Student Competition for the 2018 Astrodynamics Specialist Conference

Mission Design to Optimally Visit Easily Recoverable Objects for Asteroid Mining Applications

Background:

Emerging interest in space tourism, colonization and habitation garnered significant interest in asteroid mining operations among astrodynamists. To this end, a set of 12 Easily Retrievable Objects (EROs) have been identified in the recent past. These objects can be transferred to the Sun Earth Lagrange points with relatively small propulsive capabilities. The twelve EROs are: 2006 RH120, 2010 VQ98, 2007 UN12, 2010 UE51, 2008 EA9, 2011 UD21, 2009 BD, 2008 UA 202, 2011 BL45, 2011 MD, 2000 SG344 and 1991 VG.

Imagine we are engaged in playing this celestial game of billiards and are interested in harnessing the resources pertaining to most of the 12 REOs, an interesting approach to this challenge is to carry thrusters of low propulsion (Isp = 3000), to be placed on all the REOs. In theory, the 12 REOs can then be propelled to the Sun Earth Lagrange points for harvesting and mining with low thrust propulsion capability. We envisage a scenario where this can be accomplished in a single mission with a bus that carries all the low thrust payloads. The challenge is to carryout mission design studies to investigate a feasibility of this scenario.

The competition is to design a space mission that can harness maximum resources pertaining to all the 12 REOs. At some optimal launch time in 2018, it is anticipated that a single spacecraft carrying all the low thrust propulsion systems takes off from a Geostationary parking orbit. The spacecraft/bus is then required to visit a maximum number of REOs in an optimal fashion, before ending its life in deep space. The winning design will have the lowest cost measured in terms of both the fuel consumed and the mission duration, in addition to maximizing the number of EROs visited.

Constraints and Guidelines:

Common bus to house all the low thrust propulsion systems
Launch date in 2018 is open and should be considered for the mission design
Rendezvous is encouraged, but not required.
Intercepting trajectory designs should show safe offset distance in the interception process
Both impulsive (at departure and each arrival) and continuous thrusting options are admissible, but the total fuel expenditure should be normalized to account for this discrepancy.
Mass audit should account for varying mass of the delivery process
REO orbits are defined by JPL Horizon system.

Technical Goals and Objectives:

Minimize the total mass required for delivering the thrusters
Visit a maximum number of REOs in the same mission
Minimize the total mission time.

Rules:

- Teams should consist solely of graduate and undergraduate students at accredited universities.
- Cross University teaming is allowed as are multiple teams from a single university.
- Non-student mentors or advisors are allowed, but must be explicitly acknowledged, along with their contributions, and will be considered in the adjudication process.
- Final design submission will consist of
    - A < 25 page document, not including references, budget information or equipment lists (payloads for the low thrust systems for each REO)
    - Up to 2 posters presenting the spacecraft design and proposed mission operations
    - A 20 minute presentation of the concept
    - Additional mock-ups, simulations or tactile presentations are allowed

Constraints and Guidelines:

- Student teams should declare their intent to participate by the paper abstract due date by submitting an abstract, nominal list of team members and commitment for at least one team member to attend the conference.
- The final design documents are due to the competition organizers 2 weeks in advance of the conference.
- External reviewers and judges will be used to rank the submissions.
- Student presentations will occur at the conference as part of the conference poster session.
- Final selection of winning concepts will be announced at the conference banquet