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DYNAMICS OF ORBITS FOR SPACE MISSIONS TAKING INTO ACCOUNT A DISTURBING BODY IN AN ELLIPTICAL-INCLINATED ORBIT: APPLICATIONS TO PLANETARY MOONS

Abstract

A classical subject of research in celestial mechanics is the study of the motion of celestial bodies under the influence of non Keplerian gravitational fields. In recent years this type of research has become important in planning future missions of spacecrafts that intend to visit planetary moons. Due to its special characteristics some planetary moons of Jupiter, Saturn and Neptune have been object of great interest among scientific community as potential bodies to receive the visit spacecrafts. Among them: Europa, Ganymede, Callisto, Enceladus, Titan and Triton. Space missions that intend orbit these and others bodies many times will require low-altitude orbits having high inclination (desired for a better coverage of the body's surface) for gravity and surface mapping. Such missions can be planned focusing to characterize these bodies, studying since the surface and until the atmosphere behaviour (in case of its existence), all thought to have significant bodies of liquid water beneath their surfaces, as potentially habitable environments. Thus, there is a great necessity for having a better comprehension of the dynamics of the orbits around these planetary moons. This comprehension is essential for the success of missions having this nature. In this context, this work aims to perform a search for low-altitude polar orbits around these bodies. The study considers orbits of a spacecraft around a planetary moons being perturbed by a third-body. Some applications also consider perturbations due to non-uniform distribution of mass (J2 and J3) of the planetary moon. A simplified dynamic model for these perturbations is used. The disturbing body is considered in an elliptical-inclinated orbit. The single-averaged method is used to obtain a new model for the third body perturbation which is explicitly dependent on the mean anomaly of the disturbing body. The Lagrange planetary equations, which compose a system of nonlinear differential equations, are used to describe the orbital motion of the spacecraft around a planetary moon, taking into account the planet of the system considered (Jupiter, Saturn or Neptune) as the disturbing body. The present work is an extension of some works in literature which are based in the theory presented in Prado (2003). Results presented here are obtained by performing numerical simulations to find near-circular polar orbits to be used in the studies concerning these and others planetary moons of the Solar System with applications in astrodynamics and aerospace engineering.