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# PLANET CENTROID EXTRACTION ALGORITHM FOR APPROACH PHASE WITH SUB-PIXEL ACCURACY BASED ON DSP

**Abstract**

The planetary approach is one of the most important phases of deep space exploration, and its navigation accuracy determines the success of orbit, descent and landing missions. Autonomous optical navigation is commonly used for the approach phase due to its strong autonomy, low cost, and high accuracy. The high-precision centroid extraction method is very important because the extraction accuracy affects the estimation accuracy of the autonomous optical navigation. In addition, with the rapid development of the high-resolution camera, the image size is larger. Image processing algorithms are difficult to meet the requirements of real-time and high-precision, so it is necessary to develop image processing algorithms that can be applied in spaceborne hardware systems, especially DSP. For the above problems, a DSP-based high-precision centroid extraction method is proposed. The semi-Physical simulation platform is designed, including a target simulator, optical camera, and DSP. According to the imaging characteristics of the target, the approach phase is divided into two phases, far and near. For the long-distance approach, the target is a light spot, and a sub-pixel centroid extraction method is proposed. First, threshold segmentation is used to separate the target from the background, and then the region centroid extraction method is used to achieve preliminary centroid extraction. Finally, a sub-pixel correction method is performed based on gray value and image gradient to obtain a more accurate centroid position. For close proximity, the target is a two-dimensional projection graphic. An ellipse fitting method based on pseudo-edge removal is proposed to realize centroid extraction. First, the adaptive edge detection method is used to extract the edge of the target. Then the pseudo-edge is detected and removed by calculating the angle between the sun direction and the edge gradient direction. Finally, the ellipse fitting algorithm is used for the real edge fitting to achieve accurate centroid extraction. To verify the feasibility and effectiveness of the proposed algorithm, this paper takes Mars as an example to perform a semi-physical simulation. The results illustrate that the preliminary extraction accuracy of the light spot is better than 0.7 pixels, and the extraction accuracy is better than 0.4 pixels after sub-pixel correction. The accuracy is improved by about 40 percent, proving the effectiveness of the proposed sub-pixel correction algorithm. The Mars centroid extraction accuracy for close proximity is better than 0.7 pixels, meeting the accuracy requirements for autonomous navigation information recognition for the approach phase of deep space exploration.