CycloMedia's aerial and ground-based image databases

NCG – December 18, 2008

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Overview

- Introduction
- Aerial imagery
  - LuchtfotoNL project
  - Image database
- Terrestrial imagery
  - Mobile Mapping System DCR7
  - System Calibration
  - Panorama database
- Research at CycloMedia
  - Future of the databases
- Conclusions

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Introduction to CycloMedia

- Spin-off (1989) T.U. Delft, Faculty of Geodesy
- Specialized in large-scale, systematic geo-imaging:
  - Aerial: The Netherlands complete, except Schiphol area
  - Terrestrial: The Netherlands completed, now updating

- Aerial:
  - LuchtfotoNL project in 2008
- Terrestrial:
  - Georeferenced 360° panoramic imagery from all public roads
  - Mobile mapping systems developed in house
  - Up to date imagery (Netherlands of 2006 or more recent)
  - History (recordings of previous years are kept)

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Aerial Imagery: LuchtfotoNL 2008

- Unique project: 10 cm resolution of the entire Netherlands

- Data is captured by Blom Aerofilms Ltd.

- Specifications and quality control by ingenieursbureau **Geodelta**

- Stereo imagery
- Ortho photo mosaic

- One season: 4 planes

- Yearly updating

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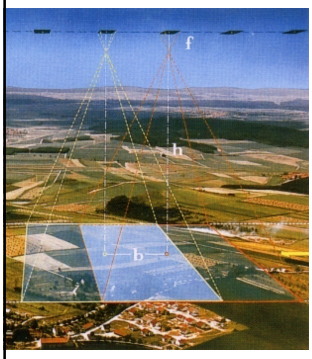
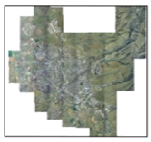
LuchtfotoNL 2008 - Workflow



Ruwe beelden

Controle punten
Aerotriangulatie
Blokvereffening

Cut lines
AHN 25



Ortho10
Orthofotomozaïek
10 cm GSD, +/- 20 cm XY
Nauwkeurigheid

Stereo10
Sterecbeelden 10 cm GSD
Klaar voor gebruik in
fotogrammetrische werkstations

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LuchtfotoNL 2008 – some numbers

- Camera: Vexcel Ultracam D & X:
  - D: 90 Mpixel & X: 140 Mpixel
- Overlap: 60% / 30%
- 150,000 stereo images: ~ 40TB
- Orthophoto: ~ 10 TB
- Total storage > 50 TB

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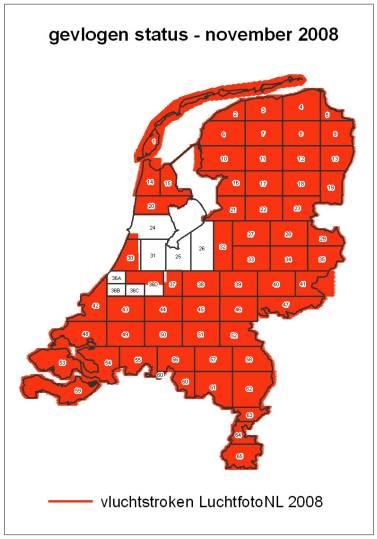
LuchtfotoNL 2008 – current status

- 92 % photographed
- Schiphol area missing ...
- Ongoing:
  - Orthophoto production
  - Delivery
- Planning for next year:
  - Higher resolution?
  - More overlap?
  - Demand?



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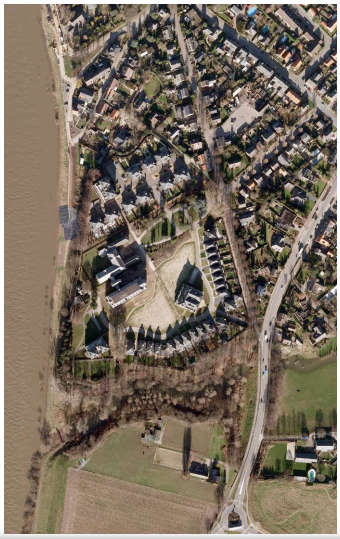
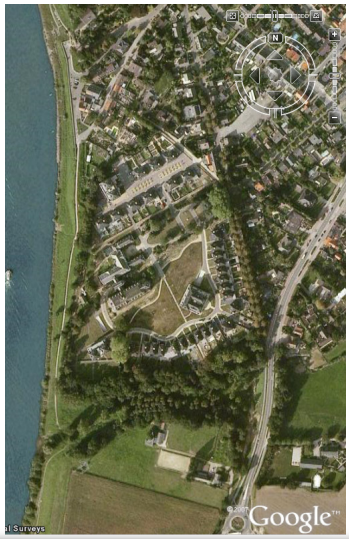
Aerial photography 10 cm resolution





