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Author: Mrs. Jia Wang
1Science and technology on aerospace flight dynamics laboratory, Beijing, China2Beijing aerospace control center, Beijing, China;, China

LUNAR SURFACE SAMPLING FEASIBILITY EVALUATION METHOD FOR CHANG'E-5 MISSION

Abstract

As China's first spacecraft that unmannedly carrying out lunar surface samples and returning to the earth, the Chang'E-5 detector is the most crucial probe which will complete lunar surface sampling and return missions in the third phase of the lunar exploration project of China. As one of the key tasks of the mission, lunar sampling is directly related to the success of the first lunar surface sampling return mission in China. The sampling decision needs to be made based on topography analysis results and characteristics of the exploring area. On account of the unknown extraterrestrial terrain environment and uncertainty of the sampling objects, we propose a sampling feasibility estimation approach for safely implementing lunar surface sampling. Considering the feature of lunar sampling process, we combined the three-dimensional topography of lunar surface with five parameters of the sampling area, flatness, slope, slope aspect, accessibility of the mechanical arm distal end, and safety of sampling condition, in order to generate the sampling feasibility results for the exploring area. The first three values are calculated based on a digital elevation model (DEM) of the landing area that generated using stereo images captured by the surveillance cameras. The last two values are computed based on the mechanical properties of the arm and kinematics analysis of the arm articulated joints. After receive all the quantitive parameters described above, we weigh them to obtain the final evaluation value of the sampling feasibility indicator for each pixel of the DEM. Meanwhile, a multichannel sampling area analysis graph is generated combined all the indicators above as well as the sampling feasibility values. A simulated lunar DEM images with resolution 5 mm/pixel is utilized to test our proposed method. For test purpose, we set the display range (e.g., from blue to red) of the sampling feasibility according to the principle that stones bigger than 4cm can not be adopted. Therefore the areas that are feasible are denoted in blue, the rest pixels are more red, more dangerous for sampling. Our strategy takes into account the influence of almost every possible factor that may interfere the sampling process, and provide quantitive assessment of the sampling feasibility for the exploring area. The generated multichannel graph provides and visualizes the scientists with significant reference information for determining the detection targets, which will be applicated in Chang'E-5 sampling return mission in very near feature.