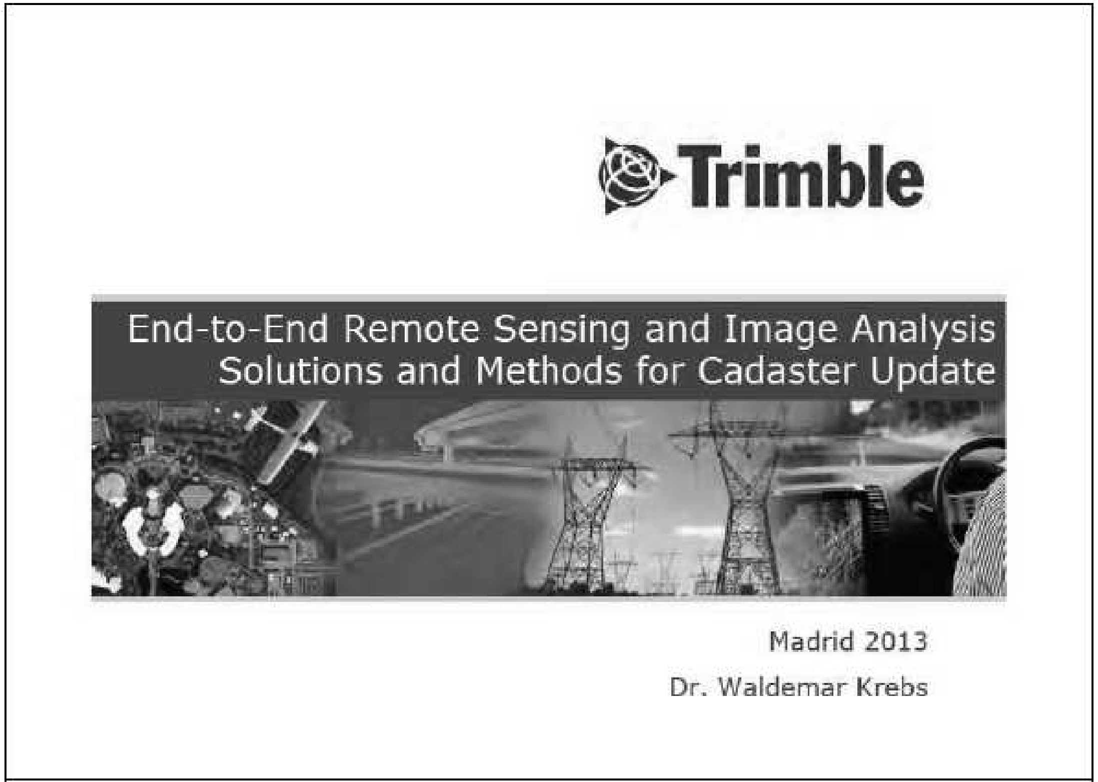


Trimble

End-to-End Remote Sensing and Image Analysis Solutions and Methods for Cadaster Update

