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SIMULATION OF THE MARS-6 LANDER IMPACT

Abstract

The USSR launched Mars-6 spacecraft in 1973. The spacecraft consisted of a flyby bus and a descent module – a lander. The Mars-6 orbital station remained within the asteroid belt, while the lander, during its descent, managed to deploy the parachute and return to Earth data about the Martian atmosphere. However, with the lander about to fire its retrorockets, all contact was lost. Modern satellite photography makes it possible to find a place where the lander will fall. Mars-6 can be found with the MRO, U.S. satellite that takes images of the Martian surface with a 26 cm resolution. This is how in 2013, Vitali Egorov and his group of space enthusiasts found the Mars-3 lander at the bottom of the giant Ptolemaeus Crater. However, to make the group's work possible, it is necessary to have initial information about the possible surface damages marks pattern. Because the Mars-6 landing must have failed, the lander's components and the parachute may not be clearly seen even in a high-resolution satellite image. After high-velocity impact with the planet's surface, the lander could have produced a crater and rebounded far away from the surface. It is necessary to use modern physics-based numerical simulation methods to directly model the lander's impact with the planet's surface for further detailed impact analysis. The results will help determine the dimensions of the crater that could have been formed at impact at a given velocity, as well as the rebound distance on the initial impact with the planet's surface. Thus, with the values of these parameters at hand, we can reduce the satellite imagery search coverage and locate the lander on the planet's surface. This paper presents a solution to the Mars-6 lander hard landing problem. LS-DYNA solver, well known by its capabilities of high-speed nonlinear process simulation, was used for numerical model creation and analysis. The lander model is validated by a normal landing process simulation. The impact process was modeled using the Arbitrary Lagrangian-Eulerian method, which could describe large deformations and crater shape in Marian solid. The Martian soil is considered as a mixture of aeolian sands and rocks regolith. Multi-variant simulation for different impact angles and combinations of soil properties have been carried out. An area on the Mars surface has been found that is in good agreement with the results of numerical modeling. This area is proposed to be studied in more detail.