ASTRODYNAMICS SYMPOSIUM (C1)
Optimization, Guidance and Control (11)

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# LYAPUNOV-BASED LUNAR CAPTURE GUIDANCE SCHEME

## Abstract

An electric propulsion system has been applied to interplanetary missions because of its higher specific impulse. And these interplanetary missions may include the planetary capture stage to reach the desired mission orbit or for the earth return leg of a sample return mission. In this planetary capture stage, the spacecraft which departure from the earth or return to the earth must decelerate to make the closed orbit at the target mission planet.

There are many approaches for this problem. One of these approaches introduced by Y. Gao and C. A. Kluever([1]) is the earth capture guidance law using the blended steering control. In that paper, the capture guidance is separated in to three basic phases. The main idea of this guidance law is very simple and reliable using a robust method such as Perkins's universal low-thrust spiral trajectory. However, this guidance law must be sequentially operated and the blending parameter must be calculated and updated at every specific time for the planetary capture stage. And the optimal technique such as shooting method is used to find the optimal parameter values. Therefore, the main focus of this paper is to find very simple and a single guidance scheme. To find this guidance scheme, another approach based on Lyapunov feedback control is introduced by S. R. Vadali([2]). In that paper, the Lyapunov feedback control is used for orbital capture guidance. However, this guidance law cannot entirely describe the two dimensional orbit due the scalar of eccentricity and energy, and this Lyapunov candidate can be applied only a circular target orbit. Therefore, in this paper, the modified equinoctial element is used as Lyapunov candidate to describe the three dimensional orbit.

Unlike the orbit transfer problem between closed orbits, the planetary capture problem has two constraints. One thing is that the spacecraft coming to the planet with hyperbola orbit conditions must be accomplished the closed orbit conditions before passing the first periapsis. And the other one is that the periapsis altitude of the spacecraft does not small than zero to prevent the crashing problem. For this reason, the variable gain approach is used to accomplish the closed orbit conditions rapidly. And the penalty function method is used to prevent the crash problem