Madrid 2013

Dr. Waldemar Krebs

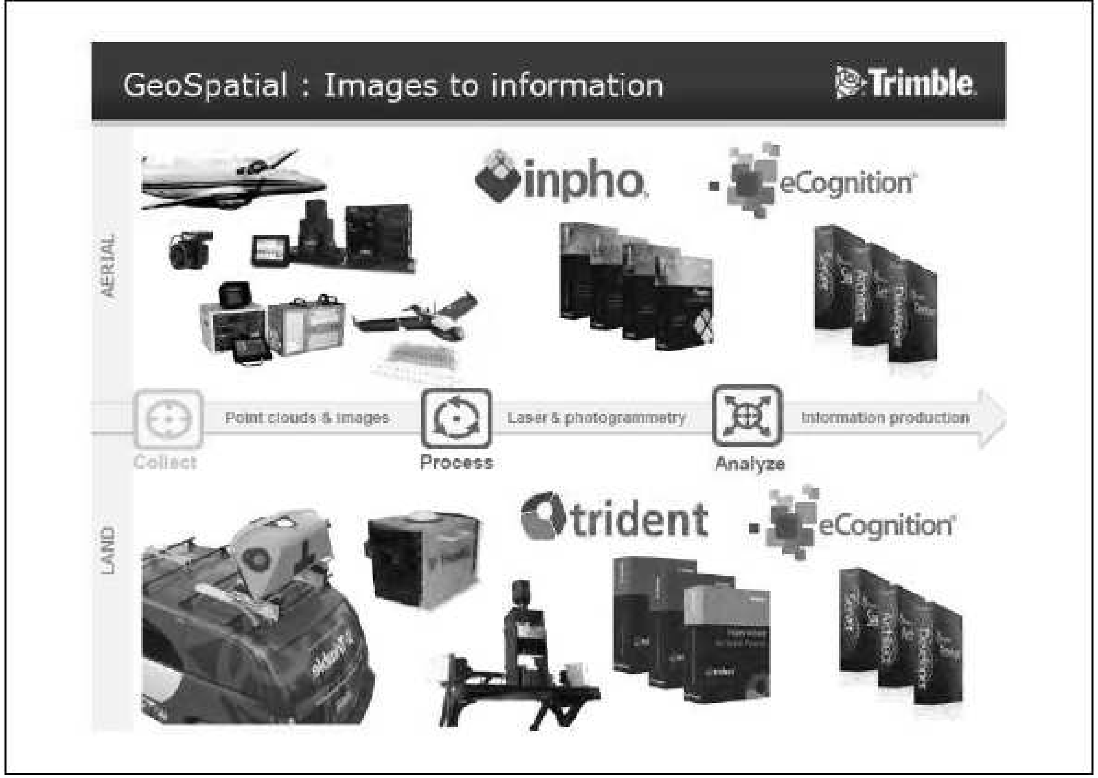
Aerial Workflows: field-to-finish

Trimble

- Medium Format Camera
- Direct Georeferenced Camera System
- Laser Scanning (LiDAR) with Imaging

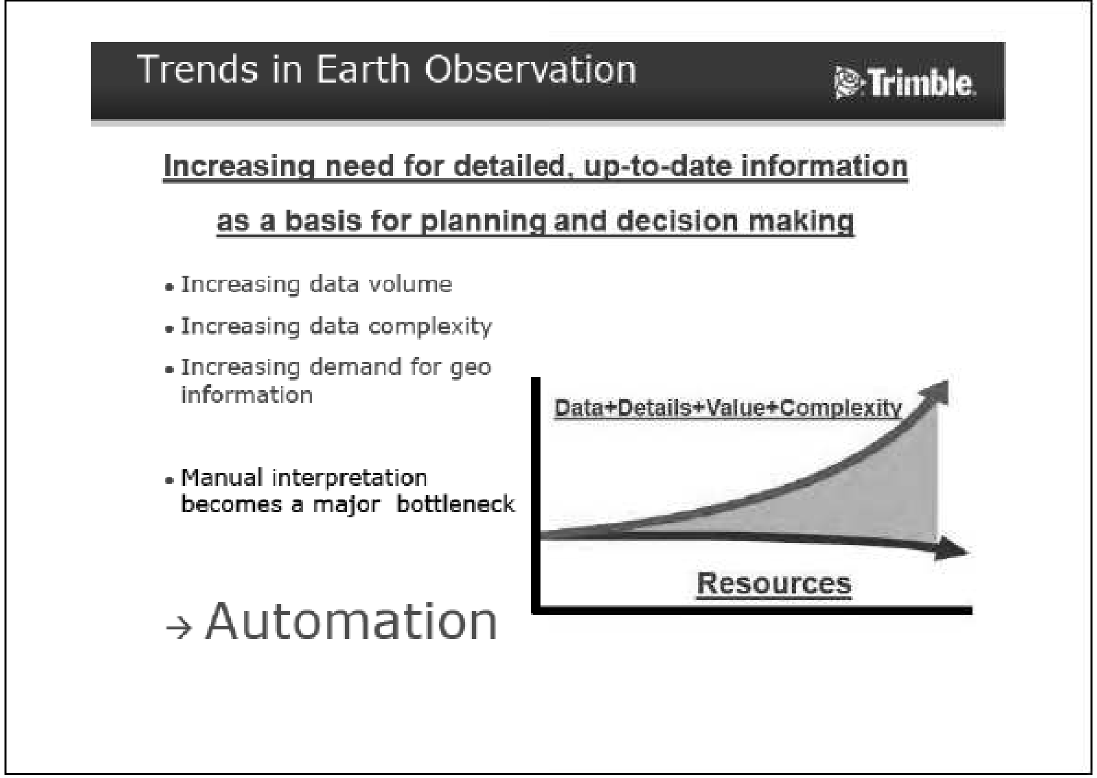
- Ortho Photos
- Image Mosaics
- Elevation Models

- Data Fusion
- Feature Extraction
- Automated Interpretation



GeoSpatial : Images to information

Trimble



Trends in Earth Observation

Trimble

Increasing need for detailed, up-to-date information as a basis for planning and decision making