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LuchtfotoNL 10 cm resolution (Google)

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LuchtfotoNL 10 cm resolution (CycloMedia)

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  - **Mobile Mapping System DCR7**
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Terrestrial Imagery

- CycloMedia develops mobile mapping systems in-house:
  - Bringing aerial photogrammetric principles “to the ground”
  - Including elaborate system calibration

- And CycloMedia develops:
  - Cyclorama production and hosting software
  - Tools for viewing, GIS-integration, 3D measurement
  - Content analysis tools (new!)
- Core product: 360º spherical panorama’s
- 16 mobile mapping systems in operation (end 2008)
- Yearly updating

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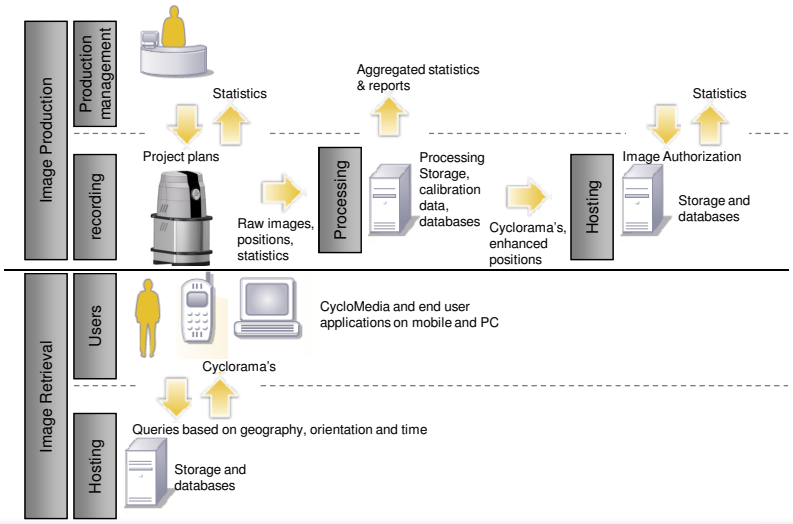
More than a recording system: the workflow



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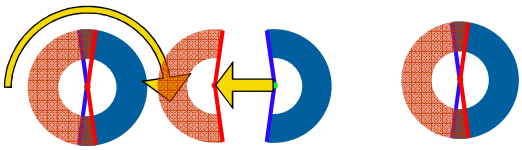
Principle of old versus new recording system



180º rotationdrive

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Prototype DCR7a

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DCR7 production version

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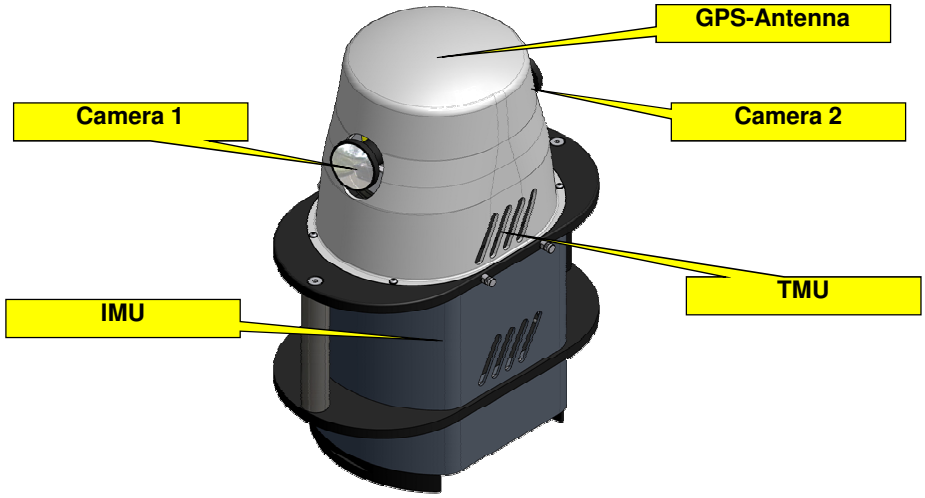
DCR7 Camera System



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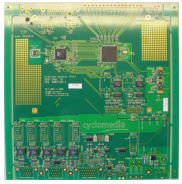
DCR7 main components

