UNIVERSITEIT GENT

FACULTEIT WETENSCHAPPEN

Integration of raster and vector data for 3D city modelling

URMO3D

- Orfeo Project OR/02/02

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Presentation overview

- URMO3D…
- …In one sentence
- Objectives
- Study areas
- Methodology

Presentation overview

- Flowchart
- Discussion
- Conclusion
- Related projects : DIFDEM & MAMUD

- VHR sensors deliver high quality stereo pairs with images from one orbital pass (IKONOS, QuickBird, Pleiades)
- Spatial resolution : 1 m
- Suitable for urban 3D modelling

- Improvement of current methods

URMO3D …

… in one sentence

Extracting hybrid 3D city model based on raster **and** vector data from the same data source, i.e. satellite stereo pair (Pleiades)

- Raster = Digital Surface Model
- Vector = 3D features of the built-up area

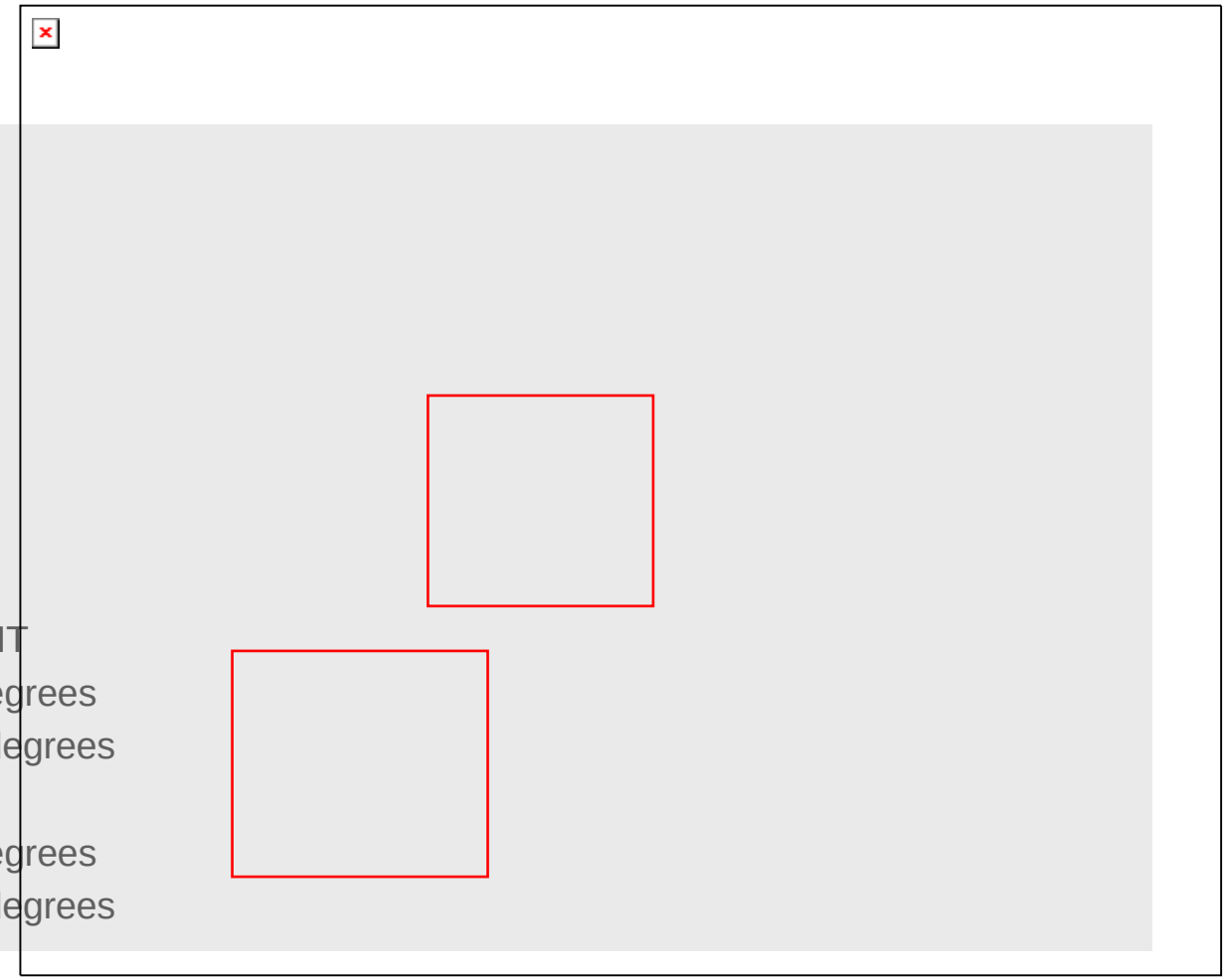
Goals of the project

- Defining a methodology to model and visualise an urban scene in three spatial dimensions, based on satellite images (future Pleiades)

Goals of the project

- Optimising and assessing the accuracy of raster DSM and 3D vector extraction from VHR stereo pairs
- Integration of three basic photogrammetric products (DSM, 3D features and orthoimages) in a hybrid 3D city model
- Testing the multi-temporal analytical capabilities of the developed model in a rapidly changing urban environment (Cairo, Egypt)