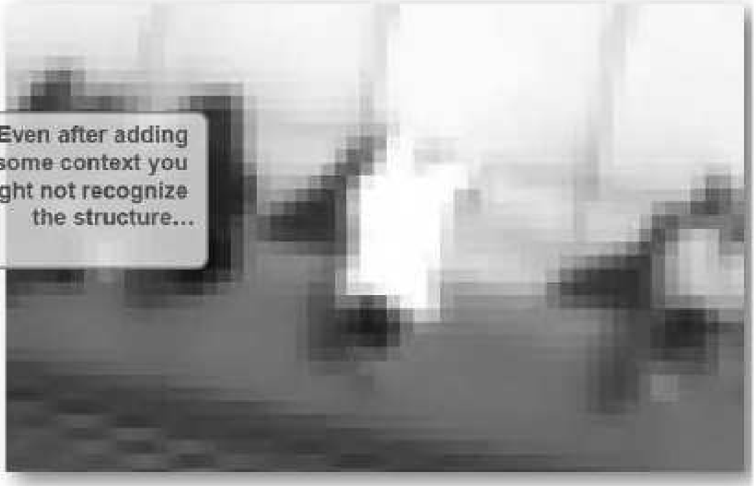
- Increasing data volume
- Increasing data complexity
- Increasing demand for geo information
- Manual interpretation becomes a major bottleneck

→ Automation

eCognition Technology

eCognition Community

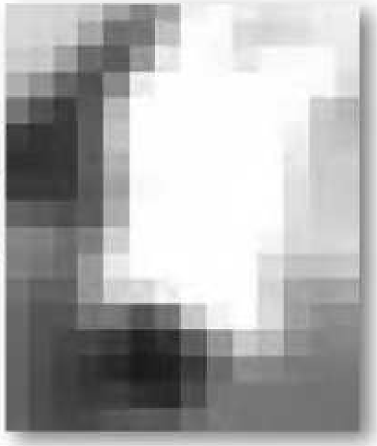
Information Extraction



Even after adding some context you might not recognize the structure…

Information Extraction

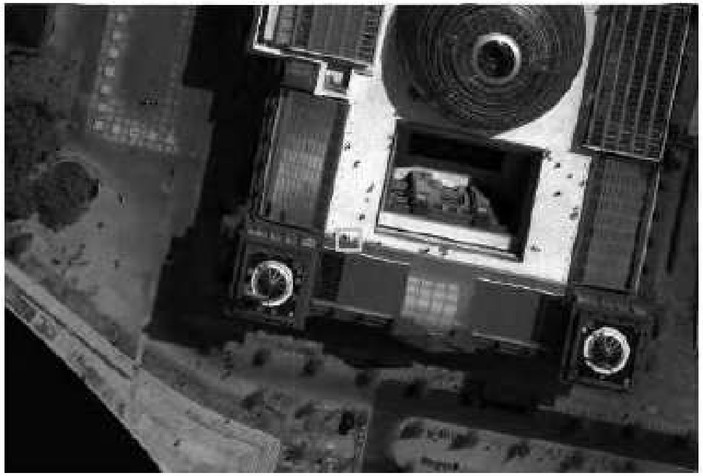
→ Context counts



Which kind of structure can be seen here?

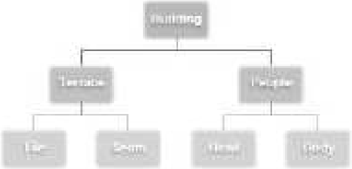
Information Extraction

→ Context counts



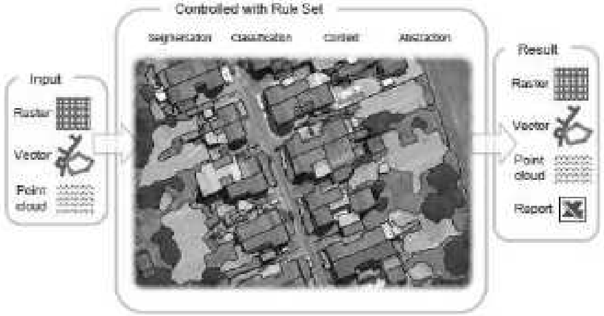
Why do we see what we see?

- Human Visual Perception
  - Analyzes groups of pixels
  - Incorporates context
  - Works on multiple scales



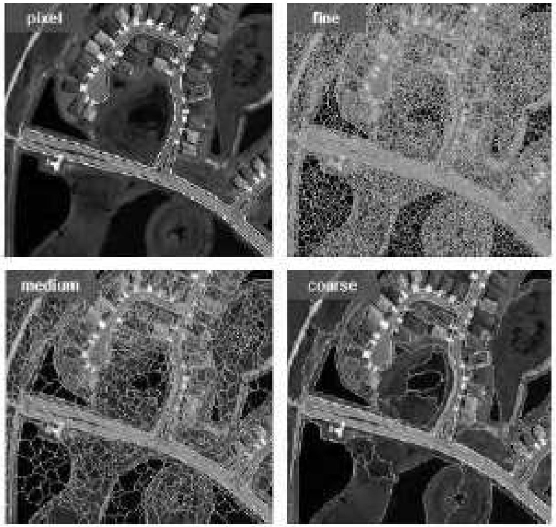
→ So does Object Based Image Analysis (OBIA)

Dynamic image analysis workflow



- fuses raster, vector and point cloud data stacks for processing
- uses pixels, objects and object networks for superior analysis
- leverages context rules to achieve greater result accuracy
- enables 2D, 3D and time series data analysis

Multiresolution Image Segementation

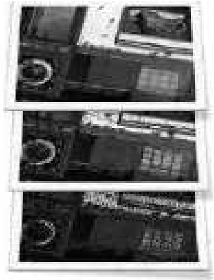


Object generation on multiple scales to adress differently scaled classification task within one project

Build up a hierarchical network of image objects, which allows the representation of the image information content at different resolutions (scales) simultaneously.

