Public Abstract

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Next generation launch vehicles are a major current area of research for both military and civilian applications. Current vehicle concepts often include a re-usable booster stage, which will fly back to the launch site after releasing an upper stage rocket to go onto orbit. It is desirable for the booster stage to be able to navigate and fly back to its landing site autonomously, with no human intervention, using on-board guidance and control methodologies. Current computer technology has made this possible, and a major area of research is in adaptive, robust guidance techniques that are capability of successfully landing the vehicle even under adverse atmospheric conditions, vehicle failures and last minute changes to the landing site.

A booster executing a rocket-back maneuver to return to the launch site will often re-enter the atmosphere in a steep dive, with much lower kinetic energy than a vehicle returning from orbit. The guidance for this sort of mission is the focus of the research presented here. The guidance approach is designed to manage the vehicle trajectory through a steep dive, pull-up and glide to the runway, and align the vehicle to the runway centerline and bring it to a successful landing. The vehicle must also not exceed any of its design limitations, and must be capability of gliding the full distance possible, when needed. All of these factors are included in the guidance software. The current guidance approach will also work for a vehicle that starts in a shallow glide condition, such as would be appropriate when returning from orbit. Thus, the methods here work for both return to launch site type mission as well as return from orbit missions. The guidance software has been extensively tested for a wide variety of vehicles and missions and the results are presented here.