AUTOMATIC BAND MATCHING FOR BEIJING-1 MICRO-SATELLITE MULTI-SPECTRAL IMAGES

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INTRODUCTION

Beijing-1 micro-satellite is an international cooperated EO project, which has been handed over to China after the on-orbit test period. This satellite carries Multi-spectral (MS) imaging camera which has 32 meters Ground Sampling. There are three wave bands, the visible light green wave band (520 ~ 620nm), visible light red wave band (630 ~ 690nm) and near-infrared wave band (760 ~ 900nm). Each wave band has two MS imaging cameras with 600 kilometers swath width individually. As each camera is an independent imaging system, the complete matching between different bands can not be gained only depending upon optics technology. Actually the MS data transferred from satellite gives such outstanding mismatching, which cannot be ignored.

In this paper, we use automatic image registration to solve the problem mentioned above. Image registration is the process by which we determine a transformation that provides the most accurate match between two images. In traditional method for image registration, choosing control points between reference image and destination image should to be done by hand. Such method is time-consuming and tedious. Such operation also brings low efficiency and speed, which can not fit the fast processing, especially for the large scale down-link image data. In this paper we introduce an automatic registration algorithm, which uses MI (Mutual Information), GA (Genetic Algorithm) and MQ (MultiQuadric) methods. It is important for high accurate matching of wave bands to reach the level of sub-pixel, which can be brought out by the way of automatic image registration.

MI has recently been used as a similarity measure for image registration because of its generality and high accuracy. The mutual information between two variables is a concept with root in information theory and essentially measures the amount of information that one variable contains another. As a similarity measure, it has a number of advantages. In particular, it assumes no prior function relationship between the images. Rather, it assumes a statistical relationship that can be captured by analyzing the images' joint entropy. Mutual information is closely related to joint entropy.

MQ method is a radial basis function. Its present functional forms are flexible and may be modified quite easily to further adapt to local distortions. It includes a tension-like parameter which can be used to adjust its behavior relative to local distortions. The principal shortcoming of the MQ method is the quite intensive computation; fortunately it can be overcome by our parallel computation system used in Beijing-1 Ground Preprocessing System. From the tests with Beijing-1 MS images, the MQ method has produced lower residual errors than polynomial methods.

Finally, we design a special registration algorithm. Firstly, select one of three MS bands, generally the near-infrared wave band, as the reference image, while taking another band as destination image. Secondly, choose certain control points on the reference image averagely and then take each control point as the seed spot to choose certain size match window on both of the reference image and the input image. Next, take the MI as matching basis, and automatically search control points in corresponding windows. After the control points selected, we use the MQ method to adjust the input image.

In order to enhance the registration efficiency, we search the control points not computing all of the values of MI about each pair match windows, but using the Genetic Algorithm to seek the maximum value of the MI. Using Genetic Algorithm to seek the maximum value of the MI has a number of advantages. In particular, it can seek the maximum value rapidly and accurately.

We take the down-link data from Beijing-1 as examples to check the work of the above registration. The size of Beijing-1 MS images is more than 50000 lines and 10000 pixels. The tested areas includes mountain, Urban areas, plain, snow-covered area and sea. In some areas, the accuracy of choosing control points is high. But in some special places, such as desert areas、()marine areas or large clouds areas, the accuracy of control points will decline. In order to improve the accuracy of geometric correction, we use curve fitting function to get rid of the control points which bring large errors. The results have shown that the entire matching accuracy is less than a pixel.

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