Core Technology Components

Image Object Hierarchy



Object Attributes

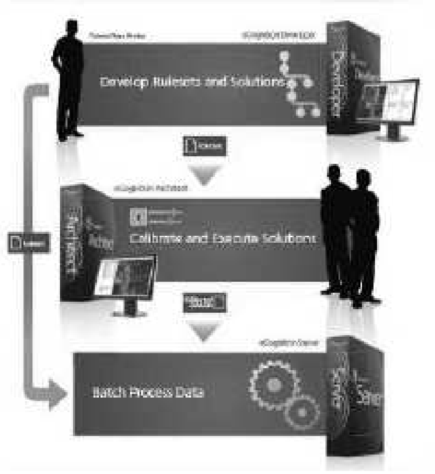
Rule Set
(Cognition Network Language)

eCognition Software Suite

eCognition Developer
Is the development environment for object-based image analysis.

eCognition Architect
Provides an easy to use front end for non-technical professionals allowing them to leverage eCognition technology.

eCognition Server
Provides a processing environment for the batch execution of image analysis jobs.



Cadastral Change Detection

eCognition Community

Christian Weise

Aerial Workflows: field-to-finish

inpho

eCognition

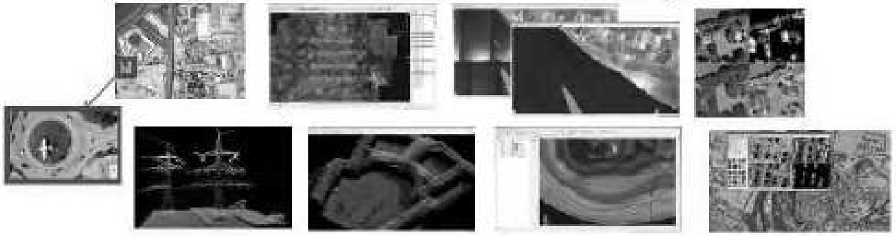
AERIAL

- Medium Format Camera
- Direct Georeferenced Camera System
- Laser Scanning (LiDAR) with Imaging

- Ortho Photos
- Image Mosaics
- Elevation Models

- Data Fusion
- Feature Extraction
- Automated Interpretation

Collect → Point clouds & images → Process → Laser & photogrammetry → Analyze → Information production



Cadastral Change Detection

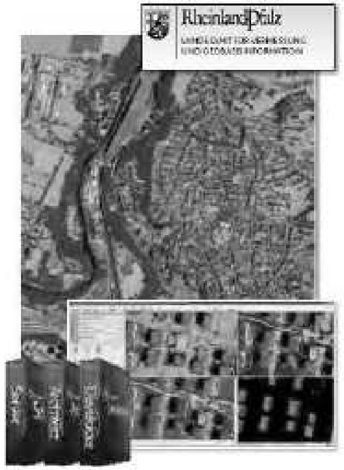
- Project PI – Cadaster Administration Rheinland-Pfalz
  - Landesamt für Vermessung und Geobasisinformation, Rheinland-Pfalz, Germany
- Background
  - Excellent precise cadaster
  - But too "old"
  - Change detection based on aerial data time consuming (20.000 images)
- Goal
  - Semi-Automatic detection of changes
  - Optional adjustment of automatic processing
    - Consideration of changed input data
    - Definition of change
      - Area
      - Tolerance
  - **Easy to Use** User interaction by means of easy-to-use graphical user interfaces (GUI)

