Aerial Images Rectification Using Non-parametric Approach

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***Abstract*—Geometric distortions caused by different sources usually are accumulated and not present singly in a remotely sensed image. In addition, the effects of geometric distortions are found unequally in the entire image. Hence, aerial images should be rectified before proceed with subsequent images analysis. Control points and geometric transformation are the essential components in non-parametric approach. Barrel and perspective distortions are usually found in aerial images. This paper studies the deformation rate contributed by control points at different regions in an image before rectification according to different distribution patterns. Besides, this paper also discusses the appropriate geometric transformation through the concern of the expected distortions. Experiments are conducted using grid images and aerial images to investigate the effect of distributions of control points and the efficiency of global and local geometric transformations for aerial images rectification. It demonstrated that control points at different image regions have different deformation rates, control points distributed at image centre are less distorted and local transformation performs better in rectifying images with complex distortions.**

Keywords-aerial image rectification; geometric distortions; non-parametric approach; control points distribution; geometric transformations

I. Introduction

Aerial images are acquired using a camera attached vertically to an aircraft. As one of the major platforms in capturing remote sensing images, aircraft-based system normally operate at flying height of 200m to 15,000m [1]. Aerial images are ideal for mapping small areas and easier to adapt according to specific needs. For example, the level of image details could be improved by adjusting the flying height of the aircraft and weather conditions, and the types of data captured could be controlled with changeable or multiple cameras [2]. Aerial images which provide closer look to the areas of interest are widely used in generating digital map, monitoring crop growth and managing ecology. However, like other remotely sensed images, aerial images contain geometric distortions.

Geometric distortions are one of the common types of error encountered in remotely sensed images [3]. Geometric distortions are caused by different sources such as camera lens, earth curvature, topographic relief and attitude inconsistencies the aircraft [4]. Various studies on geometric distortions have been carried out. Jensen [3] presented the analysis of individual effect on an image based on different sources of geometric distortions. Zhao et al. [5] investigated the effect of image distortions caused by camera incline in multi-format aerial digital camera. They calculated the ratio of ground sampled distance change in image derived in the study based on single camera tilts in one direction with 15, 18 and 20 degrees. Yang et al. [6] analyzed the flight height and attitude of aircraft to propose real-time rectification. They claimed that the imaging area would be changed with the changing of the aircraft height and attitude. Xiang and Thian [7] discussed the impact of radial and tangential distortion model. They found that points at the corners of the image are displaced by as much as 100 pixels for 8 mm lens and 160 pixels for 4.5 mm lens used in their test.

Geometric distortions usually are accumulated and not present singly in an image. Geometric distortions composited in aerial images lead to deformation between the aerial images and the true environment. The relative position of objects in the scene would be affected [8] and the quality of the data collected would be degraded due to distortions [3]. Furthermore, the effects of geometric distortions are found unequally in the entire image [9]. Such ambiguous occurrence of distortions forms a higher complexity of deformation to the images. Hence, aerial images which are naturally distorted should be rectified before proceed with subsequent images analysis.

This paper studies the rectification of aerial images based on non-parametric approach. In the study, experiments are carried out firstly using simulated data of grid images with imitated distortions as a pilot study. The impact of different distributions of control points and geometric transformations in handling the imitated distortions are examined using the simulated data. Then, further testing is proceeded with real aerial images. This paper attempts to investigate the distribution of control points and the appropriateness of geometric transformation for aerial images rectification through the consideration of expected distortions.

This paper is organized with five sections. The background of image rectification is presented in Section II. In Section III, aerial images rectification using non-parametric approach is discussed. The experiments conducted in the study by using grid images and aerial mages are explained in Section IV. In Section V, experimental results are shown to compare the rectification rate. The conclusions of this study are summarized in Section VI.