Mars Exploration (3)
Mars Exploration (2) (2)

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LANDING SITE MAPPING FOR CHINA'S TIANWEN-1 MISSION

Abstract

Tianwen-1 spacecraft, China's first Mars exploration mission, was successfully launched from Wenchang Space Launch Center in Hainan province on July 23rd, 2020. As of January 3rd, 2021, the flight mileage of Tianwen-1 spacecraft has exceeded 400 million km. Subsequently, in early February, the Mars-braking will be implemented after it approaches Mars, and it will enter into the Mars circular orbit to prepare for the subsequent landing on Mars. It consists of a Mars orbiter and a landing rover to conduct a global and comprehensive exploration of Mars, and to carry out regional patrolling on the Mars surface, separately. China's Mars exploration mission has some new characteristics and difficulties. This paper describes the overall design framework of the teleoperation based on the design of "perception, detection, mobile" patrol detection cycle firstly. High precision mapping of landing site is critical for both safe navigation and achievement of the mission's science and engineering goals. Then, we introduces the landing site mapping method based on multi-source data at different scales and on different turnaround times using orbital, descent and rover images. The orbital images, including CTX images, medium resolution camera and high resolution camera on the mars orbiter. To support landing site analysis and characterization long before the launching, we produced a 5 m/pixel seamless DOM mosaic of the predefined area (approximately 40 km*100 km) using CTX images acquired before 2020 based on a developed two-stage method. After orbiting but before landing, we expect to product several more DOMs with higher accuracy using high resolution camera images, and its resolution is better than meter lever. Similar to that of CE-3, CE-4 and CE-5, some imaging devices of the landing rover will be turned on during the EDL process. Among them, GNC optical sensor and the Covered Wifi camera are downward-looking aim to the Mars surface. Using the two kinds of data, we can product DOM with higher accuracy for medium and long-term planning after landing. After landing, local DEMs and DOMs with 0.02 m/pixel will be produced routinely at each waypoints along the rover traverse. In addition, we have developed automated bundle adjustment and 3D wide baseline mapping techniques, and tested by the Yutu-2 Rover. Experimental results demonstrate the effectiveness of the proposed techniques and verify that the mapping capability of rover can be extended from tens of meters to hundreds of meters.