Notice of University Oral Examination

Geodesy and Geomatics Engineering

Doctor of Philosophy

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Head Hall – Room E-11 @ 3:00 pm

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TECHNICAL DEVELOPMENT FOR AUTOMATIC AERIAL TRIANGULATION OF HIGH RESOLUTION SATELLITE IMAGERY

ABSTRACT

Because they contain abundant spatial information, high resolution satellite images are widely used in a variety of applications. Aerial triangulation is one of the most important technologies to obtain accurate spatial information from those images. Thus aerial triangulation is always an important research topic in the photogrammetric community and automatic aerial triangulation is a common goal of such PhD research activities. To date, many techniques have been developed to improve the efficiency and accuracy of aerial triangulation. However, for processing high resolution satellite images, automatic aerial triangulation still faces many challenges, including tie point extraction and sensor model refinement. The purpose of this research is to develop and test new tie point extraction, sensor model refinement and bundle block adjustment methods for improving the automation and accuracy of aerial triangulation.

The accuracy of tie points directly determines the success of aerial triangulation. Generally both the corner point and the gravity center point of a rectangular or circular object can be used as tie points, but the resulting outcomes can vary greatly in aerial triangulation. However, this difference has not drawn much attention from researchers yet. Thus, most of the tie point extraction algorithms only extract various corners. In order to quantify the difference between corner and center tie points for image registration, this research analyzed the error introduced by using corner or center tie points in different cases. Through quantitative analysis and experiments, the author reached the conclusion that the 'center' points, when used as tie points, can improve the accuracy of image registration by at least 40 percent over that for the 'corner' points.

Extracting a large number of tie points is the prerequisite of automatic aerial triangulation. Interest point matching can extract tie points automatically. To date numerous interest point matching algorithms have been investigated. Those algorithms can be grouped into two categories: area based and feature based. However, both area based and feature based algorithms share a common limitation: ambiguity in a homogeneous area. Neither of the methods could efficiently extract tie points from the low texture area. In this research, a robust interest point matching algorithm has been developed. This algorithm incorporates spatial information through constructing a control network from 'super' interest points. Experiments show that the proposed algorithm almost solved the ambiguity problem in a "poorly textured" area.

Sensor model refinement is the core of aerial triangulation. The challenge is the use of the Rational Polynomial Camera (RPC) model in some high resolution satellites, such as IKONOS and QuickBird. Although some direct methods and indirect methods have been investigated, they either require excessive information concerning the RPC which is unavailable to the public (direct methods), or has rigorous conditions which seriously limits its applications (indirect methods). In this research, a generic method was developed for RPC refinement. The proposed method does not need any information about the RPC itself, and is not restrained by any conditions. Theoretically, the proposed generic method can be used in any kind of camera in which RPC is used as a sensor model.

Based on the proposed generic method for RPC refinement, a robust bundle block adjustment model is developed. This bundle block adjustment algorithm can efficiently process the high resolution satellite images and can reach sub-pixel accuracy in image space and sub-meter accuracy in object space. Experiments were conducted to verify this application.

Faculty Members and Graduate Students are invited to attend this presentation