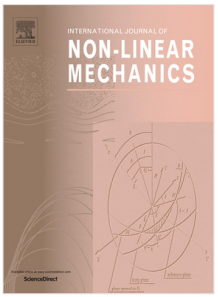
Accepted Manuscript



A new approach for the determination of the global minimum time for the brachistochrone with preselected interval for the normal reaction force value

Radoslav Radulović, Bojan Jeremić, Slaviša Šalinić, Aleksandar Obradović, Milan Dražić

PII: S0020-7462(17)30618-2
DOI: https://doi.org/10.1016/j.ijnonlinmec.2018.02.001
Reference: NLM 2971

To appear in: *International Journal of Non-Linear Mechanics*

Received date : 1 September 2017
Revised date : 7 February 2018
Accepted date : 8 February 2018

Please cite this article as: R. Radulović, B. Jeremić, S. Šalinić, A. Obradović, M. Dražić, A new approach for the determination of the global minimum time for the brachistochrone with preselected interval for the normal reaction force value, *International Journal of Non-Linear Mechanics* (2018), https://doi.org/10.1016/j.ijnonlinmec.2018.02.001

A new approach for the determination of the global minimum time for the brachistochrone with preselected interval for the normal reaction force value

Radoslav Radulović[a], Bojan Jeremić[a], Slaviša Šalinić[b,*], Aleksandar Obradović[a], Milan Dražić[c]

[a] *University of Belgrade, Faculty of Mechanical Engineering, Kraljice Marije 16, 11120 Belgrade 35, Serbia*
[b] *University of Kragujevac, Faculty of Mechanical and Civil Engineering, Dositejeva 19, 36000 Kraljevo, Serbia*
[c] *University of Belgrade, Faculty of Mathematics, Studentski trg 16, P.P. 550, 11000 Belgrade, Serbia*

Abstract

We consider the brachistochrone problem of the particle with a preselected interval for the normal reaction force value as well as the terminal position of the particle lying on an arbitrary planar curve. We use optimal control theory to solve the formulated brachistochrone problem. Here we treat the brachistochrone curve as a bilateral ideal constraint. We study the cases of symmetrically and unsymmetrically preselected intervals for the normal reaction force value. We show that in the case of a symmetrically preselected interval for the normal reaction force value, the brachistochrone curve is a two-segment curve, and in the case of an unsymmetrically preselected interval, it is a three-segment curve. We present a numerical procedure for the identification of the global minimum time of motion. Finally, we present several examples to illustrate the approach proposed in the paper.

Keywords: Brachistochrone, Optimal control, Global minimum time, Singular control

1. Introduction

It is well known that a solution of the classical brachistochrone problem is a one-segment curve – cycloid (see e.g. [1]). In a homogeneous gravitational field a particle starting motion from a specified position with a specified magnitude of initial velocity arrives in a minimum time at the specified terminal position moving along the cycloid. Thereat, the cycloid is considered as a bilateral constraint, that is, the particle must slide along the cycloid like a bead on a wire. However, [2–4] considered so-called unrestrained brachistochrone problem of the particle, where the brachistochrone curve represents a unilateral constraint for the particle, that is, the particle must slide along the brachistochrone curve like a block on an inclined plane. In addition, the inclination angles at the initial and terminal positions of the particle on the brachistochrone curve were specified. In [2–4] it is shown that the solution of the unrestrained brachistochrone problem, in a general case, represents a three-segment curve composed of a cycloidal subarc and

*Corresponding author
Tel.: +381 36 383269; fax: +381 36 383269
Email addresses: salinic.s@ptt.rs (Slaviša Šalinić), salinic.slavisa@gmail.com (Slaviša Šalinić)