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Funding Source: NASA Space Grant Consortium


## Near-optimal launch guidance using energy-angular momentum relationship


The nonlinear dynamic equations for launch vehicles make the optimal control solution difficult to obtain. These solutions have multiple parameters (i.e. Lagrange multipliers) for which the proper initial values must be determined. Not only must these initial multipliers result in the desired final state, but they must also produce trajectories that satisfy other necessary boundary conditions required for optimality. Computationally intensive algorithms with relatively long calculation times are required to find these optimal initial conditions. A control algorithm for the second stage of launch vehicles is developed using a relationship between the current state of the vehicle and its steering angle. This method relates known initial conditions and requisite final conditions of energy and angular momentum by a quadratic function, leaving a single variable to be optimized while guaranteeing that the vehicle will reach the desired orbit. Constraints for the design variable are found and methods are developed to determine the value of this parameter for which this system achieves its best performance. The burn time for this system is within a few percent of the burn time for the optimal control system. Thus, near-optimal solutions are found by iterating on only a single parameter.