TRAJECTORY OPTIMIZATION FOR A HEAVY LAUNCHER: A HAMILTON–JACOBI APPROACH

O. BOKANOWSKI, E. BOURGEOIS, A. DÉSILLES, AND H. ZIDANI

Abstract. In this talk, we will present a global optimization approach for the flight of a three-stage launcher. The aim of this trajectory optimization problem is to minimize the consumption of ergols that is needed to steer the launcher from the Earth to the GEO. Here the global optimization procedure is based on Hamilton-Jacobi-Bellman approach. The optimization problem takes into account a complete flight model and includes the transfer from the GTO to the GEO orbit. It leads to a control problem in 6-dimensional state-space and involves some additional optimization parameters.

We first set the problem in the framework of optimal control problems and show how to deal with the parametrs without increasing the dimension of state space. Then we present the global optimisation procedure based on solving some Hamilton-Jacobi equations. We study the convergence result of the optimization procedure and show the relevance of the approach for appraoching the optimal trajectory.

As the control problem is set in a high dimensional state-space, we analyse the computation effort to be made for solving the corresponding Hamilton-Jacobi equations and compare the optimal result with a reference trajectory provided by CNES.

This work has been carried out in the frame of CNES Launchers' Research and Technology program.

Keywords: Trajectory optimisation, Hamilton-Jacobi appraoch, ENO scheme, feedback reconstruction

Mathematics Subject Classifications (2010): 34H05, 49J15, 49L20

References

[1] O. Bokanowski, E. Bourgeois, A. Désilles, and H. Zidani Global optimization approach for the climbing problem of multi-stage launchers Submitted, 2015

Olivier Bokanowski, Laboratoire J.-L. Lions, Université Pierre et Marie Curie & UFR de Mathématiques, Université Paris-Diderot, France.
E-mail address: boka@math.jussieu.fr

Eric Bourgeois, Centre National d'Etudes Spatiales, Paris, France
E-mail address: Eric.Bourgeois@cnes.fr

Anna Désilles, Unité des Mathématiques Appliquées (UMA), Ensta ParisTech, Université Paris-Saclay, France
E-mail address: Anna.Desilles@ensta-paristech.fr

Hasnaa Zidani, Unité des Mathématiques Appliquées (UMA), Ensta ParisTech, Université Paris-Saclay, France
E-mail address: Hasnaa.Zidani@ensta-paristech.fr