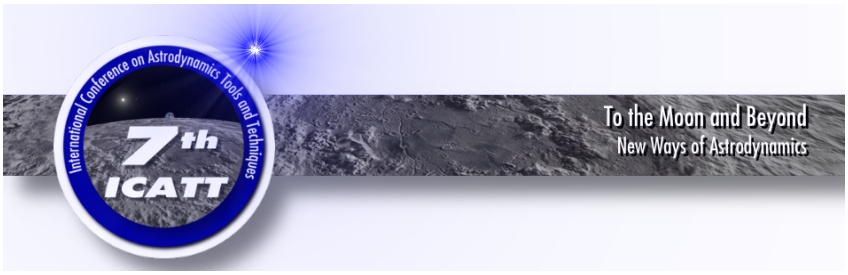

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Automated optimization of low-thrust trajectories

Modern space missions often require a large velocity increment, which leads to the need to use main electric propulsion systems with a high value of the specific impulse to reduce the mass of the active propellant and increase the mass of spacecraft in target orbits.
To improve the efficiency of space transportation operations, optimization of the low-thrust trajectories is required. Optimization of such trajectories is a complex problem, due to a number of reasons, including the limited size of the domain of existence of solutions, the possibility of the existence of many optimal solutions, the nonsmooth dependence of boundary conditions on control parameters, the complexity of the mathematical model of optimal motion, the high sensitivity of optimal trajectories to variation in control parameters. The above factors significantly complicate the process of optimizing the trajectories of spacecraft with electric propulsion system and increase the relevance of the problem of automating the calculation of optimal trajectories.
Probably, there is no universal method for automating the solution of the problem, but a number of computational approaches and methods have been found that make it possible to achieve a high degree of automation of many practical problems within the framework of an indirect approach to solving the problem of optimal control based on the application of the maximum principle. These approaches and methods include the continuation method for automating the choice of the initial approximation, the high-precision calculation of the derivatives using the complex step method or the dual numbers in solving boundary value problems and in calculating the right-hand sides of differential equations for conjugate variables, smoothing discontinuous control.
A method for automated optimizing the trajectories of a spacecraft with electric propulsion system is developed, which includes the use of the above techniques and the sequence of solving problems of optimization of power-limited, minimum thrust acceleration, minimum thrust, and constant exhaust velocity trajectories, ensuring smooth continuation from one subproblem to another and with the diagnosis of existence solution of the problem.
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Summary

Primary authors: IVANYUKHIN, Alexey (Research Institute of Applied Mechanics and Electrodynamics of the Moscow Aviation Institute (RIAME MAI)); Dr PETUKHOV, Vyacheslav (Research Institute of Applied Mechanics and Electrodynamics of Moscow Aviation Institute)

Presenters: IVANYUKHIN, Alexey (Research Institute of Applied Mechanics and Electrodynamics of the Moscow Aviation Institute (RIAME MAI)); Dr PETUKHOV, Vyacheslav (Research Institute of Applied Mechanics and Electrodynamics of Moscow Aviation Institute)

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