The robust spacecraft location estimation algorithm toward the misdetection crater and the undetected crater in SLIM

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The paper propose the spacecraft location estimation method the crater data detected from a camera shot image towards the SLIM (Smart Lander for Investigating Moon) mission [1] proposed by JAXA. In the conventional planetary landing, a spacecraft generally requires the large landing are without obstacles to land a safe area "where is easy to land". This means conventional approach is difficult to land at the area which is very close to an exploration target because of decreasing the safe area. To overcome this problem, JAXA forces on the pinpoint landing on moon and aims at establishing the method of landing at pinpoint area "where is desired to land" in the SLIM mission. To achieve this goal, it is indispensable for a spacecraft to estimate its current location in real time. One of approaches for such location estimation is done by matching (a) the crater map created beforehand from the camera shot image taken from "KAGUYA" (SELENE) satellite launched by JAXA with; (b) the craters detected from a camera shot image over the moon from the spacecraft. For this purpose, our previous research proposed the ETSM (Evolutionary Triangle Similarity Matching) method [2] which searches the current location through match of the crater map with the craters on the camera shot image.
The algorithm of this method use GA (Genetic Algorithm) [3] to search extensive area and search similar triangles between crater map and camera shot image. This method is also robust the shift of the crater between crater map and camera shot image. However, if the percentage of misdetection crater which is detected in camera shot image but not detected in crater map and undetected crater which is detected in crater map but not detected in camera shot image is high, the estimate accuracy of this method is affected.
To tackle this problem, we propose the TSM (Triangle Similarity Matching) method base on the ETSM method. Firstly, this method searches a similar triangle of camera shot image from crater map. Secondly, this method forms triangles of craters based on the similar triangle between crater map and camera shot image. Finally, this method checks the relative relationship of similar triangles. This method ends the search when similar triangles that relative relationship also matches are found and estimates the place that there are these triangles of crater map as the spacecraft estimation location. This method searches from a place close to the location of GNC information.
To investigate an effectiveness of the TSM method, we conducted the experiments in 1000 different camera shot image with the ETSM method and the TSM method. And we also conducted the experiments in various cases (*i.e.*, Roll, Pitch, Yow and altitude are different). From the experimental results, we have revealed that the TSM method can achieve a high estimation accuracy in various cases.

References

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