SPACEFLIGHT MECHANICS AND ASTRONAUTICS - EDITORIAL OF THE SPECIAL ISSUE

This issue of the Applied Mechanics section of the Romanian Journal of Technical Sciences is dedicated to Spaceflight Mechanics and Astronautics. With so many satellites in orbit today, there exists an increased need for accurate orbit prediction, as well as new space technologies, like the concept of formation flying. In the same time, the continuously increasing number of space debris objects that are currently orbiting in the vicinity of our planet and needs to be tracked makes the search for computationally efficient and accurate orbit prediction methods a priority.

The main challenges for accurate orbit prediction stem from the complex mathematical model of earth's gravity, as well as from the other perturbations is that influence the behavior of the satellites: atmospheric drag, solar radiation pressure, and for satellites flying in high orbits – the lunar attraction. The numerical treatment of the aforementioned factors, although accurate, requires very high computational capabilities, that are not very easily accessible. Therefore, more efficient methods need to be developed, both for orbit prediction as well as uncertainty estimations.

The papers that are published within this issue of the journal cover important topics in spaceflight mechanics:

The first paper of the series included within the current issue of the journal proposes a new solution to the main problem in artificial satellite theory, that is dealing with the motion of a satellite around an oblate planet. Unlike previous similar solutions, the one that is off does not excavate the critical inclination singularity that exists because of the truncation of the gravitational potential.

The second paper proposes the concept of fractional derivative to be used full the incorporation of a large number of perturbations into the mathematical model of a satellite's orbit. Through this method, combined with historical data on the past positions and velocities of a satellite, the authors claim a more accurate solution for the long term propagation of a satellite's orbit.

The third paper, entitled ”Quasi-optimal Deceleration Of Rotations Of A Gyrostat With Internal Degree Of Freedom In A Resistive Medium”, offers the mathematical model for the detumbling of an in-orbit satellite, by means of averaging techniques asymptotic methods. The case where there are loosely tighten objects inside the satellite is also taken into account.

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The fourth paper is entitled ”Foucault-like Properties In The Full - Body Relative Spacecraft Motion” and offers the complete solution to the mathematical problem describing this dynamical system. The problem is separated into an inertial motion with respect to a frame adequately chosen and the problem of computing an orthogonal tensor valued function from a Darboux-Riccati initial value problem.

The fifth paper describes the air-bearing testbed of spacecraft formations and its associated experiments. The control algorithms that are used dim the pre-launch testing of satellites are also presented. The experiments show that centimeter level and less than one degree level accuracy may be achieved. The system is able to test multi-spacecraft control algorithms within highly sophisticated mission scenarios.

The sixth paper presents the most general form of a natural intermediary potential is that may be used as an approximation in the main problem of artificial satellite theory. The paper opens the way to new perturbation theories and proves that all the historical intermediaries is that were proposed starting with the second half of the last century are particular cases off the proposed general intermediary.

The seventh paper, entitled ”Time optimal deorbiting of solar sails”, proposes the use of the solar radiation pressure orbital perturbation as a propulsive mean for optimal end of life disposal maneuvers. After formulating the necessary conditions for optimality, the numerical solution of the two-point boundary value problem is facilitated by averaging the Hamiltonian with respect to both satellite and Sun longitudes.

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