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APPLICATION OF OPTICAL NAVIGATION IN CHANG'E-5T1 MISSION

Abstract

Chinese Chang'E-5T1 mission designed to test the lunar return technology has achieved a great success. The CE-5T1 spacecraft consists of service module and return module, which are joined together during the trans-lunar phase and free return phase until the separation at the height of about 5000km to the Earth surface.

The relative distance of these two modules after separation is determined by the separation speed. The reliable monitoring of the separation is crucial to the safety warning of the return module and the decision making in case of separation failure. However, the initial relative distance and speed are almost impossible to obtain in real time relying either on telemetry or ground tracking and orbit determination, since the telemetry can just supply the separation message and the accuracy of the ground tracking and orbit determination cannot satisfy the precision requirement at the height of 5000km.

Fortunately, the monitoring camera aboard the service module can be used to conduct the optical navigation. In this paper, the feasibility and strategy of this technique is studied for the separation phase based on true data. Firstly, the mission is sketched briefly, including the trajectory design and flight procedure. Then, the observation model is developed and the filtering algorithm is investigated. Next, the images of the monitoring camera are processed into binary images and the edges are detected using the canny method, from which the observation data is further acquired. In the end, the relative position and velocity are solved using the extended Kalman filter, and compared with the designed index. It is proved that the navigation method is effective for this mission and may benefit to the deep space exploration.