MULTI-IMAGE SPACE RESECTION BASED GEOMETRIC CALIBRATION FOR FOUR BANDS CCD CAMERA

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Abstract:

High altitude photographic work such as Aerial photogrammetry and UAV photography has very high demands on geometric optical parameters of the CCD camera, one millimeter or one pixel error of geometric optical parameters tends to cause a few meters or even dozens of meters error on the ground, so the camera's high-precision geometric optical parameters calibration is a crucial step for data geometry process after aerial photogrammetry. Four-band CCD camera is a multi-spectral aerial array camera developed by the Institute of Remote Sensing Applications, Chinese Academy of Sciences. In this paper, we introduced the geometric calibration theory and experiment with the Four-band CCD camera. The result of calibration was validated by two methods.

Geometric optical parameters mainly include the principal distance, the principal point offset, and distortion parameters. There are many calibration methods, and some of them need few control points, such as Self-Calibration, Calibration based on Vanishing Point, etc. But most methods need control points. Because the accuracy is not good enough without control points even the algorithm is the best. In order to meet the high-precision measurement of geometric optical parameters for aerial photography, this paper is based on three-dimensional control calibration field of camera calibration method.

The camera calibration was carried out in Close-Range Photogrammetric laboratory of Wuhan University, using Four-band CCD camera take photos at different locations in Three-dimensional Control Calibration Field. And then, get the 3D coordinates of every

control point in the photos from the database of all the control points. This procedure was done in a semiautomatic software.

In this paper, we acquired the initial value of inner orientation elements (the main distance and principal point offset) and the exterior orientation elements (three elements in a straight-line and three angles elements) by DLT method. And then use single-image space resection and multi-image space resection methods to get the geometric optical parameters of camera, and conclude a collusions that multi-image space resection is more superior than single-image space resection.

For the validation, two methods were tried: 1) retrieve the pixel coordinates from the camera geometric parameters and control point's spatial coordinates. And then get the error value of between the result and the real pixel coordinate; 2) using the Space Forward Intersection method, calculate the spatial coordinate from pixel coordinate of the points which is new and never joint any calculation before, then, get the Mean Square Error of spatial coordinates. After these two validations, multi-image space resection has been proofed to be a more reliable CCD camera calibration method, and it can achieve very high accuracy.

Keyword：Camera Geometric Calibration, Multi-Image Space Resection, CCD Camera, Space Forward Intersection

References:

[1] Desong Ma, Zhengyou Zhang. "Computer Vision". Science Press. Beijing. 1998.

[2] Wenhan Xie. "Multi-image Vanish Points Based Camera Calibration Method Research". Wuhan Univ. 2004.

[3] Wenhao Feng. "Close Range Photogrammetry". Wuhan Univ. Press. 2002.

[4] Dong Wang, Wenhao Feng. "CCD camera calibration based on space resection with multi-image". SCIENCE OF SURVEYING AND MAPPING. 2006，31（4）：64-66.