Ghent



2003-09-18 11:07 GMT
Azimuth: 210.4809 degrees
Elevation: 68.83065 degrees

Azimuth: 346.8062 degrees
Elevation: 78.86692 degrees

Cairo

2005-01-20 08:43 GMT

Azimuth: 155.8838 degrees
Elevation: 66.94662 degrees

Azimuth: 52.3463 degrees
Elevation: 68.90756 degrees

Fieldwork Cairo

Measuring Ground Control Points with C-NAV differential GPS

- receiver
- antenna
- laptop

Fieldwork Cairo

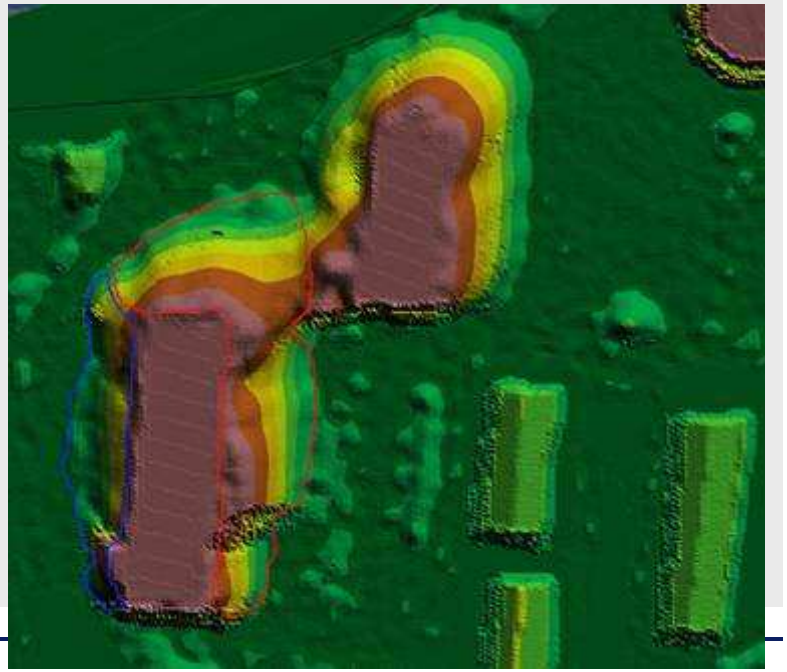
Methodology

- Creating a hybrid 3D city model from VHR stereo pairs (raster * vector)
- Using the vector model to compensate for shortcomings of the raster model and vice versa

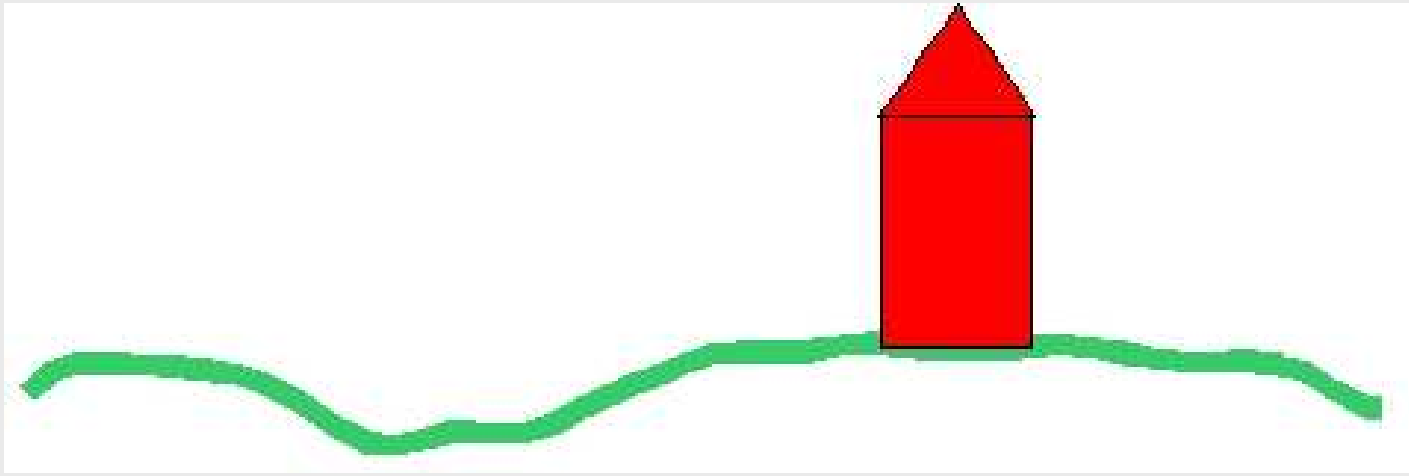
Raster and Vector Surface Model

- Raster : area covering, suffers from occlusion
- Vector : very good to represent 3D features from built-up area, not all features