▨ Existing Buildings

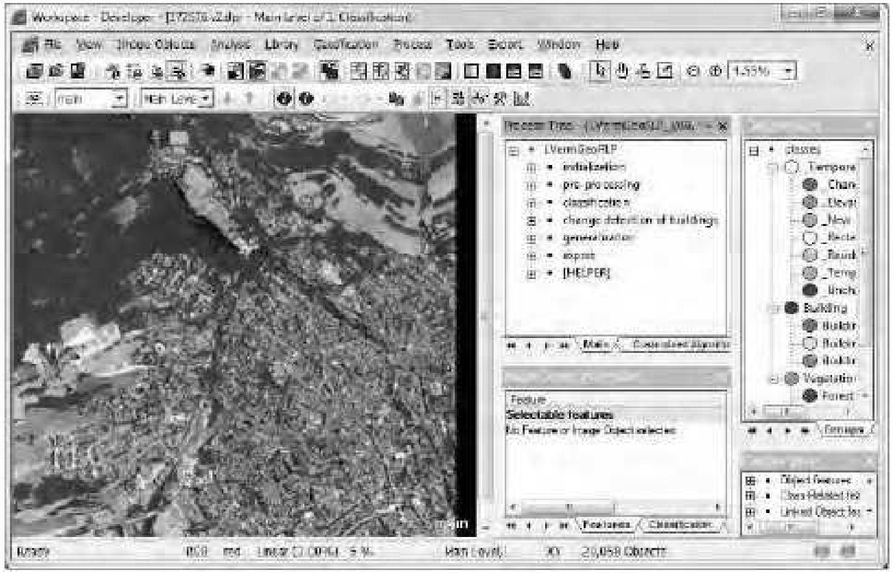
⬚ Development Area

Cadastral Change Detection

- Solution
  - Automated detection of building changes in cadastral data (building footprints vs. aerial photography and height data)
  - Extracted information
    - Buildings
      - New buildings
      - Changed buildings
      - Non mapping-relevant
    - Vegetation
      - Elevated vegetation
      - Ground vegetation
  - GUI for optional manual adjustment of automatic processing rules
  - GUI for visual quality assurance/control (QA/QC) and manual editing
  - GUI based on user requirements
- Data
  - **RGB + NIR ortho-photos (0.2 m)**
  - **LIDAR DSM/DTM (1 m)**
  - **Building footprints (Vector)**

