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ON THE SOLUTION OF A CONTROL PROBLEM FOR THE MOTION OF AN OBJECT IN THE DENSE LAYERS OF THE ATMOSPHERE

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The paper deals with the construction of algorithms for solving an optimal control problem for a nonlinear dynamic system in the presence of phase constraints. The system under consideration describes the motion of a controlled object as a rigid body in the dense layers of the atmosphere under the gravitational and aerodynamic forces. The desired control must minimize a terminal performance index under a number of constraints on the control and the phase state of the dynamic system. The performance index characterizes the accuracy of bringing the center of mass of the object to a given set with a required direction of its velocity. The control is carried out by changing the spatial orientation of movable control elements of the object structure. A time-iterative procedure is proposed for the construction of admissible controls. The procedure is based on the sequential use of the aerodynamic force acting on the controlling elements, which provides the desired direction of the velocity vector of the center of mass under all the constraints. To determine the required moment, it is proposed to use a relation that connects it with the moment of the aerodynamic force acting on the remaining surface of the object with the desired direction of the velocity vector. For this moment, the values of the control parameters that implement it are calculated. The efficiency of the proposed algorithm for constructing admissible controls is illustrated by a model example of an applied optimal control problem. In this problem, the dynamic system describes the motion of a stage of a launch vehicle (recoverable block) in the atmospheric section of its trajectory, where the block moves to a specified landing area. The results of numerical simulation are presented.

Keywords: nonlinear dynamic system, optimal control, phase constraints, admissible control, static equilibrium.

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