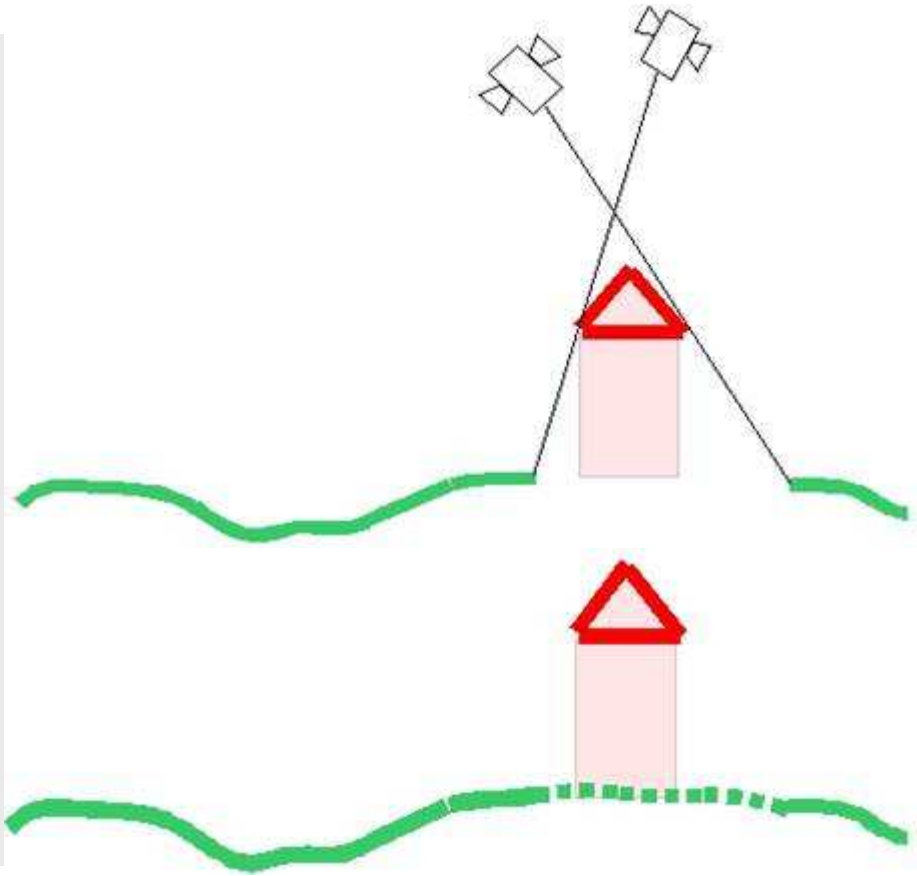
Raster and Vector Surface Model

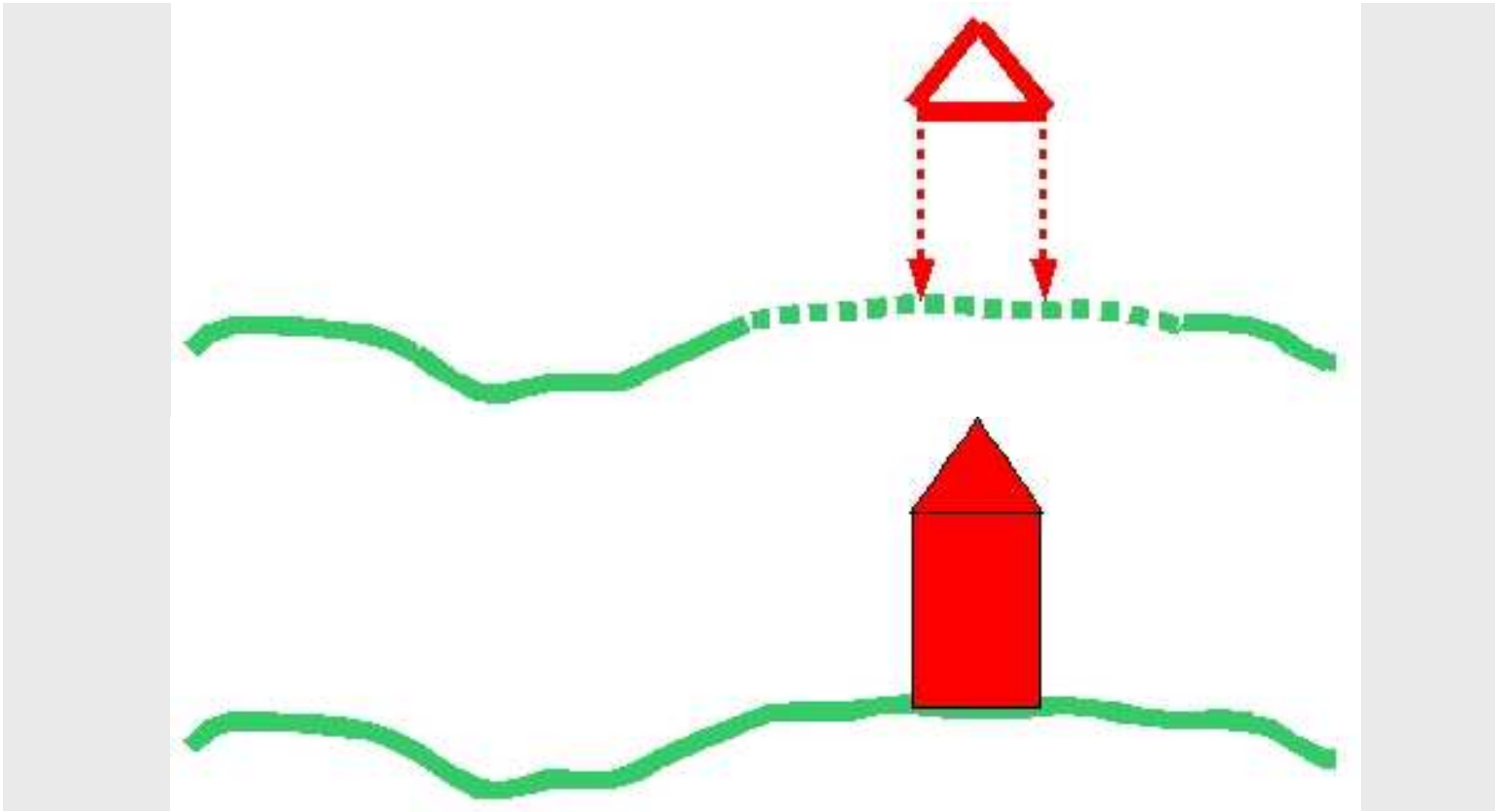


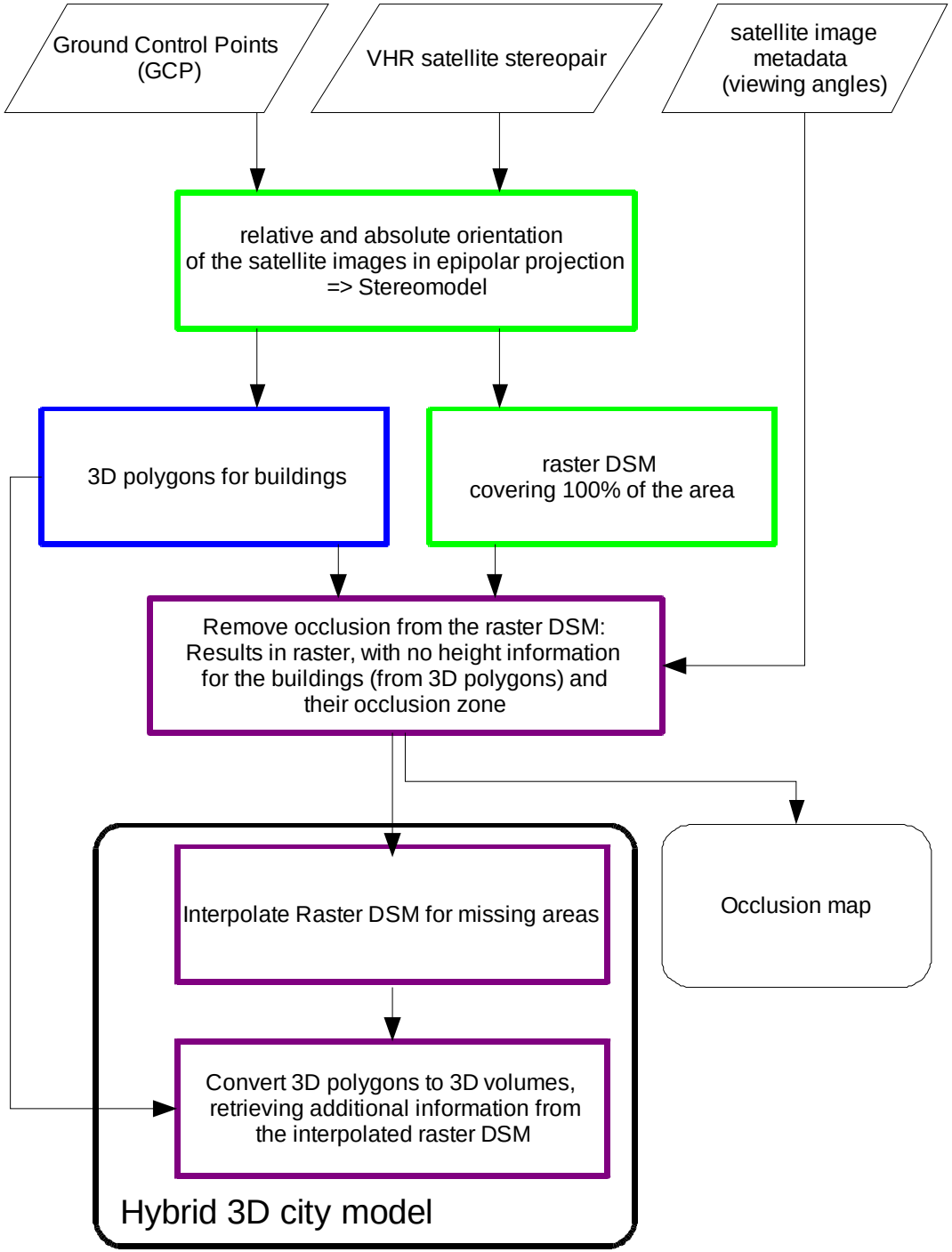
Hybrid Surface Model



Data retrieved from satellite stereopair






Ground Control Points (GCP)
VHR satellite stereopair
satellite image metadata (viewing angles)
relative and absolute orientation of the satellite images in epipolar projection => Stereomodel
3D polygons for buildings
raster DSM covering 100% of the area
Remove occlusion from the raster DSM: Results in raster, with no height information for the buildings (from 3D polygons) and their occlusion zone
Occlusion map
Interpolate Raster DSM for missing areas
Convert 3D polygons to 3D volumes, retrieving additional information from the interpolated raster DSM
Hybrid 3D city model

Optimising raster DSM extraction from satellite stereopair

- Optimal match window & window spacing for the matching algorithm (VirtuoZo software)
- Test on rural and urban area from the same IKONOS stereopair
- All test areas are approx. 1600 by 1300 pixels

