ISSN 0081-5438, Proceedings of the Steklov Institute of Mathematics, 2024, Vol. 327, Suppl. 1, pp. S138–S154.

published in Trudy Instituta Matematiki i Mekhaniki UrO RAN, 2024, Vol. 30, No. 3, pp. 149–165.

On One Approach to Solving an Applied Control Problem with State Constraints

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Received June 4, 2024; revised July 12, 2024; accepted July 15, 2024

Abstract—A control problem is considered for the translational motion of the center of mass of an object as a material point under the action of a constant modulus reactive force in the gravitational field. The reactive force acts in the direction of one of the axes of a moving coordinate system associated with the object and causes a decrease in the mass of the object according to a known law. It is assumed that the gravitational acceleration generated by the gravitational field is described by the same vector at any point. The system is controlled by changing the spatial orientation of the reactive force vector in some fixed coordinate system. The control problem is to find an open-loop control operating over a certain period of time during which the control satisfies certain constraints and ensures that the center of mass reaches a certain point on a given plane at the terminal time with the fulfillment of certain terminal conditions and a number of requirements for the current state of the nonlinear dynamic system describing the motion. An approach to solving this problem is studied in which an auxiliary control problem is solved using the decomposition of the dynamic system into three simpler systems, each of which describes one of the components of the motion of the center of mass. For two of these systems, special optimal control problems are formulated in which both the functionals to be optimized and the methods for calculating the parameters that determine the solutions to these problems significantly take into account the specifics of the terminal conditions. The required control in the main problem is determined as a result of implementing a procedure that is iterative with respect to the initial time. At each step of this procedure, a solution to the auxiliary problem is constructed without taking into account the state constraints. To control the dynamic system at the current iteration, it is proposed to use a combination of the control constructed when solving an auxiliary problem and the zero control. The results of numerical simulation using model data are presented.

Keywords: nonlinear dynamic system, state constraints, admissible control, optimal control.

DOI: 10.1134/S0081543824070101

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