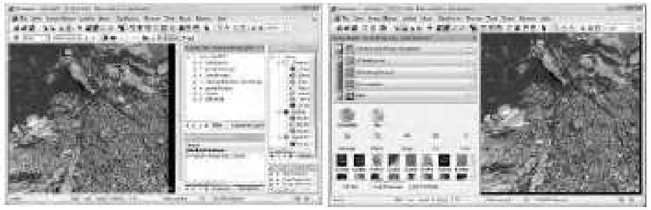


Tools – Calibration

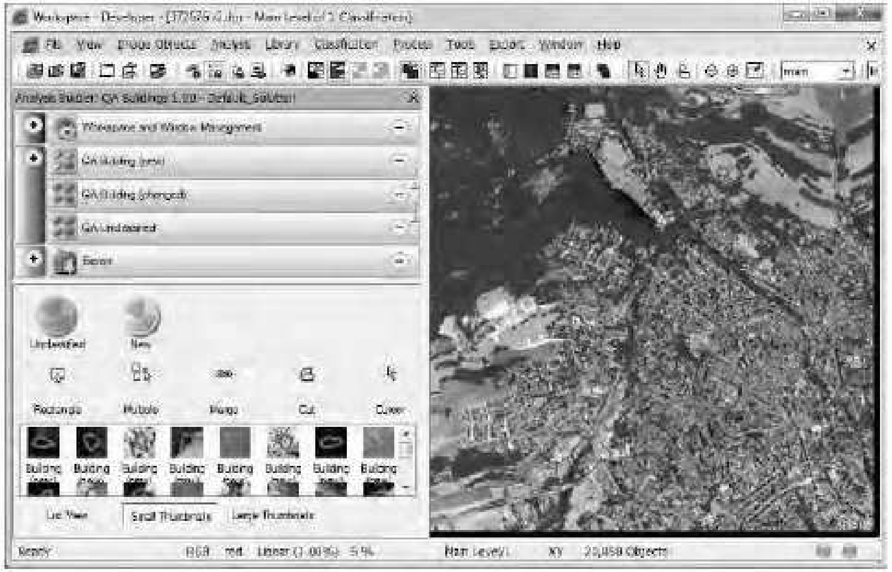


Results– Architect Solution

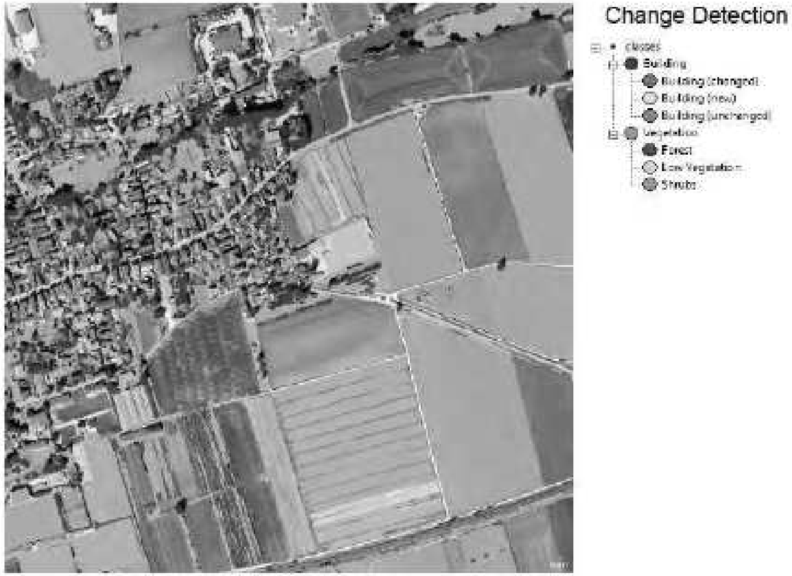
eCognition®



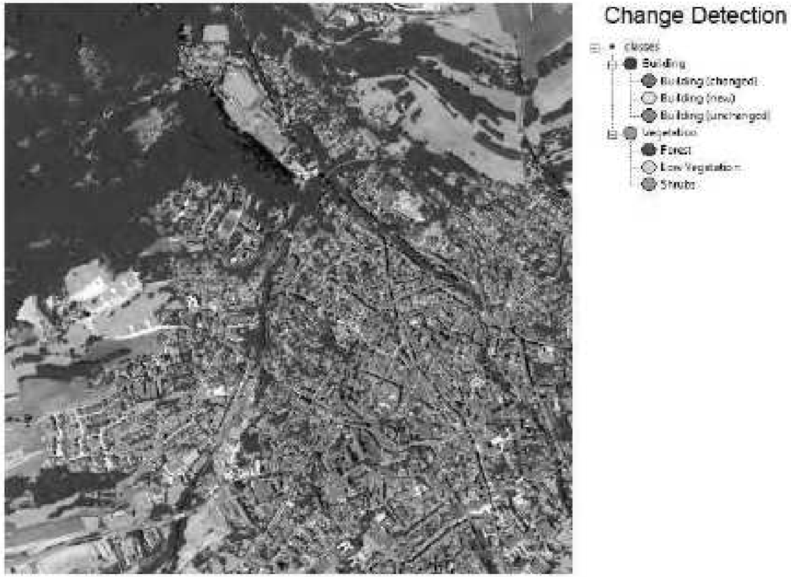
Tool – Quality Control



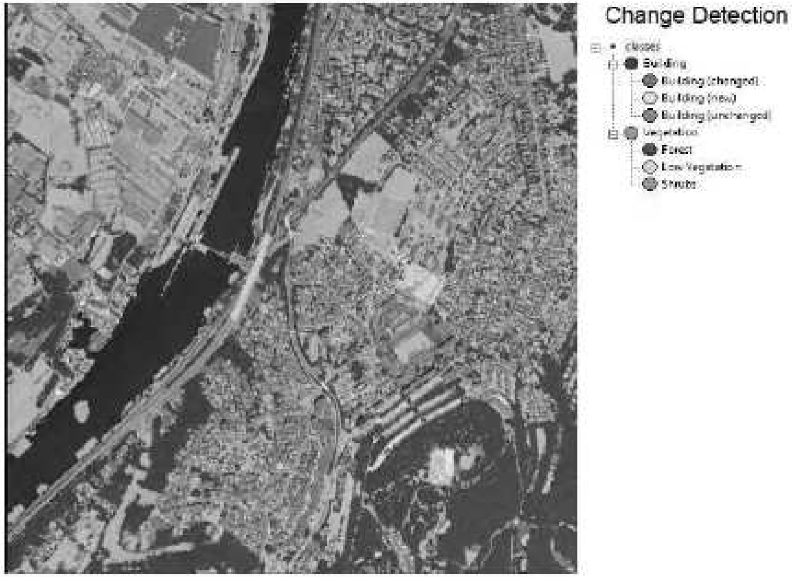
Result– Example „448_456"



Result– Example „372576"



Result – Example „328510"



Cadastral Change Detection

"eCognition and Inpho software allows us to automate time-consuming image processing workflows. Furthermore change detection of cadastral buildings (land survey register) with eCognition can be standardized and the effort for visual image interpretation and field comparison can be reduced."

Tile	Processing [h]	QA [min]	Details: QA [min]		
			New	Changed	Non Mapping-relevant
378604	01:21:43	7	4	2	1
376608	01:38:54	10	6	1	3
382586	01:09:52	10	6	2	2
382590	01:12:19	6	4	1	1
378608	01:13:49	3	2	0	1
384586	01:15:19	6	3	1	1
386586	01:05:09	27	14	8	5
...	...	...	...	...	...

