Your manuscript, AA_2015_354, has not been accepted

Rock Jeng-Shing Chern to me Jan 5

Ref: AA_2015_354
Title: Systematic Design of Optimal Low-Thrust Transfers for the Three-Body Problem
Journal: Acta Astronautica

Dear Mr. Kulumani,

Thank you for submitting your manuscript to Acta Astronautica . I regret to inform you that reviewers have advised against publishing your manuscript, and we must therefore reject it.

Please refer to the comments listed at the end of this letter for details of why I reached this decision.

We appreciate your submitting your manuscript to this journal and for giving us the opportunity to consider your work.

Kind regards,

Rock Jeng-Shing Chern
Editor-in-Chief
Acta Astronautica

Comments from the editors and reviewers:
-**Reviewer 1**

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The paper is devoted to the computation of low-thrust  transfer orbits in the framework of the planar
restricted three body problem (PRTBP). The transfer goes from some initial condition to a final state, that
can be another state, an orbit, or a set of states.


In the framework of the PRTBP, the problem considered can be summarised as follows:
- Fix a certain surface of section, Sigma, that must be transversal to the "trajectories emanating from the
initial orbit". (page 16) This is, in general, a very difficult (even impossible) global requirement.
- Consider a departing state x_0 \in Sigma and the state x_n(N) (first intersection with Sigma) of the
control-free trajectory departing from x_0.
- Denote by x(N) any final state (first intersection with Sigma) of a controlled orbit departing from x_0
(with the only assumption that the modulus of the low-thrust at must be always below a certain maximum
magnitude).
- Determine the largest neighbourhood around x_n(N), in Sigma, that can be reached by means of a controlled
orbit departing from x_0; this is: such that the distance in Sigma between x(N) and x_n(N) is as large as
possible (reachable set).
- Select the state in the reachable set that minimises the distance the target (point/orbit/set).

The key point of the above scheme is the computation of the reachability set. This is done solving an
optimal control problem.

For this control problem:
  - The cost function, to be maximised, is the distance in Sigma between the final points x_n(N) (fixed)
and x(N) (depends on the control u).
  - The dynamic equations are the discretised and controlled PRTBP differential equations.
  - The constraints are: to reach the section along a fixed direction (defined by an angle theta_d that
must vary between 0 and 2 pi) and to keep the modulus of the control below a maximum threshold.

Using the indirect formulation of the optimal control problem, the paper gives the discrete necessary
conditions of optimality.

The paper concludes with the application of the developed procedure to two examples.

The paper is interesting but, in my opinion, unnecessarily long due to the detailed explanations of
procedures and results that are only used for comparison, as could be other transfer methods that are even
not mentioned. The results obtained with the developed methodology are compared with the ones that use the
low energy transfers provided by the stable and unstable invariant manifolds. From my point of view (and
according to the title of the paper) the goal of the paper is not to compute invariant manifolds of
hyperbolic orbits and/or heteroclinic connections, although, in many cases, they can be used to determine a
first transfer guess, and which nowadays is a well known topic. The goal of the paper is to explain the
above scheme and how it can be implemented. If the authors have decided to use a variational integrator of
course they must explain what integration step,h, has been used in the different examples and which is the
resulting accuracy. This will be very useful to the reader interested in the implementation of the method.
In my opinion, is unnecessary to compare the procedure with a RK45 method (a RK78 or a Taylor procedure is
probably more accurate that the one used by the authors, but again, this is not the goal of the paper).


Some additional comments.

- Although the two examples are 2-dimensional problems, the method can be easily extended to the 3-
dimensional PRTBP, which, for the applications, is more interesting.
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- It is not true that the three collinear equilibrium points a saddle points (page 6, line -4) they are of
saddle x centre type.
- For the controlled equations of motion, the Jacobi function E (eq. 10) is no longer a first integral, so
it can not be used to compute the value of dot{y} at the reachable set (page 20, line -3).
- In example 1 the time span is fixed (t_f=1.4 adim units) is really fixed or is only an upper bound?
- What does "N" mean in eqs. (26), (27),...? Is the time of arrival to the section Sigma?
- Don't use "m_i" in eqs. (28a) and (28b) (and m in eq. 29c), since the m_i have already been used for the
masses of the primaries.
- How is "phi" in equation (30)?
- Give more details about how the two point boundary control problem is formulated and solved (equations,
initial conditions, details about the implementation of the multiple shooting).
- The reader of the paper should be able to reproduce the results of the paper. This can be done for
Example 1, but not for example 2. The different steps involved should be clearly explained and illustrated.
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