RapidEye Change Detection Services

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RapidEye Change Detection Services

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Change Detection Core Issues

- Change detection is a statistical analysis term often applied to digital signal processing.

- In remote sensing it is difficult to speak only of change detection.

- Many remote sensing projects detect and analyze changes but under different titles.
Change Detection Core Issues

Change detection applications under different designations

- Monitoring Crop Health
- Logging Monitoring
- Pipeline Monitoring
Change Detection Core Issues

- Raw Change Detection maps do not have much value for non-mapping commercial enterprises
- Has little added value for mapping/GIS companies
- End users need ready and interpreted information
- The “Analysis” part is often unique for every application
Change Detection Core Issues

Misrata Port
2010-05-29

Misrata Port
2011-09-14

Automatic Change Detection
MAD + Threshold 0.95
Change Detection Core Issues

- Raw Change Pixels
- Water masked out
- Small objects (< 10 pixels) sieved out
Assessment of War Impact

Port Gasr Ahmed
Misrata, Libya

Vessels before war
Vessels after war
Structural damages
Change Detection Core Issues

- From Change Detection to War Impact assessment is a long path to travel
- Analysis of “port damage” different than “airport damage”, “oil refinery”, “residential damage” etc.
- The question of Auto analysis versus Human interpreter? Or combined?
Change Detection Core Issues

- Find a robust change detection application
- Is the data resolution good enough to detect the changes?
- Is there a market?
- Is the service profitable? For the service provider as well as the client?
- Technical interface integration between service provider and user
Main change detection methods:

- Image Difference / Ratio
- Change Vector Analysis (CVA)
- Principal Component Analysis (PCA)
- Multivariate Alteration Detection (MAD)
- Post Classification Change Detection (PCCD)
Image Differencing / Ratioing

- Usually performed on Vegetation Indices
- Pros:
  Simple / Can fix viewing geometry problems
- Cons:
  Absolute values need calibration / Variable score for same change magnitude (20/40 = 0.5 ; 40/20 = 2)
Methods

Change Vector Analysis

In n-dimensional spectral space, determine length and direction of vector between Date 1 and Date 2

Direction and Magnitude of Change can be interpreted
Multivariate Alteration Detection:

- MAD is based on a canonical correlation analysis
- The changes detected are invariant to
  1) changes in gain and offset of measuring device
  2) linear data calibration schemes and atmospheric corrections
  3) orthogonal or principal component transformations
- Inverse gamma function converts Chi2 distribution to Probabilities 0 to 1
- Shown to be better than PCA (A Nielsen 1998)
Thresholding

- Always risk of under/over inclusion of changes
- Binary Thresholding takes an upper and lower threshold
- Hysteresis Thresholding spatially connects the weak change pixels to strong changes
Hysteresis demo

Single threshold $T > 0.7$

Stong change $T > 0.9$ (green)
Weak change $T > 0.7$ AND $T < 0.9$

First iteration results
Final result (2 iterations)
End user is an Energy company

Goal is to detect urban encroachment around the water reservoirs

Total Area approx 12,500 SqKm

Four times per year
Change Detection Service at RapidEye

System Components:

- Image Acquisition and Management System
- Preprocessing:
  - Co-registration
  - Data clipping to AOI
  - Noise Reduction
- Multivariate Alteration Detection + Thresholding
- Ground Cover Change Analysis + Binary Merging
- Vectorization
- Quality Control
- PDF Report Generation
Change Detection Service at RapidEye

Sample delivery product

Detecção de Mudanças

Reservatório em perigo: Barr_8504
Estado: PE
Municipio: JAU
Coordenadas UTM/SAD 69:
E 754716
N 7527576
Área aproximada da mudança: 596.9 m²

2011_Q1

2011 Q2

Propriedade:

Alpa:

Indique a fixação observada no campo:
Overview Image Concepcion - Chile 22-01-2010
Overview Image Concepcion - Chile
27-02-2010
Overview Area Affected
Image Date:
2009-04-26

Location:
Washington DC

Product Level:
L3A

Image Size:
1000x1000 pixels
Image Date: 2009-04-27

Location: Washington DC

Product Level: L3A

Image Size: 1000x1000 pixels

Relative Image to Image accuracy Approx. 1 pixel
**Product:**
Basic Change Information

**Effort:**
Full automatic

**Issues:**
Many artifacts also categorized as change
1. View angle differences
   Generates false change information.
2. Noise and non-linear Radiometric errors will also result in false change information

Uninteresting change data:
e.g. Car traffic
Product:  
Refined Change Information

Effort:  
Manual and/or semi-auto postprocessing  
Customized change objects identification

In this case, only false change pixels were manually eliminated.
Close Up 1
Close Up 1

Park space of PNC bank
Image 26-04 sunday (empty)

Image 27-04 monday (full)
Close Up 2
Mystical emergence of vegetation within one day or sunday morning event, tents were raised removed on monday
Close Ups 3
Close Ups 3

Construction site (many things happen)
Logging Monitoring

Illustration 20: IRS LISS III image 2007, resampled to 5m res.
Illustration 21: RapidEye image 2009, 5m res.
Illustration 22: automatically extracted change polygons
Flooding
Flooding
Flooding
Flooding
Thank You