MAMASU
Detecting man-made structures in urban areas using multi-spectral and geometric classification methods

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Hotel Metropole Brussels May 6 2004

Belgian Science Policy

CCG — Centre for Cartography and GIS

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Research teams

- Centre for Cartography and GIS (Brussels, VUB)

  - Frank Canters
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- Telecommunication and Information Processing (Ghent, UGent)
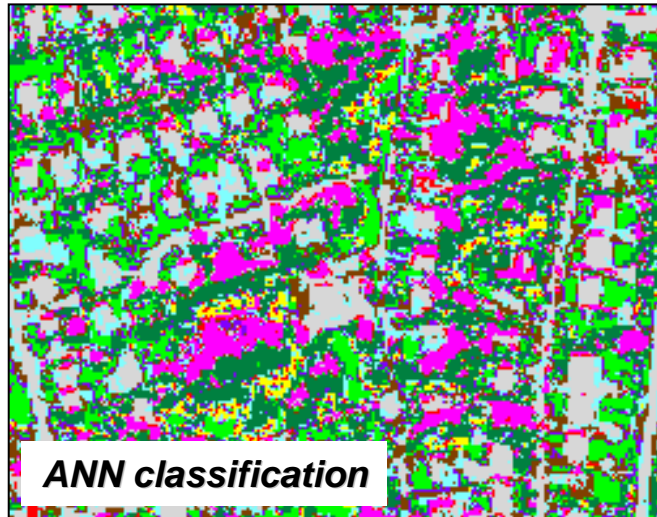
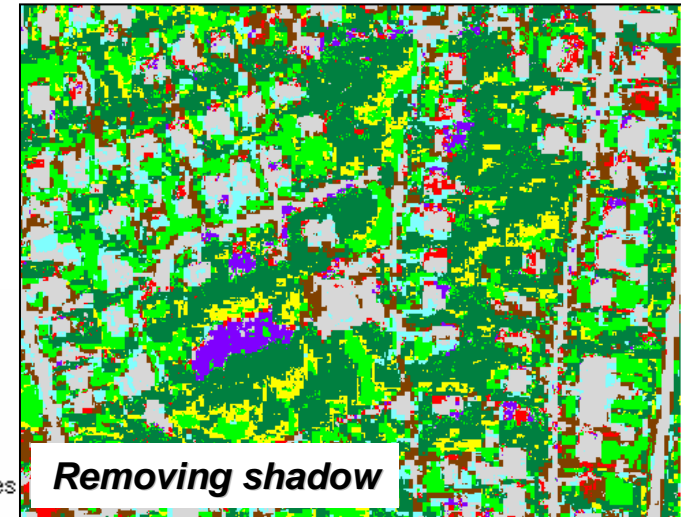 - Johan D'Haeyer
  - Sidharta Gautama

Motivation

- Identifying man-made structures in urban and suburban areas is a difficult task

- Multi-spectral
  - Soft classification: possibilistic information
  - Secondary information: texture
  - Post-classification: knowledge-based reclassification

- Computer vision
  - Automatic detection of linear features: roads
  - Parameterized models: buildings
  - Grouping of primitives:reconstruction of objects

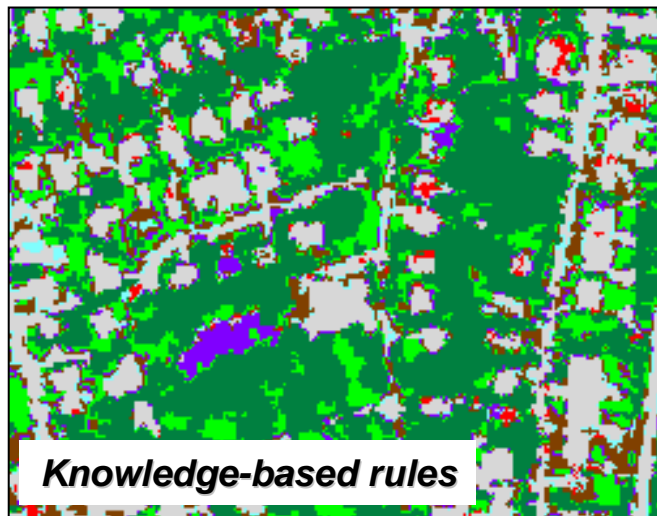- Combining both approaches: integrated approach to classification
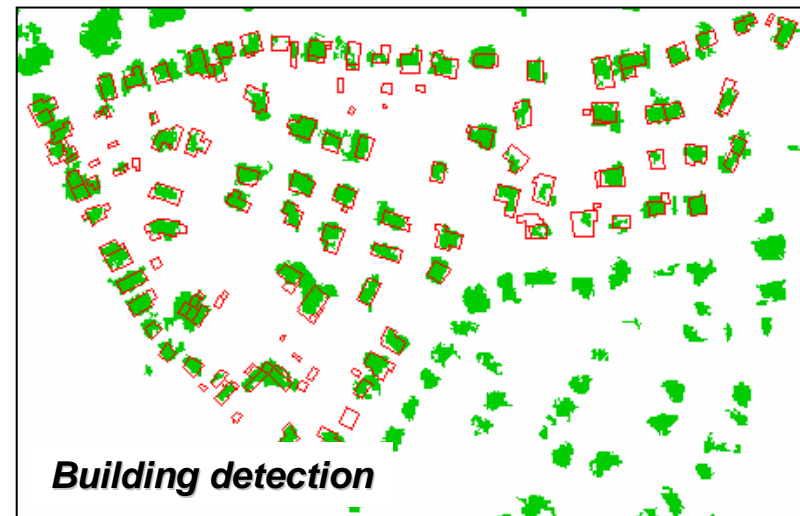
Motivation

