Updating Urban DataBases from Aerial Photos:

A Methodology
for extracting and structuring information
during matching

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Why updating?

Ensure permanent data validity :
- ☐ for conventional users
- ☐ for applications (urban planning)

Updating
- ☐ New data acquisition
- ☐ Interpretation and Integration
- ☐ Corrections

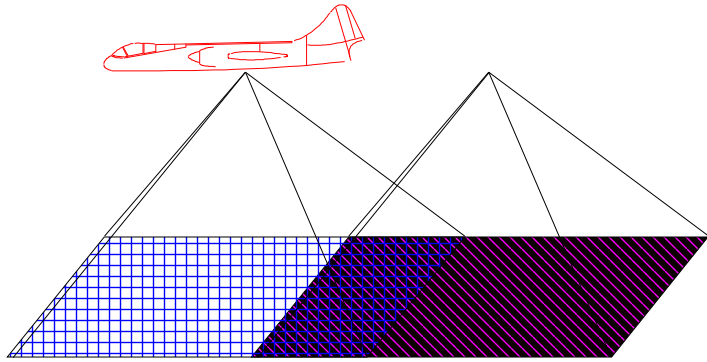*Very time-consuming* ➔ *Automatize the system*

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PHOTOPOLIS Project
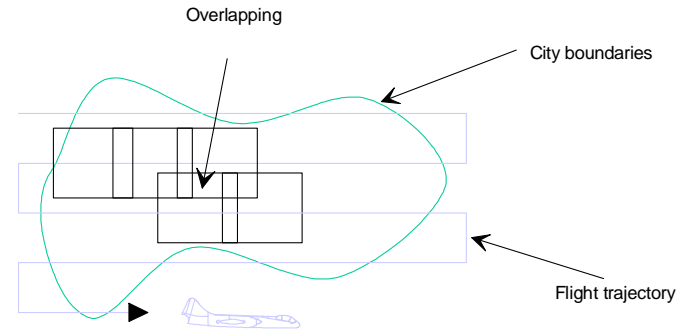
- City of Padua, Italy
- Periodic aerial photos
- Planar city --> few distortions
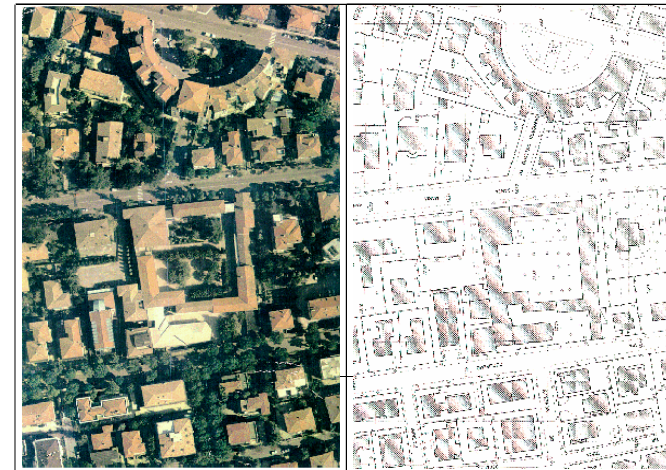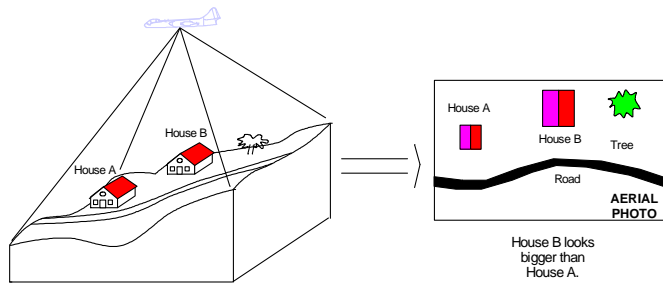- Existing urban database to update
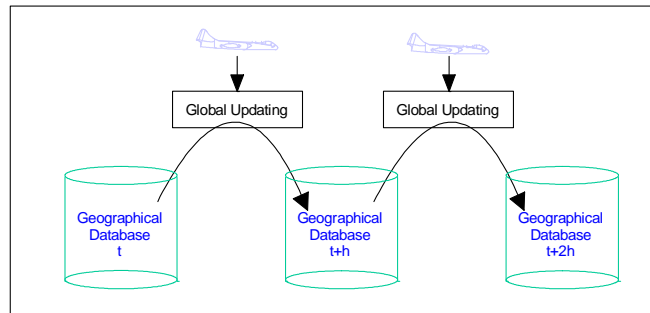
Taking aerial photos with overlapping

