AUTOMATED TRAJECTORY GENERATION AND GUIDANCE FOR A NEW LAUNCH VEHICLE FLIGHT PHASE

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ABSTRACT

Much effort has been put into developing technologies for next generation re-usable launch vehicles. Fully re-usable launch vehicles include a booster stage that is designed to land, usually near the launch site, after it has released the upper-stage, which continues to orbit. The fuel reserve needed to turn the booster stage around will usually be minimal For this reason, once the booster stage has completed a rocket-back maneuver, it will typically be at a high altitude (exo-atmospheric) but with low kinetic energy and a steep flight path angle on re-entry. Traditional re-entry guidance is designed for vehicles with a high velocity, and shallow flight path angle, and thus these traditional approaches are not appropriate for a low energy re-entry (LOER). The current research presents a set of guidance algorithms that will successfully guide a vehicle to landing starting from LOER condition. The guidance algorithms are designed to ensure the vehicle can achieve near optimal range performance when required and also to execute a sharp pull-up maneuver that balances the load factor constraint against the need to pull-up quickly before the dynamic pressure constraint is exceeded. The guidance approach has been tested for a wide variety of vehicles and mission scenarios, including more traditional initial conditions that would occur at the end of a High Energy Re-entry (HIER) from orbit. Thus, the guidance approach we have developed can be used as a more robust version of Terminal Area Energy Management (TAEM) guidance, as well as for LOER and has been tested for a wide range of vehicles, including the Space Shuttle and vehicles with a wide variety of L/D capability. Significant development has also gone into the engineering considerations needed to implement the guidance algorithms on a real vehicle. Program execution time, application of vehicle constraints, trajectory repeatability and other factors are all addressed in order to meet this need.