Trudy Instituta Matematiki i Mekhaniki UrO RAN

Vol. 29 No. 3 2023

MSC: 49J15, 93C95

DOI: 10.21538/0134-4889-2023-29-3-62-72

ON THE SIMPLEST TIME-OPTIMAL PROBLEM WITH PHASE CONSTRAINTS IN THE CONTROL OF THE SPATIAL ORIENTATION OF A BODY

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Various problems of control of the spatial orientation of a rigid body arise in many applied problems of control of this body in the atmosphere under gravitational and reactive forces. Here, one of such control problems is investigated in an extremely simplified statement. The rotational motion of a rod around its mass center on a plane under the action of a force which is constant in absolute value and applied to one of the ends of the rod is considered. The rate of change of the angle between the rod and the vector that specifies the direction of the force is used as a control parameter. There are constraints on the control and the current phase state of the linear dynamic system describing the rod motion. The desired control must satisfy the constraints and take the system from its initial state to a given terminal state in the minimum time provided the phase constraints are fulfilled. The structure of the optimal control is designed in the time-optimal problem in the presence of phase constraints. The questions of existence and uniqueness of a solution of this optimal control problem are discussed. The obtained results are illustrated by examples of numerical solution of several model problems.

Keywords: linear dynamic system, phase constraints, time-optimal problem, optimal control.

REFERENCES

1. Lebedev A.A., Gerasyuta N.F. *Ballistika raket* [Missile ballistics]. Moscow: Mashinostroenie Publ., 1970, 244 p.
2. Abgaryan K.A., Kalyazin E.L., Mishin V.P. *Dinamika raket* [Missile dynamics], 2nd ed., Moscow: Mashinostroenie Publ., 1990, 464 p. ISBN: 5-217-00354-5 .
3. Blagodatskikh V.I. *Vvedenie v optimal'noe upravlenie (lineinaya teoriya)* [Introduction to optimal control (linear theory)]. Moscow: Higher School Publ., 2001, 239 p.
4. Vasil'ev F.P. *Metody optimizatsii* [Optimization methods], in 2 books, Moscow: MTsNMO Publ., 2011, book 1, 620 p.
5. Vasil'ev F.P. *Metody optimizatsii* [Optimization methods], Moscow: Publ. House "Factorial Press", 2002, 824 p.
6. Vasil'ev F.P. *Lektsii po metodam resheniya ekstremal'nykh zadach* [Lectures on methods for solving extremal problems]. Moscow: Publ. House of Moscow State University, 1974, 374 p.
7. Thomas H. Kormen, Charles I. Leiserson, Ronald L. Rivest, Clifford Stein *Introduction to algorithms.* Cambridge: The MIT Press , 2001, 1202 p. Translated to Russian under the title "Algoritmy: postroenie i analiz", Moscow: Publ. House "Williams", 2011, 1296 p.

Received April 8, 2023
Revised July 31, 2023
Accepted August 1, 2023

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Cite this article as: D. A. Novikov On the simplest time-optimal problem with phase constraints in control of the spatial orientation of a body. *Trudy Instituta Matematiki i Mekhaniki UrO RAN*, 2023, vol. 29, no. 3, pp. 62–72.