New Methodological Developments

CNES ORFEO Program

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Namur, February 12, 2008
Introduction

Goals of the presentation

- Results from French labs involved in ORFEO
- Most of them are (co-)funded by CNES for ORFEO methodological research

Methodological objectives

- Pre-processing
- Change detection
- Segmentation
- Object recognition
Pre-processing

- No major theoretical new results within the last year
- Ortho-registration now available in OTB 2.0
- Radiometric corrections for optical sensors available in OTB 2.0
- Image registration (ITK framework) documented for remote sensing images
Outline

Pre-processing

Change detection
  Similarity measures
  DB update

Segmentation
  Line segment detection
  High Order Active Contours
  Point Marked Processes
  Multi-resolution classification

Object recognition
  Structural object recognition
  Supervised geometric recognition
  Spatial reasoning
Statistical similarity measures
Multi-scale change profile

▶ Researcher
  ▶ Télécom Bretagne: Grégoire Mercier
  ▶ CNES R&T funding.

▶ Objectives
  ▶ Improve the estimation of similarity measures for multi-sensor images.
    ▶ Few pixels; Multi-scale approach; Statistical modeling

▶ Results: multi-sensor multi-scale change profile
  ▶ Use of series cumulant expansion for statistical divergence (mutual information, etc.)
  ▶ Optimized multi-scale computation: computation time for windows from $5 \times 5$ up to $51 \times 51$ is only 1.5 times higher than for a $31 \times 31$ window.
Introduction
Pre-processing
Change detection
Segmentation
Object recognition

Similarity measures
DB update

Figure: Change detection results obtained with the MCP.

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Statistical similarity measures
Estimation of multivariate Gamma distributions

▶ Researcher
  ▶ TéSA/ENSEEIHT: Jean-Yves Tourneret, Florent Chatelain
  ▶ CNES R&T funding.

▶ Objectives
  ▶ Find robust estimators for SAR pdfs
  ▶ Develop estimators for similarity measures between pdfs

▶ Results
  ▶ Estimators for Gamma pdfs for pairs of images with identical and different number of looks.
  ▶ Optimized estimator for the correlation coefficient between local neighborhoods (change detection)
  ▶ Link between correlation and mutual information for the Gamma pdf
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Figure: Change detection results using bivariate Gammas.
Semi-supervised approach
SVM classification for change detection

- **Researcher**
  - Tarek Habib, PhD student. Co-funded by CNES and Thales-Alenia-Space. End of PhD: October 2008

- **Objectives**
  - Develop semi-supervised similarity measures for change detection.
  - Multi-sensor and without prior information about the type of change.

- **Results**
  - Feature and kernel selection techniques for SVM classification.
  - Trade-off between speed and accuracy: kernel optimization/simplification.
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Pre-processing → Kernel selection → Learn

SV selection

Feature selection

Learn → Classification optimization → Kernel optimization

Classify

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DB update
Use of image and exogenous data

- **Researcher**

- **Objectives**
  - Information extraction using ancillary data (vector, raster)
  - Multi-sensor

- **Results**
  - Research just started: problem position
  - Internship working on a particular case

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Line segment detection
Use of Gestalt theory

- Researchers
  - CMLA, ENS Cachan: Jérémie Jakubowicz, Rafael Grompone. Partial CNES R&T funding.

- Objectives
  - Use Gestalt – a contrario – approaches for segment detection in HR images
  - Improve accuracy of current approaches

- Results
  - Multi-segment detector: improves Desolneux et al. detector
  - Line Segment Detector: speeds up the multi-segment detector
  - Right angle detector

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High Order Active Contours

- Researchers
  - CNES R&T funding.

- Objectives
  - Road and hydrographic network extraction.
  - In HR linear features become regions.
  - Deal with occlusions.

- Results
  - Extension of the snake approach.
  - Stable, convergent solutions thanks to appropriate energy function definitions.

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Point Marked Processes
Parameter estimation

Researchers

- INRIA: Xavier Descombes, Florent Chatelain, Josiane Zerubia. CNES R&T funding.

Objectives

- Overcome the limitations of Markov models for image segmentation.
- Use simple object models in a stochastic framework.

Results

- How to choose the meta parameters for the model.
- Counting objects.

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Using classifier fusion

- **Researcher**
  - LSIIT, Univ. Strasbourg: Pierre Gançarski, Cédric Wemmert
  - CNES R&T funding.

- **Objectives**
  - Joint use of multi-sensor and multi-scale remote sensing images for classification.
  - Integration of Pléiades-like data together with SPOT, for instance.

- **Results**
  - Multi-criteria classifier fusion.
  - Work in progress.

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Structural object recognition
High level object modelling

▶ Researchers
  ▶ SIP/CRIP-5, Univ. Paris 5: Guray Erus, Nicolas Loménie.
    Partial CNES R&T funding.

▶ Objectives
  ▶ Detect and recognize man mad objects in HR images.
  ▶ Use of structural models semi-automatically built from an
    example data base.

▶ Results
  ▶ Relational attributed graphs for object representation.
  ▶ Edition distance as a matching metric.

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Supervised geometric recognition
SVM based classification

- CNES internal studies
  - Jordi Inglada (optical), Céline Tison (SAR)

- Objectives
  - Use supervised classification for object recognition in HR images.
  - Evaluate the usefulness of geometric descriptors.

- Results
  - SVM-based image patch classifier using geometric descriptors after an unsupervised segmentation step.
  - Same approach for cartographic objects in SPOT5 images and vehicles in SAR.

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Spatial reasoning

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Spatial reasoning
RCC8 and multi-scale segmentation

- Researcher
  - C-S: Julien Michel. CNES R&T funding.

- Objectives
  - Use of spatial reasoning techniques for scene description and composite object recognition.
  - Integration into a supervised classification system.

- Results
  - Multi-scale geodesic morphological segmentation.
  - Attributes relational graph containing spatial relationships between regions of the images.
  - Object recognition by graph matching.
Spatial reasoning
Fuzzy, uncertain, reasoning

- **Researcher**

- **Objectives**
  - Integrate uncertain, inaccurate informations in the spatial reasoning framework.
  - Application to scene modeling and land-use information extraction from HR images.

- **Results**

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Credits

Contributions from all researchers involved in this research:

- Télécom Bretagne: G. Mercier
- TéSA/ENSEEIHT: J-Y. Tourneret, P. Marthon
- GIPSA Lab: J. Chanussot
- CMLA: J. Jakubowicz, R. Grompone, J-M. Morel
- LSIIT, Univ. Strasbourg: P. Gançarski, C. Wemmert
- SIP/CRIP-5, Univ. Paris 5: G. Erus, N. Loménie
- C-S: J. Michel
- Télécom ParisTech: C. Vanegas, I. Bloch, H. Maître

CNES: T. Habib, V. Poulain, C. Tison

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