Building Corner Feature Extraction Based on Fusion Technique with Airborne LiDAR Data and Aerial Imagery

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Abstract

Generally, automatic building corner or linear feature extraction from urban area aerial imagery is based on traditional computer vision corner or edge detection techniques. However, challenges and difficulties remained due to the complex characteristic of objects in urban images. Visually, the linear features in airborne LiDAR are much more distinct than those in aerial imagery, however, common criticisms arising from the low horizontal accuracy of LiDAR data. To overcome these difficulties, this study proposes a building corner extraction algorithm based on information fusion technology by integrating aerial imagery and airborne LiDAR data. According to experiment results, the proposed method can obtain the distinct building corners not only with the characteristics of uniform spatial distributed pattern based on Voronoi graph theory, but also with the shape, length, and height constrained conditions derived from LiDAR linear features. The proposed algorithm resolves the heterogeneous remote sensing data registration difficulties between LiDAR data and raw aerial imagery.

1. Introduction

Recently, airborne Light Detection And Ranging (LiDAR) is a operationally mature remote-sensing technique that integrates a laser scanner, an inertial measurement unit (IMU), and global positioning system (GPS) devices into a single instrument mounted on an aircraft to rapidly acquire precise digital surface models (DSMs). The new development tendency of LiDAR system is to integrate with aerial digital camera as well to acquired aerial imagery with direct exterior orientation parameters. The advantage of LiDAR data is the up to 1dm accuracy in height, however, suffering from the lower horizontal spatial resolution than aerial imagery resulted from low horizontal scan intervals. On the contrary, the aerial imagery has very high spatial resolution but the elevation data produced by stereo pairs only has 60-70cm vertical accuracy. How to fuse these two complementary data to overcome their own disadvantages is a research hot spot in the application of remote sensing technology. The fusion of LiDAR data and aerial imagery can be treating as an image registration on heterogeneous remote sensing data.

There are two essential steps for the traditional photogrammetry image registration based on computer vision techniques: registration control points (RCPs) selection and coordinate transformation based on the chosen mapping function. The second step is straightforward; however, many previous researches on the first step still have many limitations [1]. For a successful image registration, there are some essential factors for the selected RCPs: the uniformly distribution pattern, the high accuracy, and sufficient number of points. Grid based selection algorithm is an algorithm to regularly divide the image into a set of uniform blocks according to the number of required control points and to search interest of points for each individual block. This is an easy implement and popular method. However, due to the random characteristic of image contents, it is not easy to acquire uniformly distributed control points which is the major problem for this method. Nevertheless, it is still adapted by many famous commercial remote sensing tools in the market, such as ENVI, PCI, and ERDAS as the RCPs selection algorithm for their image registration function [2, 3].

Even though, for the traditional image matching task, it is not necessary to consider the characteristics of extracted objects to be as the control points. In a true ortho photogrammetry application, it is necessary to extract not only the linear feature of buildings but also the height of the buildings. Although, there are various algorithms to detect linear features from aerial imagery, however, due to the buildings is very complex in built up urban high resolution aerial imagery, the extracted building boundaries still need...