ANN classification

Removing shadow

Knowledge-based rules

Building detection

Legend:
- red surface
- glass
- bare soil
- water
- grass
- agriculture
- shrub and trees
- grey

Motivation

Extend spectral information with structural information through "geometric activity"

original — *edge magnitude* — *distance transform* — *edge selection*
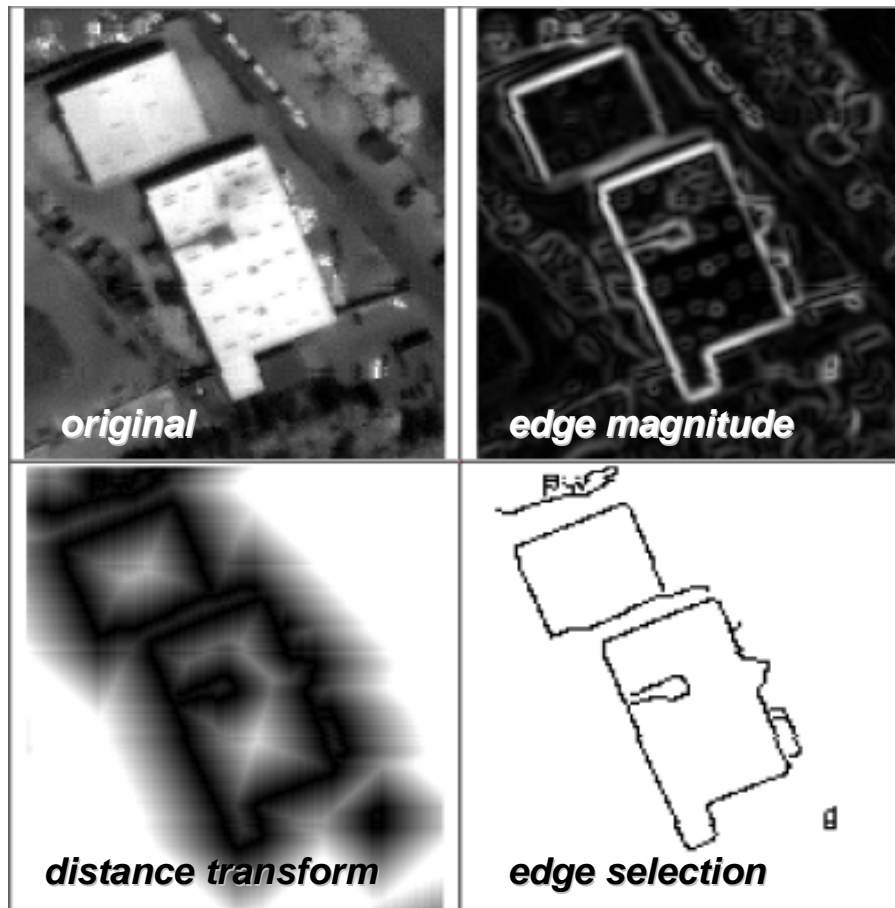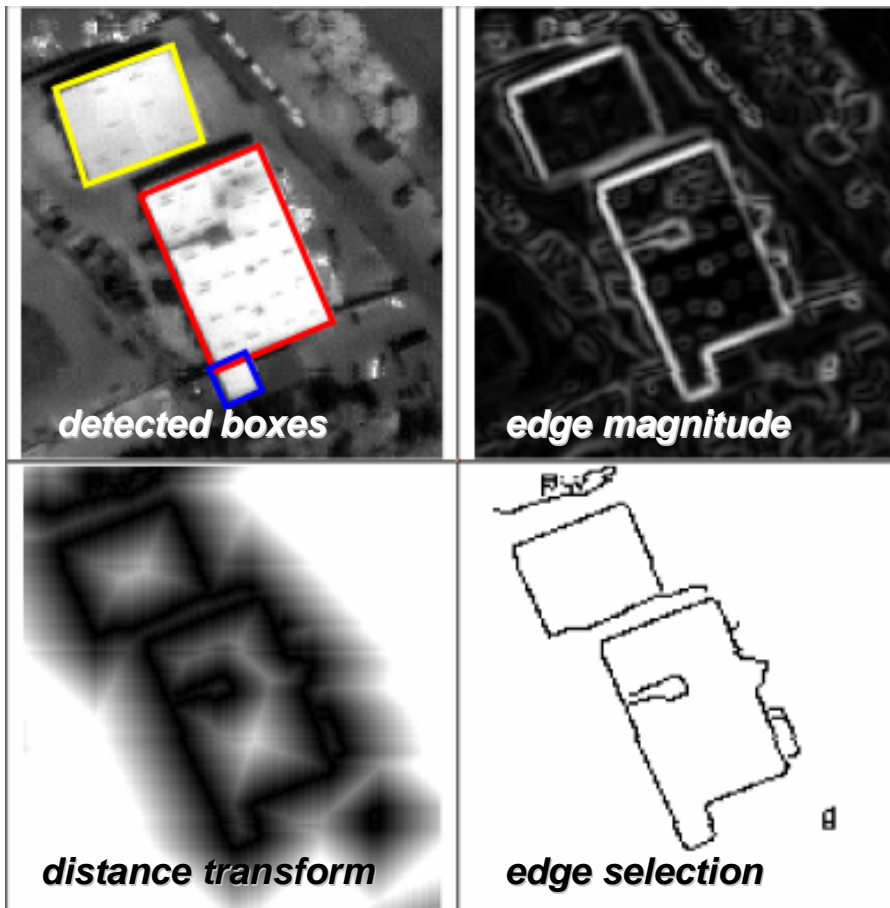
Motivation

