3D Change Detection Based on Stereo Information of Satellite Images

Abstract

This PhD research is focused on urban change detection using very high resolution (VHR) imagery acquired by different sensors (i.e. airborne and satellite sensors) and different view angles. Thanks to high amount of details provided in VHR images, urban change detection is made possible. On the other hand, due to the complicated structure of 3D urban environments when projected into the 2D image spaces, detection of changes becomes sophisticated.
In general, change detection is divided into two major steps:

1- Establishment of a relation between bi-temporal images so that the corresponding pixels/segment are related; this is called co-registration

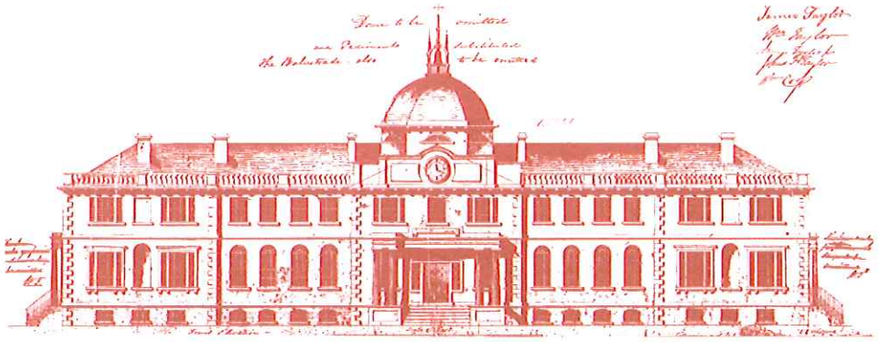
2- Comparison of the spectral properties of the co-registered pixels/segment in the bi-temporal images in order to detect changes

As far as Step 1 is concerned, establishment of an accurate global co-registration between bi-temporal images acquired by the different sensors is not possible in urban environments due to different geometric distortions in the imagery. Therefore, the majority of studies in this field avoid using multi-sensor and multi-view angle images.
In this study, a novel co-registration method called "patch-wise co-registration" is proposed to address this problem. This method integrates the sensor model parameters into the co-registration process to relate the corresponding pixels and, by extension, the segments (patches).

In Step 2, the brightness values of the matching pixels/segments are compared in order to detect changes. Thus, variations in the brightness values of the pixels/segments identify the changes. However, there are other factors that cause variations in the brightness values of the patches. One of them is the difference of the solar illumination angles in the bi-temporal images. In urban environment, the shape of the objects such as steeple houses cause difference in the solar illumination angle resulting in difference in the brightness values of the associated pixels. This effect is corrected using irradiance topographic correction methods. Finally, the corrected irradiance of the co-registered patches is compared to detect changes using Multivariate Alteration Detection (MAD) transform.

Generally, in the last stage of change detection process, "from-to" information is produced by checking the classification labels of the pixels/segments (patches). In this study, a fuzzy rule-based image classification methodology is proposed to improve the classification results, compared to the crisp thresholds, and accordingly increase the change detection accuracy.

The outputs of this research provide an opportunity to utilize the huge amount of archived VHR imagery for automatic and semi-automatic change detection.



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UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Shabnam Jabari

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

Ph.D. Candidate

Shabnam Jabari

Graduate Academic Unit

Geodesy & Geomatics Engineering

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June 24, 2015

1:00 p.m.

Head Hall
Room E-13

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Examining Board:
Dr. Yun Zhang (Geodesy & Geomatics Eng.) — Supervisor
Dr. David Coleman (Geodesy & Geomatics Eng.)
Dr. Emmanuel Stefanakis (Geodesy & Geomatics Eng.)
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BIOGRAPHY

Universities attended (with dates & degrees obtained)

2011-2015	PhD candidate, University of New Brunswick
2006-2009	MSc (Remote Sensing & Photogrammetry), University of Tehran
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Publications

Published Articles:

Shabnam Jabari, Yun Zhang, Alaeldin Suliman, (2014) Stereo-Based Building Detection In Very High Resolution Satellite Imagery Using IHS Color System, IGARS conference 2014

Shabnam Jabari, Yun Zhang, (2014) Building detection in Very High Resolution Satellite Image using IHS model, ASPRS conference 2014

Shabnam Jabari, Yun Zhang, (2014) Stereo Based Very High Resolution Satellite Image Classification using RPCs, ASPRS conference 2014

Shabnam Jabari, Yun Zhang, (2013) Very High Resolution Satellite Image Classification Using Fuzzy Rule-Based System, Algorithms journal

Shabnam Jabari, Yun Zhang, (2011) Implementation of fuzzy logic in canny edge detection method, 32ND symposium on remote sensing, Sherbrook, Canada

Shabnam Jabari, Mohammad Reza Saradjian, (2008) Affected Area Detection Using Intelligent Algorithms and IRS Images, Disaster Management Conference, The University of Tehran

Shabnam Jabari, Mohammad Reza Saradjian, (2008) Fuzzy Combination of Image Algebra Change Detection and Fuzzy Post Classification Comparison, 2008, mapasia2008 Conference, Kuala Lumpur, Malaysia

Shabnam Jabari, Mohammad Reza Saradjian, (2008) Fuzzy Road Tracking in Satellite images with Kalman Filtering, ISG2008 Conference, Kuala Lumpur, Malaysia

Shabnam Jabari, Comparison of Classification of Satellite images with Neural Networks and Neuro-Fuzzy Systems, (2008), Geomatics Conference 87, National Cartographic Center, Tehran, Iran

Manuchehr Shirzaie, **Shabnam Jabari**, Mahmood Zolfaghari, (2003) Correction of Cycle Slip in GPS Observations Using Wavelet Transformation and Polynomials, 10th conference of Civil Engineering, Tehran

Submitted Articles:

Shabnam Jabari and Yun Zhang, (2015) RPC-Based Co-Registration of VHR Imagery for Urban Change Detection, Journal of Photogrammetric Engineering & Remote Sensing (under review)

Shabnam Jabari and Yun Zhang, (2015) Using Off-Nadir Satellite and Airborne Imagery for Urban Change Detection, ISPRS journal of remote sensing (under review)

Shabnam Jabari and Yun Zhang, (2015) Building Change Detection Using Topographic Correction Models, IEEE Transaction on Geoscience and Remote Sensing (under review).