Flight Trajectory over a City

Overlapping

City boundaries

Flight trajectory

Object Distortions

House A
House B
Tree
Road
AERIAL PHOTO

House A
House B

House B looks bigger than House A.

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Regular Updating by Aerial Photos

Basic Steps for Updating

- image dewarping
- construction of a texture and a knowledge base (season, hour, vegetation, etc.)
- extraction of zones with homogeneous textures and comparison with the database contents,
- if a discrepancy is detected (for instance, new building) then update
- sometimes some extra information must be used such as building permit files.

Aerial Photos (1/2)

Aerial Photos
- ▣ «Snapshot» of a zone
- ▣ Scale fitting urban planning
- ▣ Color

PHOTOPOLIS Project : cadaster updating for the city of Padua, Italy
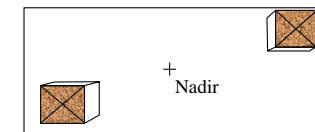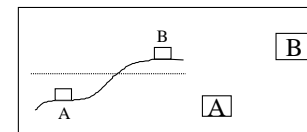
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Aerial photos (2/2)

- ▣ Information Extraction
- ▣ Comparing and matching

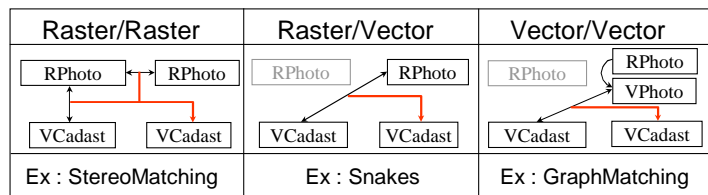*Problems linked to information extraction*
Understand, Extract and Describe information within image

Problems linked to shots
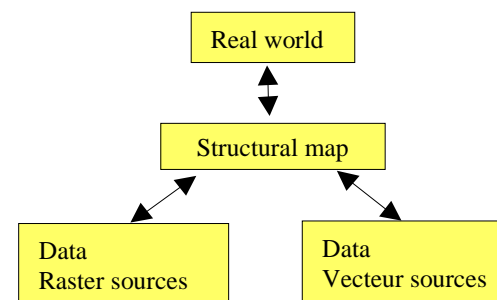

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Integrating photos

Raster/Raster	Raster/Vector	Vector/Vector
RPhoto → RPhoto ↕ VCadast — VCadast	RPhoto → RPhoto ↘ VCadast VCadast	RPhoto RPhoto VPhoto VCadast VCadast
Ex : StereoMatching	Ex : Snakes	Ex : GraphMatching

Construct a vector topological space for photos
backed on the raster space

Represent **Spaces** and **Objects**
⇨ *intra- and inter-objects relationships*

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Interaction of spaces and representations

