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LANDING CAPSULE SOFT TOUCHDOWN DYNAMICS

Abstract

Landing process of a new generation vehicle landing capsule is the topic of research. The landing of the spacecraft on the ground is one of the crucial events of the mission. This spacecraft will be reusable, so special attention is paid to the final stage of the landing process. The necessity of damping high kinetic energy, which the landing capsule has at the first contact with the surface, is a peculiarity of the landing process. For this purpose the landing capsule is provided with a mechanical landing gear containing honeycomb-type damping elements. Orientation, physical and mechanical properties of soil may differ sufficiently due to the wide variety of the expected landing surfaces. It is necessary to deeply analyze the landing process to justify specific shape and landing gear characteristics. Such analysis may be done on the basis of mathematical simulation of landing using large amount of optimization calculations. The mathematical model of the landing process is a system of differential-algebraic equations, based on the theoretical mechanics methods. Landing capsule hull and its landing gear elements are represented by a system of bodies connected by specific joints. They reflect the design features of the landing gear supports. A semi-empirical model of the landing gear support interaction with the ground is developed. The loads in the points of body connection were obtained in the process of landing dynamics simulation. Optimum characteristics of damping elements were selected. The stability of motion, performance of landing gear and area of the initial conditions required for safe and successful completion of the mission were examined. This paper considers the selection criteria for optimal characteristics of the landing gear. The formulated approach could be used as a basis for solving tasks of the interconnected bodies systems. Soft landing is one of the most important technical challenges of astronautics. Nowadays this goal actively pursued.