Mission Analysis of a Rocket-Scramjet-Rocket System for Small Satellite Launch

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A largely reusable launch system featuring a scramjet accelerator has the potential to significantly decrease the costs of small satellite launches. One such system is being developed at The University of Queensland, consisting of a reusable first stage rocket, a reusable second stage scramjet, and a disposable third stage rocket.

The application of trajectory optimisation to this system allows for an optimal flight path to be calculated, which is necessary for informed vehicle design. The trajectory of the first stage is simulated utilising the multiple shooting method to attain the best trajectory and details of this process are provided. The second and third stage trajectories are optimised using existing routines and combined with the first stage simulation to produce a three stage trajectory simulation. Currently the starting point of the second stage is fixed to ensure optimum scramjet operation. This framework can be used to analyse the launch system performance for different operating requirements.

Furthermore, this paper presents an analysis of a variety of orbital insertion missions for which the use of this small payload launch system may be advantageous. This analysis covers single launches, launches with short response time and constellation launches.