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Trajectory Optimization of Re-Entry Vehicle Using Evolutionary Algorithm

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Abstract : Performance of any vehicle can be predicted by its design/modeling and optimization. Design optimization leads to efficient performance. Followed by horizontal launch, the air launch re-entry vehicle undergoes a launch maneuver by introducing a carefully selected angle of attack profile. This angle of attack profile is the basic element to complete a specified mission. Flight program of said vehicle is optimized under the constraints of the maximum allowed angle of attack, lateral and axial loads and with the objective of reaching maximum altitude. The main focus of this study is the endo-atmospheric phase of the ascent trajectory. A three degrees of freedom trajectory model is simulated in MATLAB. The optimization process uses evolutionary algorithm, because of its robustness and efficient capacity to explore the design space in search of the global optimum. Evolutionary Algorithm based trajectory optimization also offers the added benefit of being a generalized method that may work with continuous, discontinuous, linear, and non-linear performance matrix. It also eliminates the requirement of a starting solution. Optimization is particularly beneficial to achieve maximum advantage without increasing the computational cost and affecting the output of the system. For the case of launch vehicles we are immensely anxious to achieve maximum performance and efficiency under different constraints. In a launch vehicle, flight program means the prescribed variation of vehicle pitching angle during the flight which has substantial influence reachable altitude and accuracy of orbit insertion and aerodynamic loading. Results reveal that the angle of attack profile significantly affects the performance of the vehicle.

Keywords : endo-atmospheric, evolutionary algorithm, efficient performance, optimization process
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