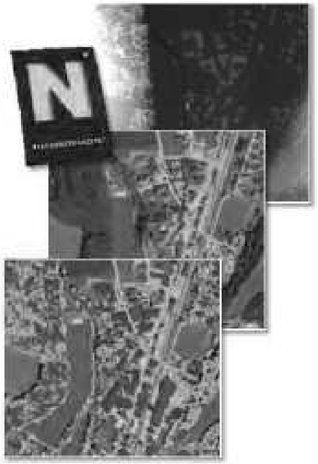
Building and Vegetation Extraction

eCognition Community

Christian Weise

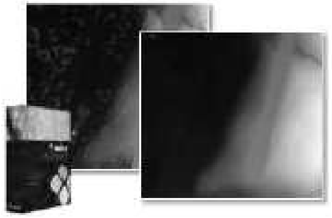
Building and Vegetation Extraction

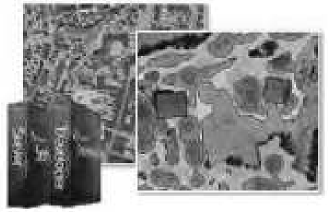
- Project PI
  - Amt der Niederösterreichischen Landesregierung (Government Lower Austria), Austria
- Background
  - Environmental Noise Directive of the European Parliament and Council requires up-to-date information about elevated objects for modeling sound-wave propagation
  - 20.000 RGB/NIR + Lidar (Lower Austria)
  - 60.000 RGB/NIR + Lidar (Austria)
  - Highly cost efficient and standardized
- Goal
  - Automatic LiDAR/RGB-NIR data processing
  - Automatic detection and classification of elevated objects
    - Buildings
    - Elevated Vegetation



Building and Vegetation Extraction

- Solution
  - Automated LiDAR processing with *Inpho Scope++*
    - Ground/non ground classification
    - Point cloud filtering
    - Mosaicing and tiling
  - Automatic information extraction with *eCognition Server*
    - Buildings
    - Vegetation (5 m height classes)
- Data
  - RGB orthophotos (0.15 m)
  - CIR orthophotos (0.15 m)
  - LiDAR DSM/DTM (1 m)





Input Data & Objectives

- **Input data:**

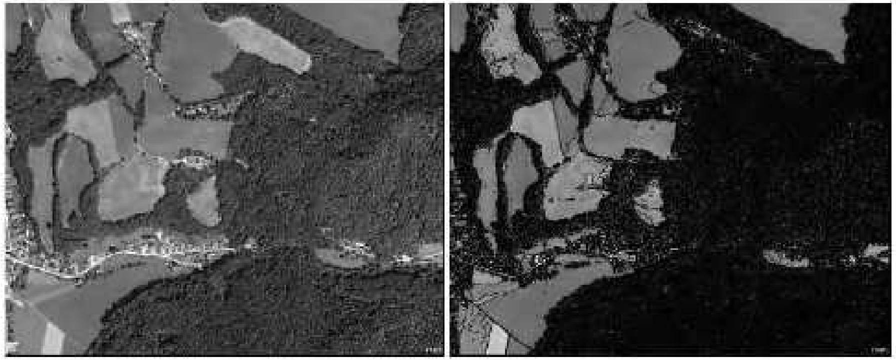
Digital Orthofotos (RGB+NIR; 0.15 cm; Austrian Sheet Line: 8340x6673 pxl) | **Digital terrain model** (1 m) | Digital surface model based on LiDAR (1 m)

- **Rule Set development for a object based extraction of**
  1. **Buildings**
  2. **Vegetation**

Results – Methodology

1. Create meaningful objects

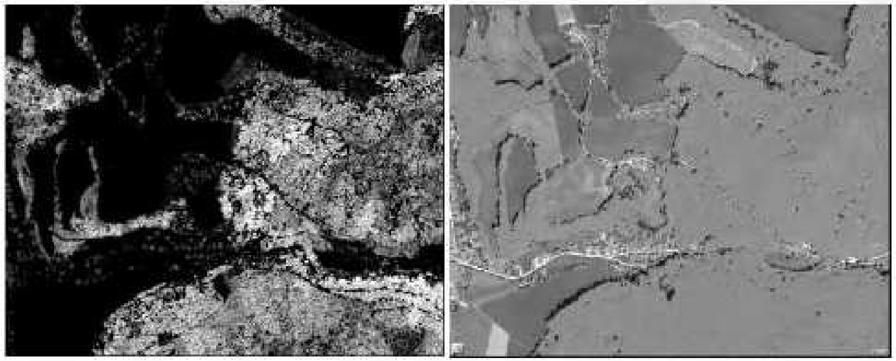
(based on orthofotos and digital surface model)



Results – Methodology

2. Classify elevated objects

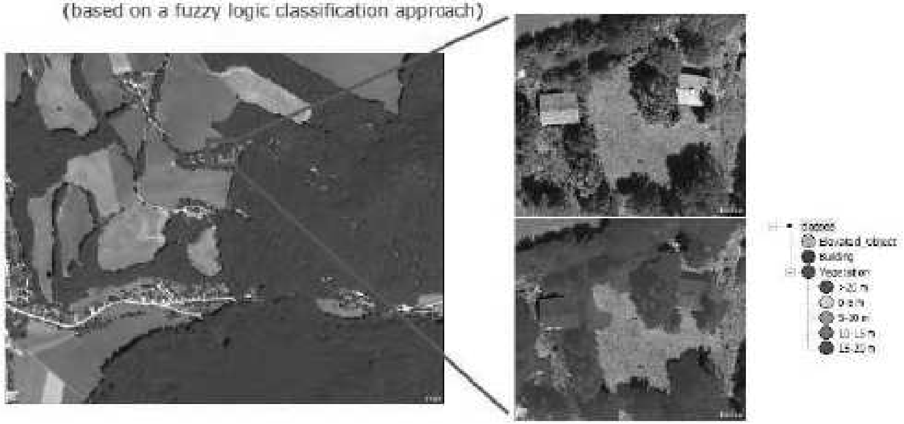
(based on the digital surface model and the digital terrain model)



