RIPS 2006 JPL Project Description

Impulsive Low Energy Transfers Between the Earth and the Moon
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Project Description:

The goal of this project is to study the classes of impulsive low energy transfers between the Earth and the Moon using the coupled restricted three body problem (RTBP) to model the Sun-Earth-Moon-Spacecraft 4-body system.

Starting from a circular low Earth orbit (200 - 1000 km orbit) and ending in a circular lunar capture orbit of 100 km radius. The transfers shall be designed using the invariant manifolds of unstable periodic orbits around the Earth or its Lagrange points EL1 and EL2 and those around the Moon and its Lagrange points LL1 and LL2. The initial guesses produced by the invariant manifolds shall be integrated into a single end-to-end trajectory using a differential corrector, also known as the parallel shooting method.

In order to fit the project into the summer time frame, only halo orbits around the EL1, EL2 will be examined around the Earth. Around the Moon, besides halo orbits, distant retrograde orbits will also be considered.

In order to classify the transfers, a key parameter is the geometry of the Sun-Earth-Moon at launch or at capture. Another key parameter is the number of times the spacecraft winds around the Earth before capturing into a lunar orbit. Due to time constraint, an exhaustive study of these parameters is not possible. Instead, the goal for this project is to minimize the total energy required for such transfers while keeping record of these key parameters.

Time permitting, a bonus problem is to find an Earth return trajectory landing on the dayside of the Earth such as the one used by the Genesis mission.

Computations shall be performed in Matlab. C and Fortran codes are also good, but should be integrated in Matlab to permit interactive analysis. A Matlab animation of the final trajectory is highly desirable, but no necessary.

Key Milestones:

1. Computation of unstable periodic orbits in the RTBP: halo orbits, distant retrograde orbits.
2. Computation of invariant manifolds of unstable periodic orbits.
3. Combining two three body systems.
4. Intersecting manifolds using Poincare Sections.
5. Constructing a multiple shooting tools: a differential corrector.
6. Finding end-to-end transfer trajectories.
7. Bonus A: Animation.
8. Bonus B: Earth return trajectory.