Computer Technology of the Global Search for the Optimal Control Problem

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Computational technologies for solving nonlinear optimization problems of dynamical systems, oriented to search both the local and the global minimum are reported. "Local" methods developed by us for over 30 years, realized using the technological basis of the program complex OPTCON-I ("OPTimal CONtrol") and serve as an auxiliary algorithm in the "global" methods.

To find the global extremum invited several families of heuristic algorithms based on both the theory of finite-dimensional optimization, and optimal control theory [1]. As one of the basic, most reliable and informative technology, we consider a family of algorithms that implement the idea of random multistart. The technology includes four algorithms for generating random admissible controls, selection algorithms and algorithms for local extrema estimates on domains of attraction [2].

Technology to the marginal reduction of extreme problems based on the idea of a consistent increase in accuracy of approximation of the original problem of optimal control of large mathematical programming problem [3]. Technology convexifying relying property hidden convexity of the optimal control problem can be achieved by local optimization to obtain estimates of the optimal value of the objective function [4]. Methods based on approximations of the reachable set based on computing technology developed by us for solving the phase estimation. Using the internal approximations of the integral funnel of a control system is sufficiently good approximation, which is then refined by local methods [5].

Technology "curved search" based on the properties of the set of attainability. For the construction of the scanning curves are used several ways to generate random utility functions and varying ways of management. At each iteration of the algorithm in addition to the global "scanning" the permissible region in the vicinity of a record management is also searching for a new approach that implements a local improvement target functional [6].

Tunnel type algorithms implement the idea of a classical global optimization is possible to construct an escape mechanism from local extrema. For problems of small dimension are good computational properties demonstrates the non-local search technology, based on the Pontryagin maximum principle [7].

The most reliable of technologies implemented by us, we believe the technology of random surfaces. The proposed algorithms require the generation of a set of Euclidean balls in the terminal phase space covering the reachable set. Sizes covering the balls depends on the evaluation of the Lipschitz constant of the terminal functions, specified in the algorithm. The result of the algorithms is, in addition to approach the global optimal control, an assessment of the likelihood of a global extremum, obtained with a predetermined accuracy [8].

The proposed algorithms are implemented in C in the software package OPTCON-III (OS Windows XP / Vista, OS LINUX). With the application of the proposed collection of computational technologies generated test problems, including more than 100 model examples from various sources [9].

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2