The Technique of Rational Convexifying for Nonlinear Controlled Dynamical System

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In this paper, we propose a computing technique for optimization of controlled dynamical system based on the procedure of rational "convexifying" the initial nonconvex optimal control problem. This approach aimed at overcoming the effect of "multiplication" of controls by using of Gamkrelidzes method [1].

The optimal control problems have the property of hidden convexity (A.F. Filipov, V.M. Tikhomirov, A.A. Tolstonogov), which can be used to construct specialized methods for their study. It consists in the possibility of convexifying a velocities set of a controlled dynamical system according to the method proposed by R.V. Gamkrelidze, and the transition to an extended problem with auxiliary controls satisfying given conditions. With the use of this procedure, it is possible to obtain a lower estimate of the global extremum of the objective functional, and in some cases, to convexify the reachable set. In order that any trajectory optimal in the initial problem be optimal in the extended one, it is necessary and sufficient to perform the correctness property by extension: the lower bounds of the functional in the initial and extended problems must coincide.

We developed several ways to reduction the extended problem to the standard form and variants for accounting constraints on auxiliary controls, based on the use of penalty functions, modified Lagrange functions and other approaches. We have identified a class of nonlinear optimal control problems for which, after carrying out the procedure of convexifying, the reachable set becomes convex. The computational experiments carried out to study the properties of the developed technique with test collection [2] made it possible to verify their effective applicability for the study of multiextremal optimal control problems.

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References

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