Real world

⇅

Structural map

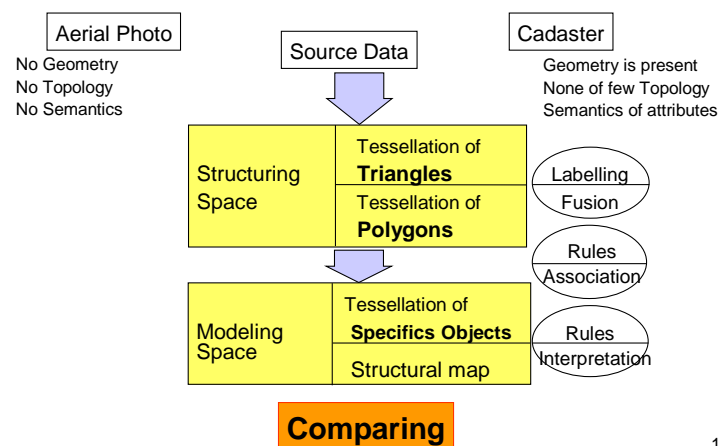Data
Raster sources

Data
Vecteur sources

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Matching Process

- Extracting objets from aerial photos
- Structuring information
- Comparing photo-objects and existing cadaster
- Identifications of similarities
- Detecting modification for a possible updating

▣ Segmentation of the image
▣   incompatible boundaries with cadaster
▣ Human interpretation
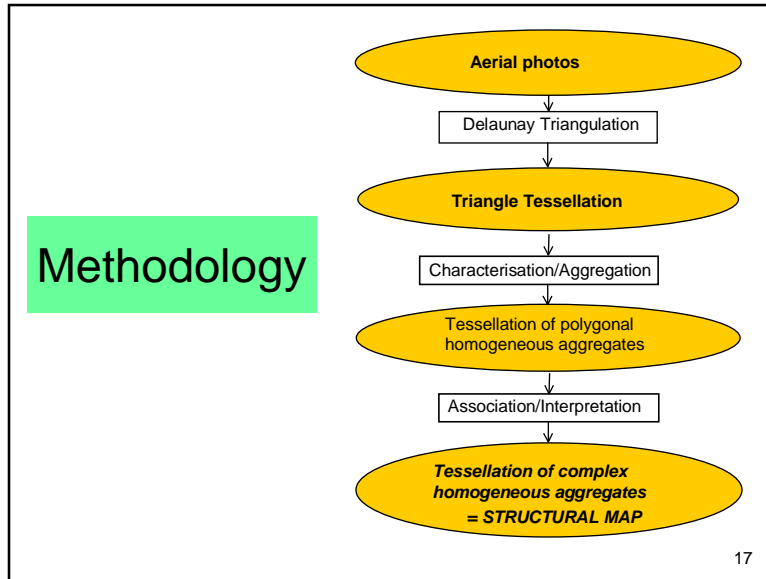▣   compatible boundaries, but a very long process

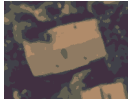Setting compatibilities between photos and cadaster

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Methodology, Description

Aerial Photo
No Geometry
No Topology
No Semantics

Source Data

Cadaster
Geometry is present
None of few Topology
Semantics of attributes

Structuring Space

Tessellation of **Triangles**

Tessellation of **Polygons**

Labelling
Fusion

Rules
Association

Modeling Space

Tessellation of **Specifics Objects**

Structural map

Rules
Interpretation

Comparing

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Slide 17 — Methodology

Methodology

- Aerial photos
  - ↓ Delaunay Triangulation
- Triangle Tessellation
  - ↓ Characterisation/Aggregation
- Tessellation of polygonal homogeneous aggregates
  - ↓ Association/Interpretation
- *Tessellation of complex homogeneous aggregates = STRUCTURAL MAP*

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Slide 18 — Application to aerial photos

