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POSITIONING TECHNOLOGY WITH MULTI-SOURCE INFORMATION INTEGRATED IN THE CHANG'E-3 LUNAR LANDING AND EXPLORATION

Abstract

The China's Chang'E-3 lunar probe that consists of the lander and the "Jade Rabbit" rover was successfully landed on the moon surface on December 14, 2013, which indicates the completion of the "landing" project in the second phase of Chinese lunar reconnaissance. One important mission of the Chang'E-3 probe is estimating the lander's position on the lunar surface and locating the navigation station that the rover reaches, which forms the prerequisite and foundation for the following lunar exploration of the rover. However, positioning with the dynamic statistical orbit determination or the same-beam interferometry measurement methods cannot meet the requirements of lunar travel and exploration for the limitation of finite precision. Therefore, novel methods, which integrate ranging and Very-long-baseline interferometry (VLBI) measurements, lunar digital elevation map (DEM), rover inertial navigation information and visual images to achieve the lander and the rover positioning tasks, are adopted in Chang'E-3 lunar exploration mission. This paper presents technical details, application characteristics and some primary experimental results of the positioning methods for lunar exploration of the Chang'E-3 lander and rover. In the lander positioning, ranging and VLBI measurements to the lander for a continuous arc are combined with precise knowledge about the motion of the moon to estimate the landing position, where the lunar DEM of Sinus Iridum is brought to constrain the calculation of elevation, which significantly improves the accuracy of positioning. The accurate position of the Chang'E-3 lander provides the basis for the holistic planning of lunar exploring missions. In the rover positioning, inertial navigation information is first used to roughly estimate the position of the rover in the current station, and then vision-based positioning method, taking the inaccurate result as an initial input, is used to calculate the rover position with a high accuracy. The high-accuracy positioning results guide the rover to approach and successfully get to scientific detection targets. As the space technology advances, the lander and rover positioning methods will be further developed and improved to satisfy new requirements emerged in the future planetary exploration.