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NONLINEAR OPTIMIZATION IN SPACE APPLICATIONS WITH WORHP

Abstract

Nonlinear optimization has grown to a key technology in many areas of aerospace industry, e.g. satellite control, shape-optimization, aerodynamics, trajectory planning, reentry problems and interplanetary flights. These problems typically are discretized optimal control problems that give rise to large sparse nonlinear optimization problems. In the end all these different problems from various areas can be described in the general formulation as nonlinear optimization problems. The success of the optimization process depends on a multitude of factors, beginning at the modeling phase with the choice of the modeling approach and ending in the final interpretation and application of the outcomes, one the most crucial choices being the choice of a suitable optimization method. Despite the increase of computational power in recent years, methods not exploiting the special structure of these problems are likely to fail.

WORHP is designed to solve nonlinear optimization problems with more then hundred of millions variables and constraints. The algorithm is an SQP method and is exploiting the sparsity of the problem on every possible level: It includes efficient routines for computing sparse derivatives, e.g. graph-coloring methods for finite differences, sparse BFGS update techniques for Hessian approximations and sparse linear algebra. Furthermore WORHP uses reverse communication which allows the user to have full control of the optimization process.

In this talk we are going to introduce WORHP and the features described. Afterwards the results from the test campaign are going to be presented. In this test campaign WORHP has proven to be the robust of the state-of-the-art nonlinear optimization solvers. Furthermore we will present a time optimal low-thrust planar transfer to a geosynchronous orbit and an emergency landing of a hypersonic flight system, both computed with WORHP.