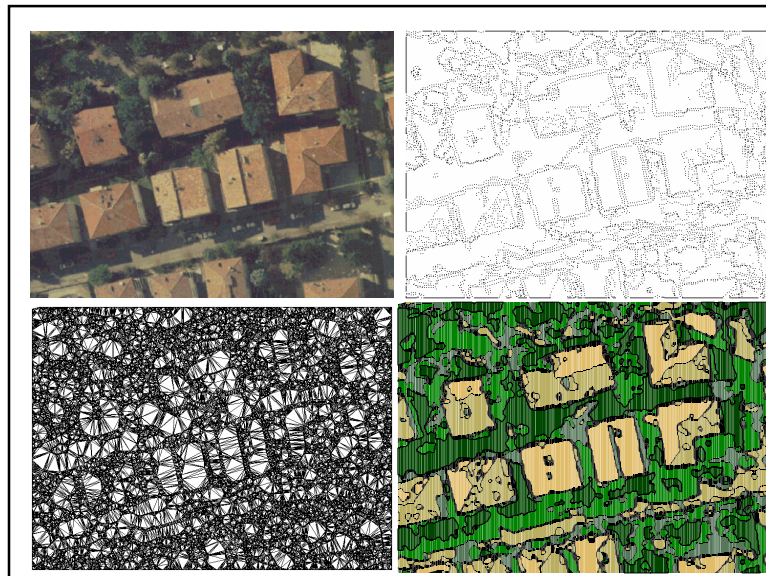# Application to aerial photos

Preprocessing
- ▣ Classifying colors
- ▣ Detecting homogeneous zones
- ▣ Selection of arbitrary points

Triangulation : constructing a structured space
Labeling : characterizing homogeneous primitives
(interior, boundaries, connection)
Fusion : creating homogeneous zones
Association : creating pictorial objects

➔ Structuring the space by means of objects and relations

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Slide 19
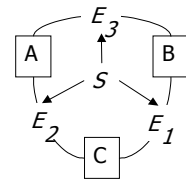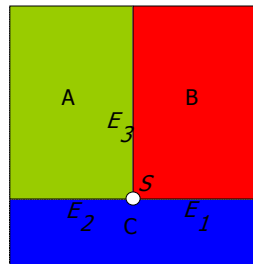

Slide 20 — Structural Map

Structural Map

- •Graph-based representation
  - ▣ objects attributes (nodes)
    - ▣ area, perimeter, axes...
    - ▣ colors (⇨ texture ?)
  - ▣ spatial relations (edges)
    - ▣ *hierarchic*
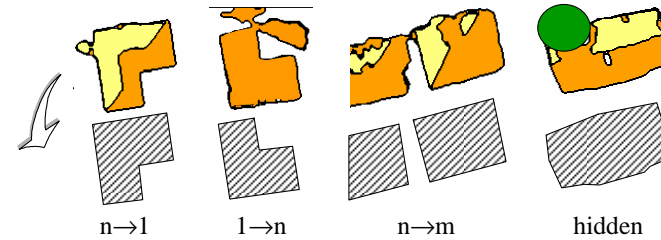   - ▣ *topologic*
    - ▣ *proximity*
    - ▣ *direction*

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Example of a structural map
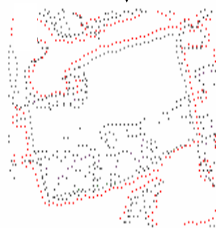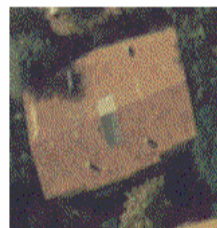

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Comparing / Matching

| n→1 | 1→n | n→m | hidden |

Complexity : using heuristics for comparing

↳ local : study of objects, their characteristics
↳ global : location of candidate objects
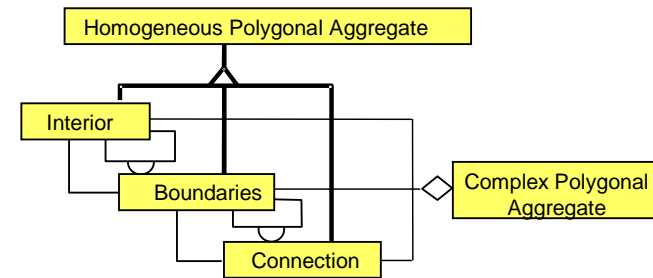study of objects' structure
↳ hierarchic and incremental matching

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Photo

Point after boundary smoothing

Homogeneous object

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Aggregates and relationships

Homogeneous Polygonal Aggregate

Interior

Boundaries

Connection

Complex Polygonal Aggregate

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Conclusion/Perspectives

- Methodology for extracting pictorial objects of a
  - raster space (by triangulation)
- Structuring information compatible with cadaster

- Extending semantic definition to

relations

- Semantic matching
- Proposing a system

Helping updating

MATCHING
YES / NON

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