Automatic land use mapping by OBIA approach supported by background knowledge

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Outline

1. Introduction
2. Dataset
3. Method
4. experiments and results
5. Conclusion
1. Introduction --- About OBIA

OBIA (object based image analysis)

- Review article:
  Object based image analysis for remote sensing, Blaschke, 2010.
- Benz et al. (2004)
- Burnett and Blaschke (2003)
- Baatz and Schape (2000)
- Blaschke and Strobl (2001)
- Hay and Castilla (2008) ....
  : GEOBIA paradigm shift for image analysis

Researchers, application fields
1. Introduction

- Why OBIA (object based image analysis):
  
  Pixel based image analysis (disadvantages):
  
  - salt-pepper effect with HR imagery,
  - neglect photointerpretive elements (texture, shape, etc);
  - low accuracy;

  Manual interpretation (disadvantages):
  
  - time consuming, need well trained expert

  OBIA approach (advantages):
  
  - incorporate useful features for photo interpretation,
  - readily integrated with vector GIS
Land use mapping

- Traditionally, land use/land cover maps are mainly generated by manually photo interpretation approach.

- However, as earth observation data rapidly accumulating, automatic or semi-automatic approaches and tools for land use generation is greatly in needed.
What about land use mapping by OBIA

Challenges:

(1) How to set the scale parameter to delineate consistent land parcel boundary?

(2) Is the delineated land parcel boundary accord with human interpretation result?

(3) It is still hard to simulate the mechanism of manual image interpretation process.

(4) …
Possible Solution:
What about incorporate geo-background knowledge into the image analysis procedure to simulate human interpretation process.

How?
Geo - background knowledge:

Contents:

- 1. Land use thematic maps which are manually interpreted

- 2. Land use change rules generated by experts
Contribution of this paper

- Aiming at generating automatic procedure of land use mapping, this paper proposed:
  1. Segmentation approach supported by old land use: Incorporate manually interpreted land use map as background geo-information in image analysis procedure.
  2. Image object classification based on geo-knowledge: Incorporate expert knowledge (land use change rule).
Purpose of this research

- Generate automatic procedure for land use information extraction from CBERS imagery
2. DATASET
2. Dataset --- Study area

Western coast of Pearl River Estuary, to the west of Hongkong, In the administration of Zhongshan city
## 2. Dataset --- Imagery

<table>
<thead>
<tr>
<th>Image source</th>
<th>Spatial resolution</th>
<th>Scene time</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPOT 5 Pansharpened imagery</td>
<td>2.5 m</td>
<td>October 23, 2003</td>
</tr>
<tr>
<td>CBERS 02B HR and MS fusioned</td>
<td>2.5 m</td>
<td>January 5, 2009</td>
</tr>
</tbody>
</table>
CBERS 02B --- 2009 (NIR, R, G)
CBERS 02B --- 2009 (R, G, B)
The land use map was produced by manual interpretation from SPOT 5 imagery in 2003.

Result accuracy of the map evaluated by field investigation shows more than 91% classification accuracy.
3. METHOD
AND EXPERIMENTS
Work Flow

Imagery → segmentation

Image Object → Classification

Results
Experiment purpose

- Automatic procedure development for land use mapping

  From CBERS 02B imagery

  At scale of 1: 50 000
3.1 Image segmentation supported by old land use map

- Segmentation algorithm:
  - Multi-resolution segmentation (Definiens, eCognition 7)
- Three level objects are segmented:
  - level 1: coarse seg, for old land use image object
  - level 2: finer seg, for new land use image object
  - level 3: same as level 2, for change detection
Land use polygon data (background knowledge)

Remote sensing imagery

Multiresolution segmentation

coarse level objects (level 1)

Multiresolution segmentation

Fine level objects (level 2)

Copy

objects (level 3)
4.1.1 experiment: segmentation --- comparison

- Segmentation without land use polygons
- Segmentation with land use polygons
- Parameters:
  CBERS layer 1-4,
  Scale parameter 100,
With or without Land use thematic

Parameters:
CBERS layer 1-4, Scale parameter 100,
with Land use polygons

Parameters:
CBERS layer 1-4, Scale parameter 100,
4.1.2 experiment: segmentation at multi-level

- Level 1: to generate old land use
- Level 2: to generate new land use
- Level 3: for change detection