Extend spectral information with structural information through "geometric activity"

each information source by itself may not be sufficient but the combination can lead to richer object models

detected boxes · edge magnitude · distance transform · edge selection

Motivation

- Two-stage process:

- Geometric activity
  - Detect straight lines and corners
  - Activity index (number of straight lines, distance, …)
  - Combined with spectral data
  - Supervised soft classifier

- Vectorization of soft classifier results
  - Detection of objects
  - Hardened classification
  - Soft classification

General objectives

- To develop geometric activity indices as an alternative for more traditional texture indices that better describe the geometry of man-made structures

- To propose a strategy for selecting the most suitable geometric activity indices to be included in per-pixel ANN classification

- To propose a method for automatic vectorization starting from the result of a soft classification

- To produce prototype software routines for the implementation of the proposed computer vision methods

- Close link to the SPIDER project (SR/00/02): better fulfill the needs of potential users of VHR in regional and local authorities

Detailed description

- 5 modules:

  - I. Data collection (VUB)

  - II. Definition and detection of geometric activity images (UGent)

  - III. Classification (VUB)

  - IV. Vectorization of soft-classifier results (UGent)

  - V. Accuracy assessment (VUB)

I. Data collection

- Study areas

  - Choice in function of morphology:
    - Differences in complexity
      - Suburban (spatially isolated objects)
      - Dense urban (spatially aggregated objects)
  - Link with SPIDER:
    - Orthorectified VHR imagery
    - Urban land-cover classifications
    - Ancillary data

I. Data collection

**Study areas**

Dense urban area

Suburban area

I. Data collection

- Class definition
  - Link with SPIDER:
    - User survey: information needs
    - Priority on man-made objects for which there seems to be an interest in deriving them from VHR
    - Analysis of spectral and geometric properties in order to identify the classes of interest

- Field campaign
  - Training and validation data (classification)
  - Computer-aided image interpretation (vectorization)
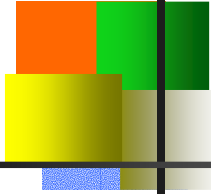
Computer-aided image interpretation

Dense urban area

Suburban area

II. Definition of geometric activity images

- Road geometric activity
  (TELSAT4 T4/02/72 & STEREO SR/02/32)

- Development of structural detection algorithms
  - Corner detector
  - Box detector
  - Hough transform (straight lines, circles)
  - Etc

- Generation of geometric activity images
  - Per-pixel indices

- Feedback from the classification module

III. Classification

- Integrating road geometric activity
    - Buildings $\leftrightarrow$ Roads

- Soft classification of man-made structures
    - Introduce geometric activity images as texture bands

- Validation
    - Quality of the output of classification results
    - Which man-made features can be accurately identified?
    - Link to definition of geometric activity indices

IV. Automatic vectorization

- Vectorization of soft classifier results
  - Modification of the algorithms developed in Geometric Activity module
  - Detection of corners, lines and polygons in the ANN classification
  - Hardened classification
  - Activation levels
    - Classification uncertainty
    - Robust: weak edges, mistakenly connect objects due to classification errors

V. Accurracy assessment

- Evaluation of classification uncertainty

- Type and magnitude of uncertainty

- Classifications using ANN
  - Thematic accuracy

- Automatic vectorization
  - Positional accuracy

Expected End Results

- Answer to following questions:

  - What geometric texture indices are most suitable for integration in a multi-spectral classification framework?
  - What are the preferred methods for automatic vectorization starting from a soft classification of VHR data?
  - How can classification uncertainty help in defining methods for detecting man-made structures in VHR data?

Expected End Results

- Deliverables:

  - A methodology for detecting a variety of man-made structures in urban and suburban environments from VHR data
  - A set of innovative geometric activity indices for the detection of man-made structures
  - Value-added products that fit the needs of potential users more closely
  - Prototype software implementation of the proposed computer vision methods