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NAVIGATION LANDMARK MATCHING FOR PLANETARY LANDING BASED ON CONTOUR POINT SETS

Abstract

The matching of terrain landmarks on the planetary surface is one of the key technologies for autonomous optical navigation. Navigation landmark matching is a bridge connecting the database map and the landing image, thereby linking navigation landmark detection and spacecraft pose estimation. As an important way to obtain the 3-D position of landmarks, the landmark matching provides correct information for the attitude and position estimation algorithm to ensure the navigation accuracy. Natural terrain features such as craters, rocks, ravines and steep slopes are widely existed on the planetary surface, and become important matching objects due to the obvious optical characteristics under lighting conditions. Aiming at the problem that current matching methods only take the crater as the single matching target and area-ratio based methods have a low matching rate, the purpose of this paper is to minimize the similarity distance of landmark contour point sets and the deviation distance of navigation landmark centers in two images, and then autonomously search and match the corresponding navigation landmarks.

In this paper, assuming that the landing image and the database image are approximately affine transformation, the proposed matching method includes the following steps: Firstly, by detecting and fitting the contours of different landmarks in two images, the similarity of landmark contour points in the two images is calculated. Secondly, the homography transformation matrix is obtained to calculate the affine transformation coordinates of landmark centers in the database image, and the deviation distance between the affine transformation coordinates and detected center coordinates of the navigation landmarks in the database image is calculated. Subsequently, considering the similarity of the contour point sets and the center deviation distance, the matching distance matrix is constructed. Finally, navigation landmarks with the smallest matching distance are searched as the matched landmark.

Simulations based on images photographed at different angles from the laboratory planetary surface sand table show that, compared with the matching method via the area ratio similarity, the contour point set contains more shape information of the landmark, and has a better effect on the evaluation of curve similarity, which contributes to a higher matching rate of navigation landmarks. In addition, the proposed method in this paper can be applied to a wider range of matching objects, such as craters and rocks in optical images.