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SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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OPTIMAL THRUST DIRECTION FOR LUNAR SOFT LANDING USING TEP

Abstract

A safe lunar landing is a key factor to undertake an effective lunar exploration. Lunar lander consists of four phases such as launch phase, the earth-moon transfer phase, circumlunar phase and landing phase. The landing phase can be either hard landing or soft landing. Hard landing means the vehicle lands under the influence of gravity without any deceleration measures. However, soft landing reduces the vertical velocity of the vehicle before landing. Therefore, for the safety of the astronauts as well as the vehicle lunar soft landing with an acceptable velocity is very much essential. So it is important to design the optimal lunar soft landing trajectory with minimum fuel consumption. Optimization of Lunar Soft landing is a complex optimal control problem. In this paper, an analysis related to lunar soft landing from a parking orbit around Moon has been carried out. A two-dimensional trajectory optimization problem is attempted. The problem is complex due to the presence of system constraints. To solve the time-history of control parameters, the problem is converted into two point boundary value problem by using the maximum principle of Pontrygen. Taboo Evolutionary Programming (TEP) technique is a stochastic method developed in recent years and successfully implemented in several fields of research. It combines the features of taboo search and single-point mutation evolutionary programming. Identifying the best unknown parameters of the problem under consideration is the central idea for many space trajectory optimization problems. The TEP technique is used in the present methodology for the best estimation of initial unknown parameters by minimizing objective function interms of fuel requirements. The optimal estimation subsequently results into an optimal trajectory design of a module for soft landing on the Moon from a lunar parking orbit. Numerical simulations demonstrate that the proposed approach is highly efficient and it reduces the minimum fuel consumption. The results are compared with the available results in literature shows that the solution of present algorithm is better than some of the existing algorithms.

Keywords: soft landing, trajectory optimization, evolutionary programming, control parameters, Pontrygen principle.