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Evaluation of Control Points' Distribution on Distortions and Geometric Transformations for Aerial Images Rectification

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Abstract

Geometric distortions are inevitable in aerial images. A raw uncalibrated aerial image acquired from a non-metric digital camera which carried by an aircraft normally has lens and perspective distortions and could not be used directly without undergoing image rectification. Ground control points (GCPs) are important features used in non-parametric approach for aerial image rectification. Although the importance of GCPs in rectifying remote sensing images has been highlighted, not many recent studies research on the quality selection of GCP, effectiveness of GCPs' distribution and sufficient quantity of GCPs. A simulation test is conducted using grid images to examine the effect of different distribution patterns of control points on distortions and geometric transformations. The rectification results are measured by using the total root mean square error (RMSE). It shows that lower order global transformation has limitation in rectifying images with complex distortions. It also demonstrates that centre distribution gives the lowest total RMSE and its total RMSE is extremely low. However, the distance analysis of control points which reflects the distortion rate before rectification shows that control points distributed at the centre of the image is actually much less distorted than control points that are placed at border and corner. Hence, uniform distribution provides better distribution of control points with the consideration of overall deformation rates at the entire image for rectification.

Keywords: Aerial image; geometric distortion; image rectification; ground control point.

1. Introduction

Aerial images provide visual record to assist human in various tasks such as generating digital map, monitoring crop growth and ecology. Aerial images are helpful especially in the regions where the cloudiness hinders optical satellite imaging because aerial images can be acquired at lower altitude under the clouds [1]. With the development of digital technology, the study of uncalibrated aerial images acquired from a non-metric digital camera has become an active research nowadays. A non-metric digital camera refers to the consumer type of digital camera that is not designed for mapping purpose [2]. The potential of consumer digital camera as the aerial image acquisition tool has been showed and reported by many researchers [3-6].

Geometric distortions are inevitable in aerial images caused by different sources. Geometric distortions are more seriously found in aerial images than satellite images [7] due to the stability of the two platforms and their height relation to the distance from the Earth [8]. Therefore, a raw uncalibrated aerial image could not be used directly and image rectification is necessary as a pre-processing step in order to extract accurate information from the images.

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