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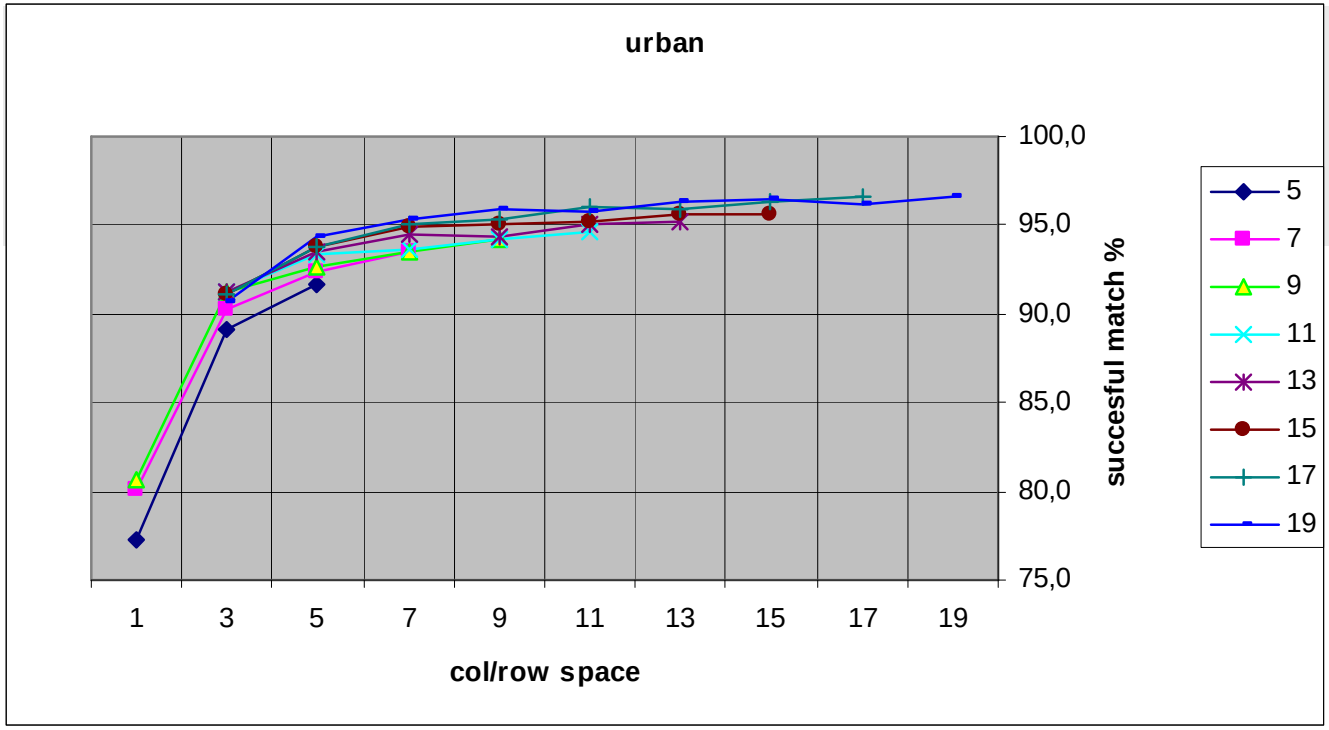
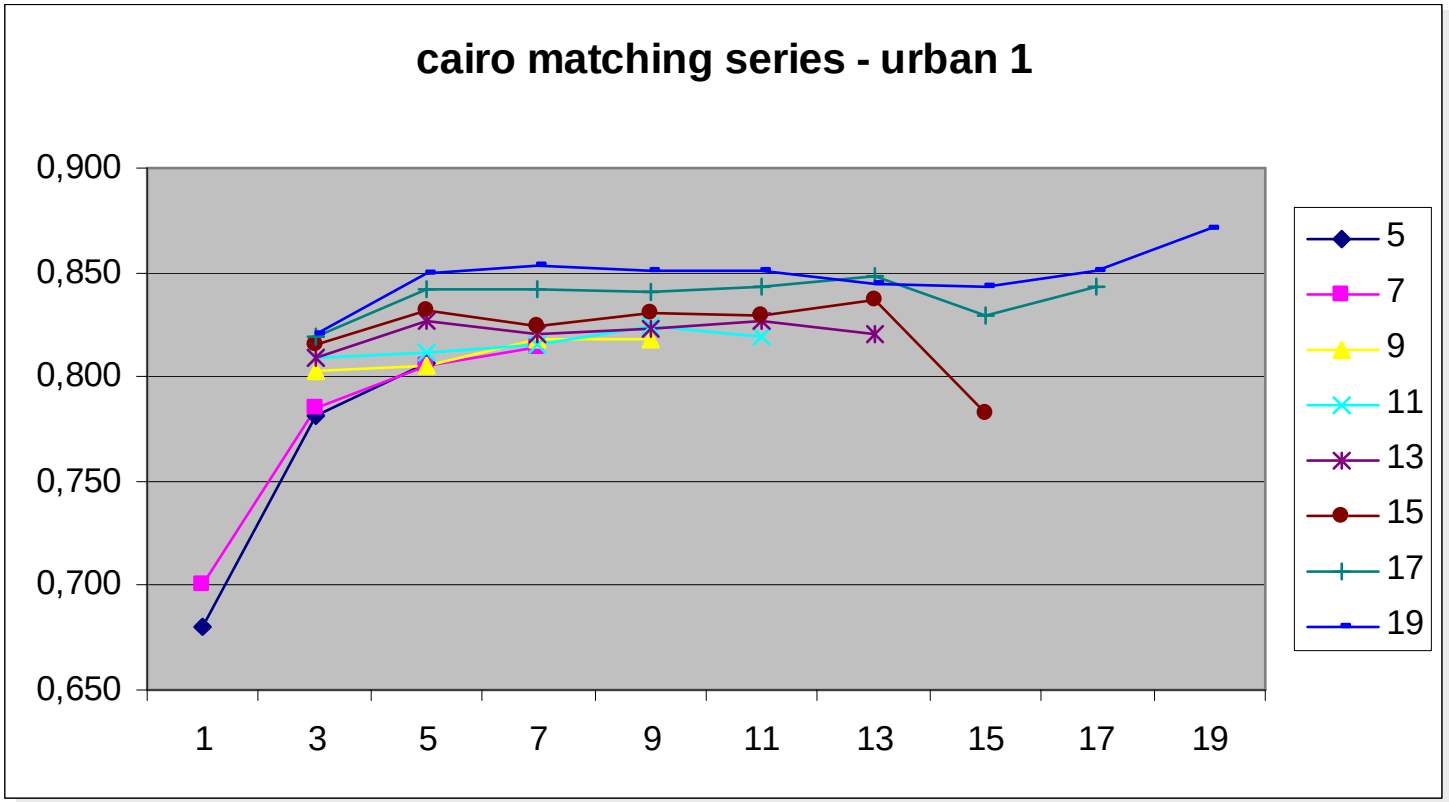
Ghent, urban


