

Introduction
Pre-processing
Change detection
Segmentation
Object recognition

New Methodological Developments

CNES ORFEO Program

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CENTRE NATIONAL D'ÉTUDES SPATIALES

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

Structral object recognition

Supervised geometric recognition

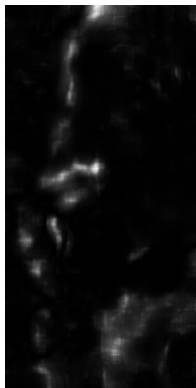
Spatial reasoning

Namur, February 12, 2008

Statistical similarity measures

Multi-scale change profile

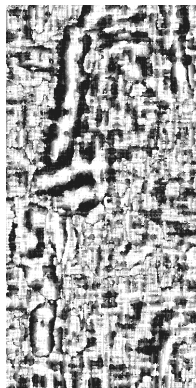
- ▶ Researcher
 - ▶ Télécom Bretagne: Grégoire Mercier
 - ▶ CNES R&T funding.
- ▶ Objectives
 - ▶ Improve the estimation of similarity measures for multi-sensor images.
 - ▶ Few pixels; Multi-scale approach; Statistical modeling
- ▶ Results: multi-sensor multi-scale change profile
 - ▶ Use of series cumulant expansion for statistical divergence (mutual information, etc.)
 - ▶ Optimized multi-scale computation: computation time for windows from 5×5 up to 51×51 is only 1.5 times higher than for a 31×31 window.



(a) Maximum of the MCP



(b) First PC of the MCP



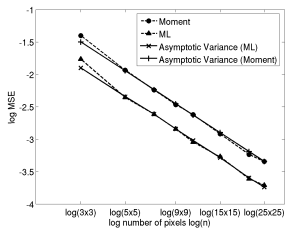
(c) Map of selected scales

Figure: Change detection results obtained with the MCP.
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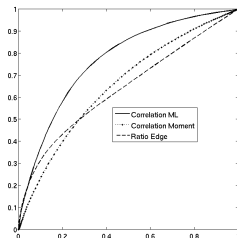
Statistical similarity measures

Estimation of multivariate Gamma distributions

- ▶ Researcher
 - ▶ TéSA/ENSEEIH: 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



(a) Estimator errors



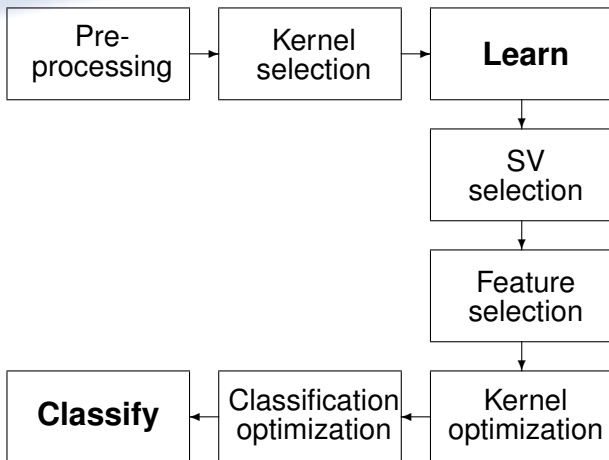
(b) ROC plot

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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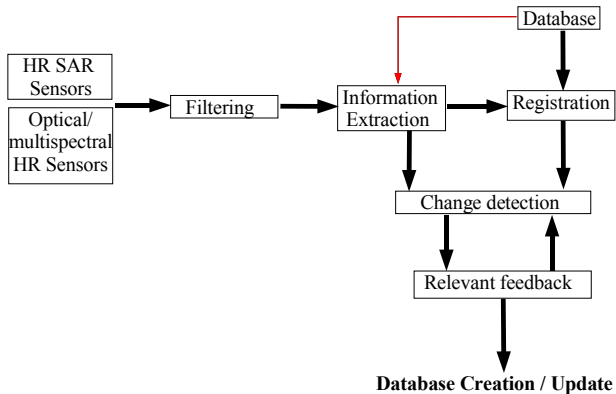
Spatial reasoning