Camera System

Camera Control



Display

Positioning System

DMI: 2x

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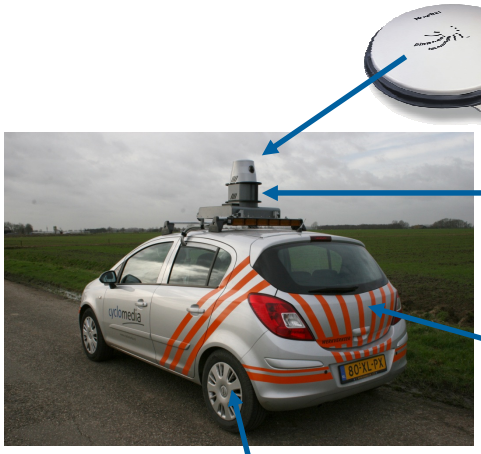
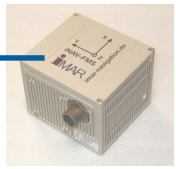
DCR7 Positioning System: GPS + IMU + DMI





NovAtel OnBoard

NovAtel's SPAN (Synchronized Position Attitude & Navigation)

www.novatel.com

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DCR7 Panorama Specifications

- Resolution ~ 10 Mpixel (13 mm pixel at 10 m)
- Seamless and parallax free (<1 pixel)
- Known image geometry: suitable for photogrammetry
- Georeferencing: position 0.1m, orientation 0.1 °

Only possible after system calibration

DCR7 Calibrations: goals

- geometrically correct Cycloramas:
  - accuracy < 1 pixel
  - invisible stitch
  - accurate 3D photogrammetric measurement
- correct orientation of Cyclorama relative to IMU
  - accuracy < 0.1 degree
  - leveled Cyclorama
  - correct horizontal orientation
- correct position of Cyclorama relative to IMU:
  - eccentricity vectors of cameras
  - eccentricity vector of GPS antenna

Positioning system SPAN results in correct position and orientation of IMU.

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Calibration steps

Calibrations consist of two main steps:

1. Indoor:
   - **Camera/lens parameters** per camera
   - **Relative boresight** (= orientation) of both cameras
   - Location of fiducials and grey card
2. Outdoor:
   - **Absolute boresight** of the cameras in relation to the IMU

No need for calibration of eccentricity vectors:
design values are accurate to mm-level.

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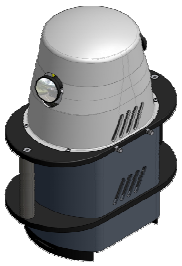
Panorama database – some numbers

- In database for The Netherlands:
  - Cyclorama's taken before 2006
  - > 10 milion Cycloramas at 10 m interval (2006, 2007)
- > 10 milion DCR7 Cycloramas at 5 m interval (2008)
- International projects:
  - Sweden
  - Litunia
  - Switzerland
  - UK
  - Belgium
  - Germany
  - Middle East
- Total storage: order 100 TB



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Research at CycloMedia

- DCR with significantly higher image resolution
- Development of applications:
  - New viewers
  - Integration with GIS and mapping tools
  - Automatic content analysis
- Large-scale 3D reconstruction:
  - Automated 3D reconstruction and modeling
  - 3D Cyclorama production

Integrated use of Cycloramas and aerial images

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Implications for the database

- DCR with significantly higher image resolution
  Data amounts will grow much faster
- Development of applications:
  - New viewers
  - Integration with GIS and mapping tools
  - Automatic content analysis

  New types of data to be accommodated
- Large-scale 3D reconstruction:
  - Automated 3D reconstruction and modeling
  - 3D Cyclorama production

  Shift from 2D to 3D data models

Next: status on the above research topics

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DCR 8: 5 times higher resolution locally

No gaps with 5 meter Cyclorama interval

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New Viewer: integration with aerial imagery

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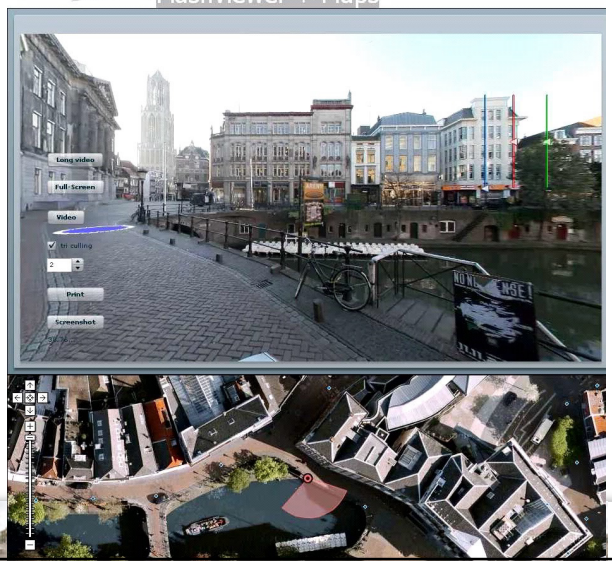

