unknown, and the time required to eliminate it is given. The sufficient conditions for bringing the trajectory of the conflict-controlled process to the terminal set in a certain finite time are established. The results are illustrated using a model example with simple motion.

Keywords: conflict-controlled process, set-valued mapping, resolving function, failure of control devices, stroboscopic strategy, Pontryagin's condition, Aumann's integral.

INTRODUCTION

One of the important areas of artificial intelligence is the methods of decision making and control in various situations [1–4], including motion control in conditions of conflict and uncertainty. Problems from this area are usually called differential or dynamic games, conflict-controlled processes [5–9].

Along with the methods that reveal the structure of the game and are focused on the construction of optimal strategies in the theory of differential games, there are approaches aimed at a guaranteed result that give sufficient conditions for completing the goal without focusing on the issue of optimality. The latter is quite justified from the practical point of view. These approaches include the first direct method of L.S. Pontryagin [6] and the method of resolving functions [8]. Both of them are based on the same principle of constructing the control of the first player using the measurable control theorems [10].

An attractive feature of the method of resolving functions is that it allows effective use of the modern technique of set-valued mappings and their selections [11] in substantiating game constructions and obtaining meaningful results on their basis. The method, in particular, substantiates the rule of parallel pursuit and the method of approach along the ray [12, 13], well known to designers of rocket and space technology.

In this paper, the method of resolving functions is used to solve the linear non-stationary control problem with violations in dynamics arising as a result of a failure of control devices. Previously, such problems were considered in [14, 15]. The essence of the problem is as follows. The conflict-controlled process develops in such a way that at some a priori unknown moment the control devices of the first player fail for the time necessary to eliminate the breakdown and which is known in advance. Then the process continues until the trajectory hits the terminal set. It is necessary to find conditions for the finiteness of time of the trajectory hitting the terminal set and control of the first player providing this result [16–18].

In this work, sufficient conditions are obtained for the solvability of the game problem of approaching the trajectory of a non-stationary conflict-controlled process with a time-varying terminal set in the event of a temporary failure of control devices. An illustrative example is given.