urban
100,0
95,0
90,0
85,0
80,0
75,0
succesful match %
1
3
5
7
9
11
13
15
17
19
col/row space
5
7
9
11
13
15
17
19

Cairo
urban 1


cairo matching series - urban 1
0,900
0,850
0,800
0,750
0,700
0,650
1
3
5
7
9
11
13
15
17
19
5
7
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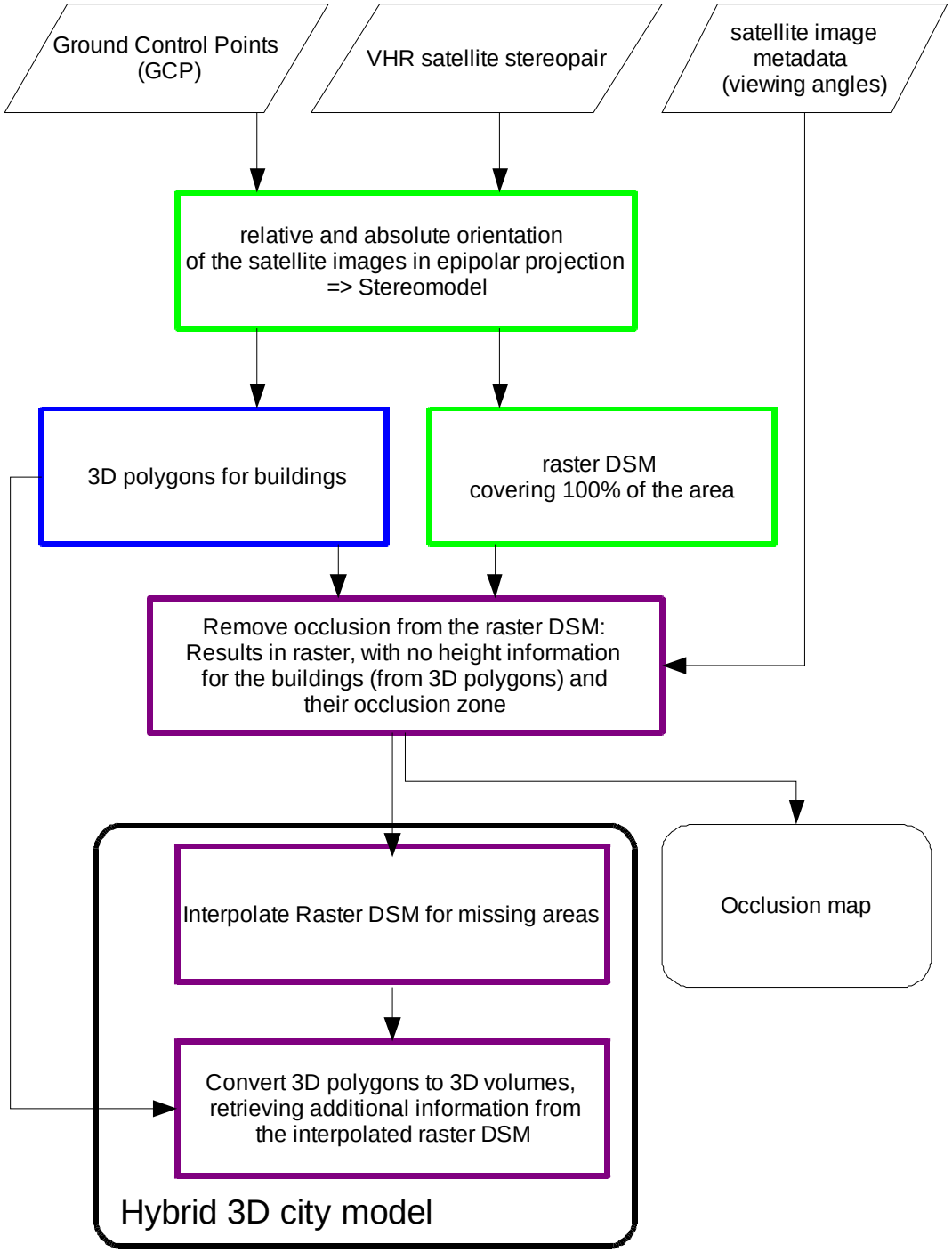
15
17
19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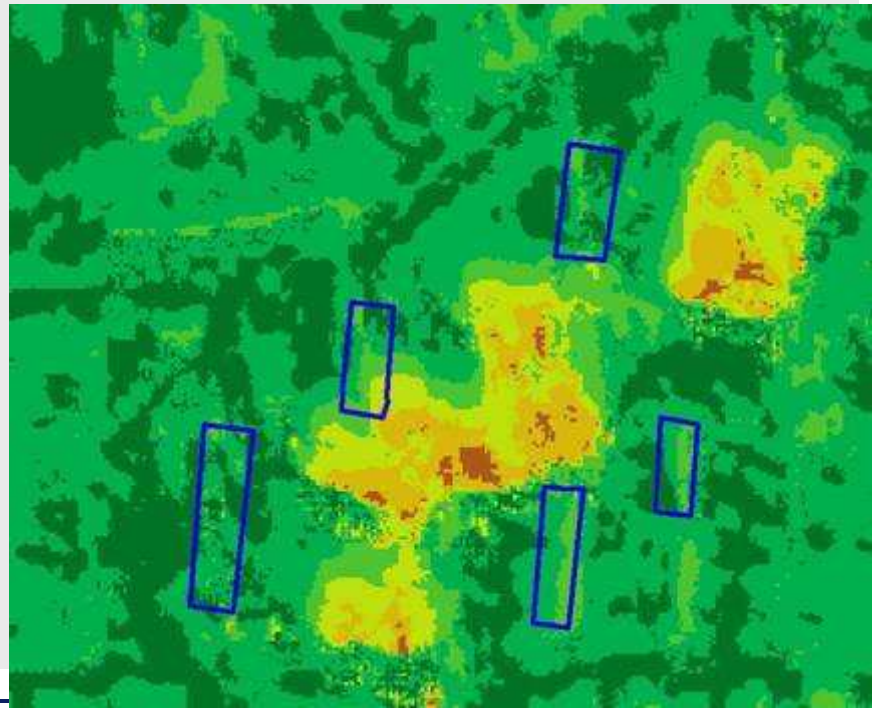
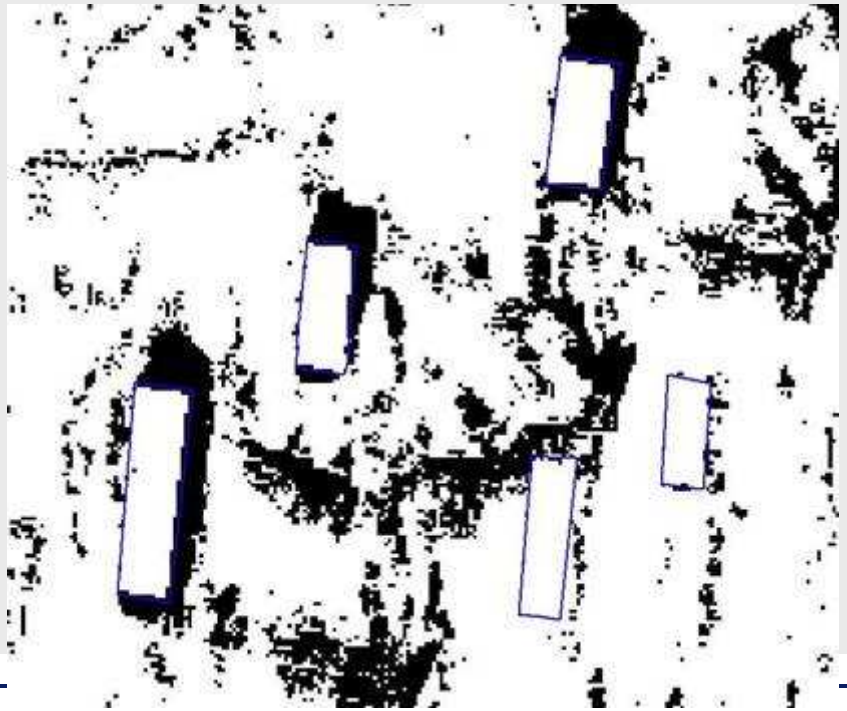
Hybrid 3D city model