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New Viewer: movie option

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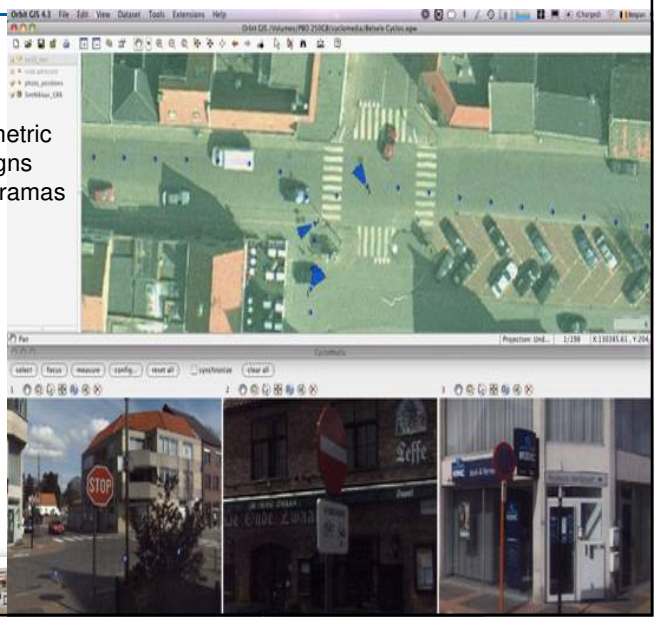
Integration with OrbitGis

Manual photogrammetric mapping of traffic signs using multiple Cycloramas



Automated Content Analysis: Traffic Signs

- New algorithm for automatic sign detection and recognition
- Detection score above 99%!
- Patent application pending
- To be extended to other objects and semi-automatic mapping

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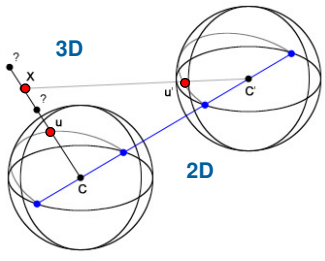
Large-scale 3D reconstruction

- Currently: Automated 3D reconstruction of point cloud
- Future: semi-automatic 3D modeling



top view of point cloud

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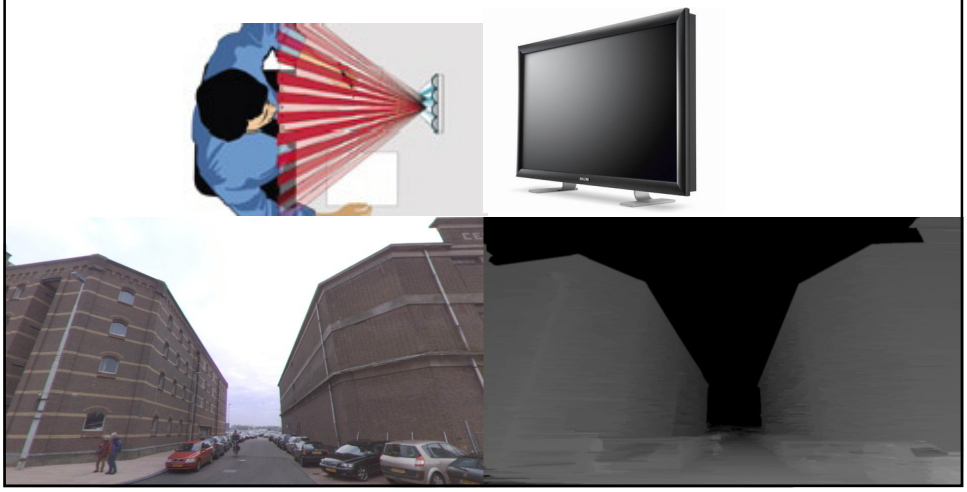
Large-scale 3D reconstruction

- Large-scale 3D Cyclorama production
- Displayed on Philips 3D display (WowVX technology)



Conclusions

- Now: Core spatial image data is available
  - High quality
  - Continuously updated
  - Data amounts increasing fast
- Future: Information extraction
  - Large-scale: what can be automated?
  - Object detection and recognition, 2D and 3D
  - Automated mapping/modeling from aerial and terrestrial images

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