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Author: Prof. Teodor-Viorel Chelaru
University POLITEHNICA of Bucharest - Research Center for Aeronautics and Space, Romania,
teodor.chelaru@upb.ro

Prof. Sterian Danaila
University POLITEHNICA of Bucharest - Research Center for Aeronautics and Space, Romania,
sterian.danaila@upb.ro
Mr. Adrian Chelaru
Romania, adrian.chelaru1988@gmail.com

REACTION CONTROL SYSTEM USING HYBRID MICRO-THRUSTERS FOR GUIDED SPACE VEHICLES

Abstract

In this paper we intend to develop a calculus model for an innovative Reaction Control System (RCS) using hybrid rocket engine technology. Our RCS uses several hybrid micro-thrusters with their thrust modulated by a separate control system. For RCS, each of the thrusters will be able to burn a few minutes and its thrust will be modulated within certain limits by controlling the oxidizer flow. In order to reduce size and weight of the RCS we will use a single oxidizer tank which which will have as output a flow distributor. The basic idea is not to stop any of the engines during system's operation but to minimize their thrust reducing the oxidizer flow. This approach is avoiding the inconvenience of repeated stopping and starting of the engine, which can create reliability problems to the entire RCS. By creating thrust imbalance between various hybrid micro thrusters, one can create torques with which the attitude or the trajectory of the vehicle can be adjusted. A feedback loop will be implemented between the guidance navigation unit of the vehicle and the hybrid micro-thrusters. We envision a system of 6 micro-thrusters. The system will contain two circuits, one for the control system representing the control loop of the RCS and the second, the oxidizer circuits. At each of the thrusters, by distributor, the oxidizer flow is adjusted and the thrust is controlled. There are tree thrusts pairs, one for each rotation: yaw, pitch and roll. The thrusters of a pair are positioned back to back so that the nozzles are in very close planes in order to obtain a symmetric torque. The average thrust value of each micro-thruster can be adjusted by the size of the fuel grain, this being proportional to the burning surface area. Technologically speaking, the achievement of the RCS system in this functional concept is favoured by the subsystem symmetry, each micro-thruster having similar construction. In terms of calculation model developed, it starts from our theoretical and experimental studies, which aimed to build a computational model for hybrid rocket engine highlighting his controllability. These studies are based on our own experiments performed in Electromechanics Ploiesti. Based on this concept we achieve a calculation of the performances of the RCS and an evaluation in their size. Conclusions and any discussion will be focused on technological possibilities for achieving the system and possible areas of application for the RCS.