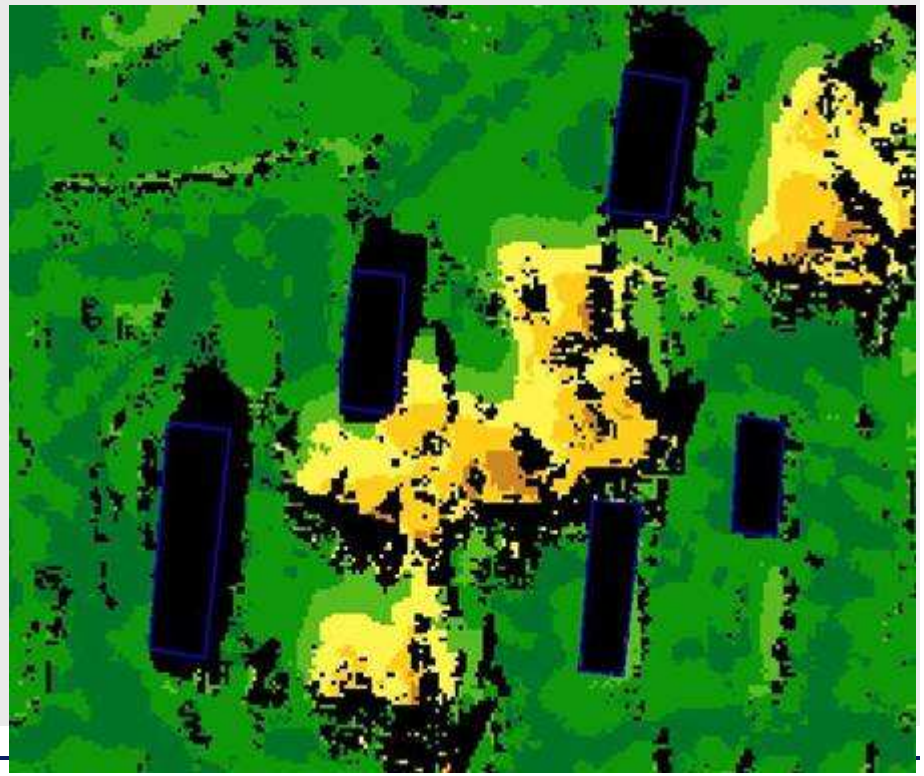
Initial raster DSM and 3D features



Combined occlusion map



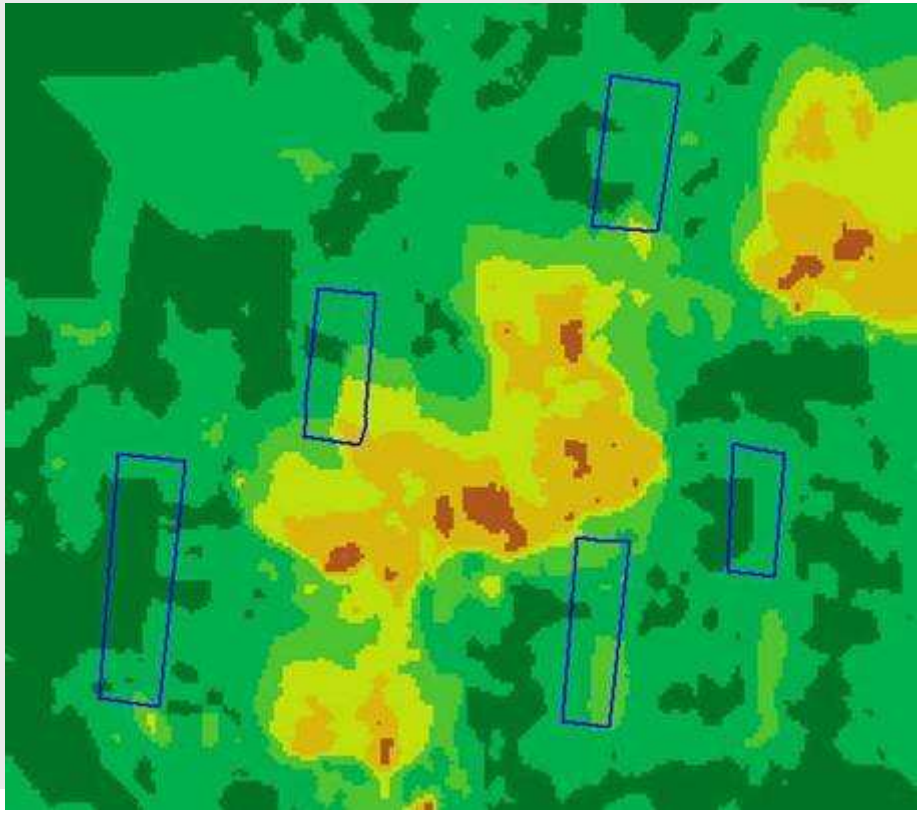
Raster DSM without occlusion and building



Interpolation

Overestimation height

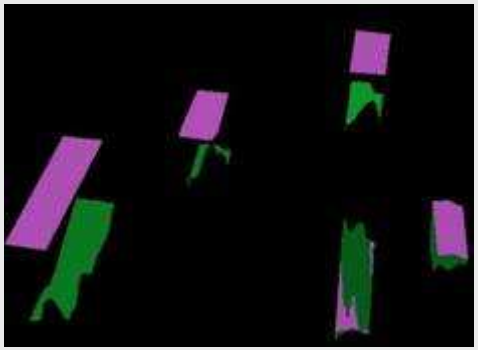
Effect of occlusion reaches beyond occlusion area

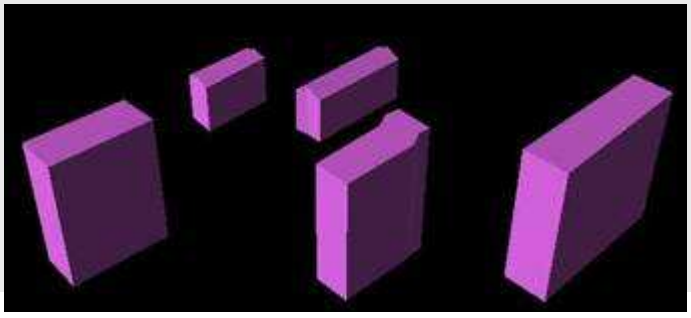


Converting 3D features to solids

New 3D features at ground level.

Any errors in the raster interpolation influence the quality of this product





Conclusion and future work (1)

- Raster DSM extraction from VHR stereopairs optimised
- Generating occlusion maps : workable method, improvement possible
  - Direct projection of 3D features on raster DSM
  - Influence of vegetation
- Conversion of 3D features to 3D solids

Conclusion and future work (2)

- Continue DSM production and processing for Cairo test sites
- Accuracy analysis for the test areas in Ghent

Questions and discussion