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DESIGN OF SAMPLER AND PATH TO THE SAMPLE CONTAINER CONSIDERING MOTION ANALYSIS OF SAMPLE ON SMALL BODIES AND CELESTIAL BODIES

Abstract

Sampling mission of asteroids has been increased in recent years. This research covers the bullet sampling method. The bullet method is a method that shoots a bullet on the surface of the asteroid and collects the scattered sample. Particles that soar up by bullets reflect within the sampler horn and be delivered inside the sample container installed in the landing aircraft. In the previous researches, the shape of the sampling device (sampler horn) and the path to the sample container that satisfies the required sample collection amount is determined based on the sampling experiments of the substance simulating the gravel on the asteroid surface. The bullet method has been adopted in both Hayabusa and Hayabusa 2 missions. This method is also planned to be adopted in the solar power sail mission (OKEANOS) and other missions. In order to improve the sampling rate of the sampler and design a sampler which can be used for general purpose and can be applied in various scenes, it is necessary to analyze the sensitivity of many parameters such as particle type, size, shape, etc. of the sampling device. However, it is difficult to analyze all combinations experimentally, due to restrictions on human cost. Furthermore, most past sampling experiments have been conducted under 1G environment which is different from the actual environment. Numerical simulation can easily reproduce scales and various gravity environments that cannot be studied by experiments. Therefore, it is significant to investigate detailed conditions by numerical simulation. The simulation model is verified by experiment. As a numerical simulation method, Discrete Element Method (DEM) is used to evaluate the particle sampling rate by changing the shape of the sampler horn, samples path to the sample container, the coefficient of friction and restitution between the samples and the sampler. In order to be able to collect a certain amount of sample under various conditions, it is necessary to understand the movement of the particles in the sampler and to find the key parameters in designing the sampler. The aim of this study is to enhance sampler sampling performance by clarifying the relation between sampler horn shape, the path to the sample container and particles behavior. It is anticipated that the outcome of the present study will contribute to enhance sampler sampling performance and produce a guideline for the design of the sampler.