<table>
<thead>
<tr>
<th>level</th>
<th>scale</th>
<th>bands</th>
<th>thematic</th>
<th>shape</th>
<th>compactness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>500</td>
<td>Band 1-4</td>
<td>yes</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Level 2</td>
<td>200</td>
<td>Band 1-4</td>
<td>no</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Level 3</td>
<td>200</td>
<td>Band 1-4</td>
<td>no</td>
<td>0.1</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Lv 1 vs Lv2

Lv 1 vs Lv2
3.2 image classification supported by land use change rules

- image objects are classified by decision rules
- Multi features used for classification
- Expert generated land use change rules are used in the classification step
<table>
<thead>
<tr>
<th>Abbreviation of the feature</th>
<th>Name of the feature</th>
<th>Computation method (or reference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BT</td>
<td>Brightness</td>
<td>(Red + Green + Blue) / 3</td>
</tr>
<tr>
<td>VI</td>
<td>Vegetation index</td>
<td>(Nir – Red) / (Nir + Red)</td>
</tr>
<tr>
<td>Entropy</td>
<td>GLCM entropy (texture)</td>
<td>Refers to (Definiens, 2007)</td>
</tr>
<tr>
<td>Old land use</td>
<td>New land use</td>
<td>Condition</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>Cropland</td>
<td>Built-up land</td>
<td>$BT &gt; 50$, $VI &lt; 0.1$, $Entropy &gt; 6$</td>
</tr>
<tr>
<td></td>
<td>Aquaculture</td>
<td>$BT &lt; 45$, $VI &lt; 0.05$</td>
</tr>
<tr>
<td></td>
<td>Cropland</td>
<td>Other condition</td>
</tr>
<tr>
<td>Shrub and grassland</td>
<td>Built-up land</td>
<td>$BT &gt; 50$, $VI &lt; 0.1$, $Entropy &gt; 6$</td>
</tr>
<tr>
<td></td>
<td>Aquaculture</td>
<td>$BT &lt; 45$, $VI &lt; 0.05$</td>
</tr>
<tr>
<td></td>
<td>Shrub and grassland</td>
<td>Other condition</td>
</tr>
<tr>
<td>Forest land</td>
<td>Built-up land</td>
<td>$BT &gt; 50$, $VI &lt; 0.1$, $Entropy &gt; 6$</td>
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<tr>
<td></td>
<td>Aquaculture</td>
<td>$BT &lt; 45$, $VI &lt; 0.05$</td>
</tr>
<tr>
<td></td>
<td>Forest land</td>
<td>Other condition</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>Built-up land</td>
<td>$BT &gt; 50$, $VI &lt; 0.1$, $Entropy &gt; 6$</td>
</tr>
<tr>
<td></td>
<td>Shrub and grassland</td>
<td>$NDVI &gt; 0.15$</td>
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<tr>
<td></td>
<td>Aquaculture</td>
<td>Other condition</td>
</tr>
<tr>
<td>Built-up land</td>
<td>Built-up land</td>
<td>All condition</td>
</tr>
</tbody>
</table>
4.2 experiment: classification supported by land use change rules

- Features:
  Spectral index, texture,
  Brightness, Vegetation Index, Texture,
- Land use change rules
  (generated by expert)
Classification tree for “aquaculture”

Level 2 objects

super-object class = “aquaculture”

Yes: BT < 45, VI <0.05 → aquaculture

No

Yes: BT > 50, VI < 0.1, Entropy > 6 → built-up land

No

Yes: BT < 45, VI <0.05 → shrub and grassland

No

Else: → aquaculture
Classification result

Quite consistent with the manual interpreted result
3.3 change detection

- As both the old land use and the new land use are generated from the procedure, land use change detection can be easily achieved.

- At object level 3, image objects are classified as “changed” and “unchanged”.
4.3 Change detection result
5. CONCLUSION
5. Conclusion

- OBIA approaches can be promising for automatic land use mapping, but there is still a long way to reach the goal “automatic”

- This paper proposes a strategy to incorporate expert knowledge into the process of OBIA to get proper result
5. Future work

- **KDD approaches**: Knowledge about land use change rules should be extracted with KDD approaches from experts and existent thematic maps.

- Feature space optimization:

- Validation of rules on different regions.
Thank you
For your attention
Any questions?