ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control (1) (5)

Author: Prof. Michael Yu Ovchinnikov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation

Dr. Danil Ivanov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation
Mr. Sergey Shestakov
Moscow Institute of Physics and Technology, Russian Federation

ORBITAL DYNAMICS OF FORMATION FLYING UNDER MASS-EXCHANGE NOVEL CONTROL

Abstract

The paper discusses the problem of formation flying relative motion control. The new approach is based on a mass exchange between satellites. One satellite initially carries a supplementary mass which separates from the satellite and collides inelastically with the other one. The satellite gets the impulse according to the momentum conservation law. Both satellites get additional impulses applied to their centers of mass. The relative trajectories are described by Hill-Clohessy-Wiltshire equations. So, the resulting relative trajectory changes after the mass transfer and it may be used for relative motion control. Described method is fuelless and the supplementary mass can be used again.

The mass exchange control approach can be applied for a wide range formation flying reconfigurations. It was shown that one can obtain a closed relative trajectory and alter the size of it by a single exchange.

The paper explores some of the optimization problems of this control approach. In particular, the problem of minimizing the mass flight time to stop the relative drift. This task corresponds to the situation when it is necessary to obtain a closed relative orbit as quick as possible. Another problem is to minimize the separation velocity to reach the closed orbit, which corresponds to the problem of energy saving. Finally, we consider minimization of the difference between the resulting and the desired relative trajectories. The solutions of these optimization problems are demonstrated on the particular examples.

The paper also studies the influence of the separation point and velocity defining errors on relative motion.

This work was supported by grants from RFBR 12-01-33045, 13-01-00665, 14-01-31313.