SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 1 (3A)

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OPTIMAL CONTROL OF SPACECRAFT DURING THE ASCENT OF MARS'ARTIFICIAL SATELLITE

Abstract

There is a necessity to increase the share of scientific equipment in the whole weight balance of a spacecraft due to the large scale of application tasks on exploration of solar systems planets. The substantial reserve for solving this problem is organization of spacecraft's movement along the energy-optimal trajectories. According to the practice using of all-propulsive scheme for orbit formation of Artificial Planet Satellite (for ex. ExoMars program) is supposed during the planning of space mission to solar system planets. At the same time the model providing preliminary aerodynamic braking of spacecraft in the atmosphere and its subsequent acceleration in the apocenter of intermediate orbit seems to provide considerable advantage in fuel consumption. The results of main spacecraft optimal control tasks solutions are listed in the work defining the principal possibility of the proposed scheme's effective realization: -maximization of spacecraft aerocapture passage; -minimization of required power inputs for orbit formation of Artificial Planet Satellite. The structure is defined of optimal two-parameter control of spacecraft by roll angle γ and attack angle α. It is shown that the maximum of upper limit for reentry corridor (hπ=max) is achieved during the movement of spacecraft with γ=1800 and α=α*, corresponding to the maximum of aerodynamic efficiency. The minimum of the lower limit (hπ =min) is provided at the change of attack angle from α* to α, corresponding to the maximum aerodynamic drag coefficient Cx max. At that γ=0. In case of power imputs minimization, the roll angle γ switches from γ=1800 to γ=0, and the attack angle changes from α* to α (Cxmax). At that, the switching period of γ and change intensity of depends considerably on conditional pericenter altitude h of entry path: the less hπ is, the earlier switches and strongly changes . It's shown that energy consumption ΔV for intended circularization depends considerably on relative pericenter altitude. Thus, if hπmax =30 km the value ΔV =145m/sec, and if hπmin = -20km the fuel consumption reaches 280m/sec, which makes it necessary to reentry close to upper corridor limit. On the whole, high efficiency of proposed injection sequence on the orbits of Artificial Planet Satellite using is shown for a high range of initial data. Thus, for formation of the orbit of Artificial Mars Satellite the advantage of required power inputs is equal to 50-100% in comparison with all-propulsive scheme.