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DB update

Use of image and exogenous data

- ▶ Researcher
 - ▶ Vincent Poulain, PhD student. Co-funded by CNES and Thales-Alenia-Space. End of PhD: October 2010.
- ▶ 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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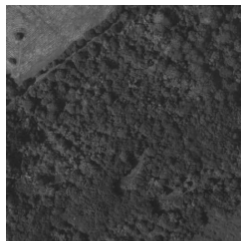
Line segment detection

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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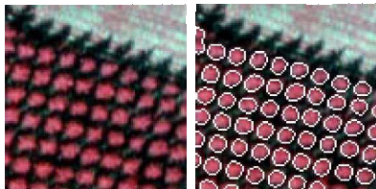
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High Order Active Contours

- ▶ Researchers
 - ▶ INRIA: Ian Jermyn, Aymen El Ghouli, Josiane Zerubia.
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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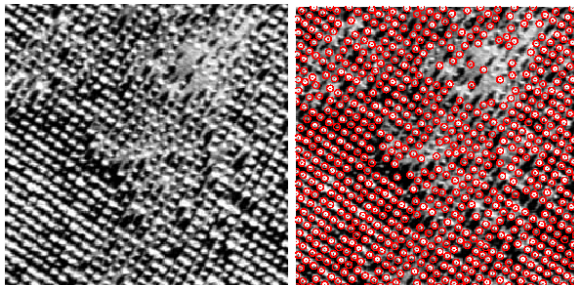
Point Marked Processes

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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Multi-resolution classification

Using classifier fusion

- ▶ Researcher
 - ▶ LSIT, 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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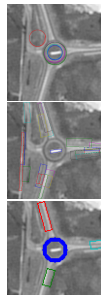
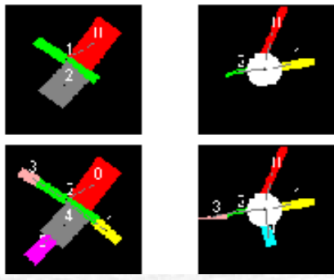
Structral object recognition

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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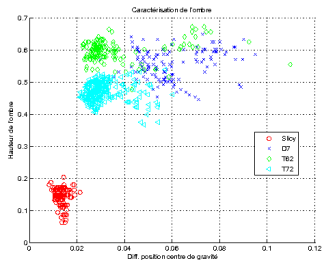
Spatial reasoning

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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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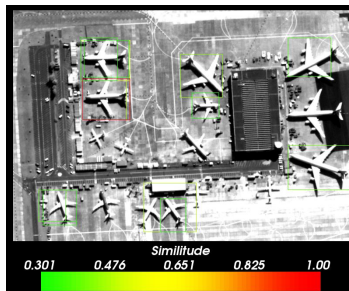
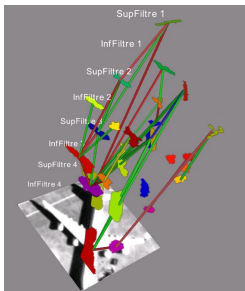
Spatial reasoning

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.

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Spatial reasoning

Fuzzy, uncertain, reasoning

- ▶ Researcher
 - ▶ Ma. Carolina Vanegas, PhD student. Co-funded by CNES and DLR. End of PhD: January 2011.
- ▶ Objectives
 - ▶ Integrate uncertain, inaccurate informations in the spatial reasoning framework.
 - ▶ Application to scene modeling and land-use information extraction from HR images.
- ▶ Results
 - ▶ Work started in January 2008.

Credits

Contributions from all researchers involved in this research:

- ▶ Télécom Bretagne: G. Mercier
- ▶ TésA/ENSEEIH: J-Y. Tourneret, P. Marthon
- ▶ GIPSA Lab: J. Chanussot
- ▶ CMLA: J. Jakubowicz, R. Grompone, J-M. Morel
- ▶ INRIA: A. El Ghouli, F. Chatelain, I. Jermyn, X. Descombes, J. Zerubia
- ▶ LSIT, 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