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Author: Mr. Yasuda Shun
Aoyama Gakuin University, Japan, yasuda.shun@ac.jaxa.jp

Mr. Tetsuya Kusumoto
The University of TOKYO, Graduate school, Japan, kusumoto.tetsuya@ac.jaxa.jp
Dr. Yoshiki Sugawara
Aoyama Gakuin University, Japan, sugawara@me.aoyama.ac.jp
Dr. Osamu Mori
Japan Aerospace Exploration Agency (JAXA), Japan, mori.osamu@jaxa.jp

BEHAVIOR ANALYSIS OF TARGET MARKER WITH SPIKES USING PARTICLE METHOD

Abstract

JAXA's Hayabusa and Hayabusa2 performed a sample return mission to collect rock samples from the asteroids. In order to touch down safely on the surface, it is necessary to know the relative velocity and position between the spacecraft and the landing site in advance. The vertical distance could be easily measured using an altimeter, but the horizontal distance was difficult to measure. Therefore, we dropped a target marker at the landing site in advance. The target marker is made of a spherical shell of aluminum alloy with four spikes on its surface, and contains many beads. After impacting on the asteroid surface, the beads dissipate energy by colliding with each other to suppress bouncing in the microgravity environment, and the surface spikes prevent rolling on the surface. However, the bounce behavior on the asteroid surface and the effect of spikes on the bounce behavior have not been investigated. The purpose of this study is to clarify the behavior of target markers with spikes on the surface of the spherical shell and multiple beads inside on the asteroid surface under microgravity environment. In order to clarify the bouncing behavior due to the structure of multiple beads inside the spherical shell, numerical analysis using the particle method was performed while changing each parameter. The behavior of the beads was different depending on the mass ratio between the spherical shell and the beads, the number of beads inside, and the initial position of the beads upon impact with the ground. The model with spikes in the spherical shell was subjected to numerical analysis such as Monte Carlo simulation. The results show that the presence of the spikes is effective in suppressing the horizontal movement of the spherical shells, and therefore, the spherical shells can be dropped accurately at the target location. In addition, experiments were conducted using a two-dimensional model in a simulated microgravity environment. In addition, experiments were conducted using a two-dimensional model in a simulated microgravity environment to verify the validity of the numerical results and to confirm the bouncing behavior. These results are expected to predict the bouncing behavior of the target marker when it is dropped and to predict the final resting position in future missions. The results of the investigation of the effects of each parameter will be used as a guideline for the design of target markers in the future.