Results – Methodology

3. Distinguish elevated objects into Buildings and Vegetation

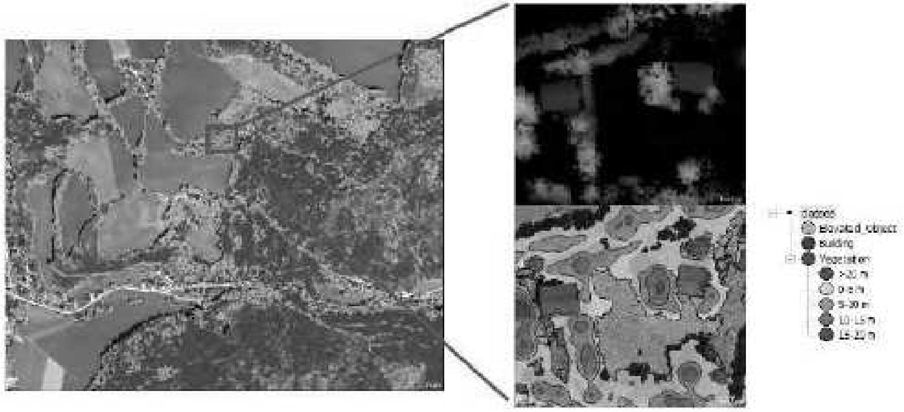
(based on a fuzzy logic classification approach)



Results – Methodology

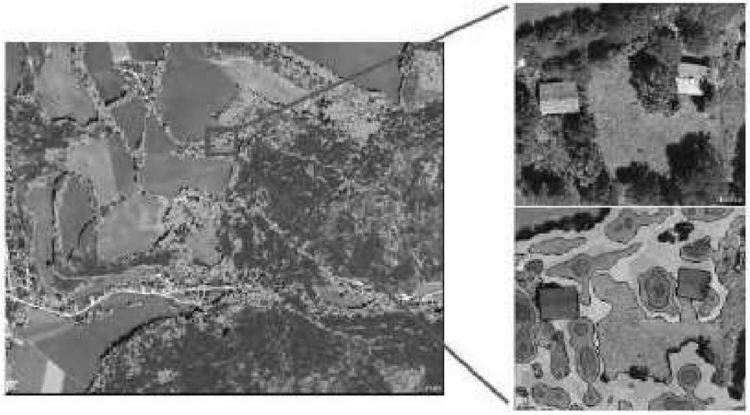
4. Distinguish Vegetation in different height classes

(based on a normalized digital surface model)

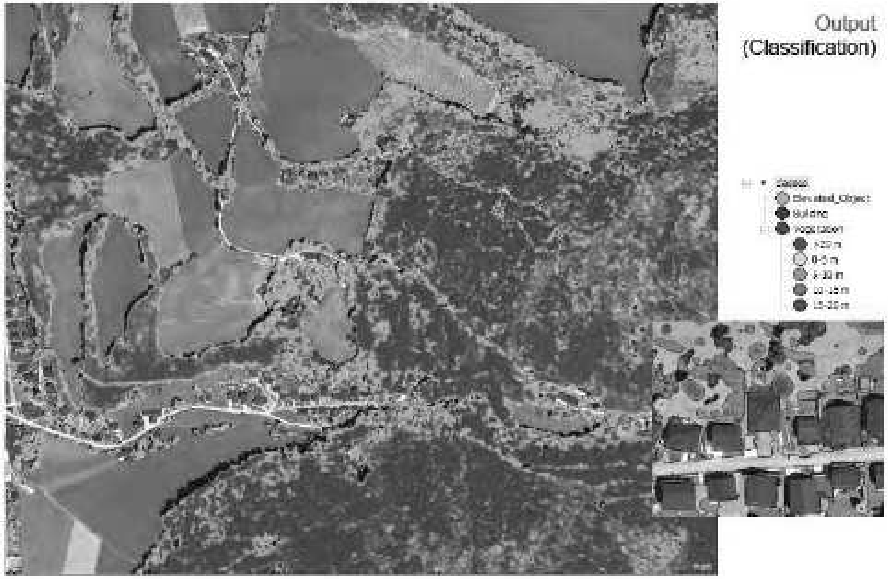


Results – Methodology

5. Generalize Buildings and Vegetation
   (based on a free customized algorithm)

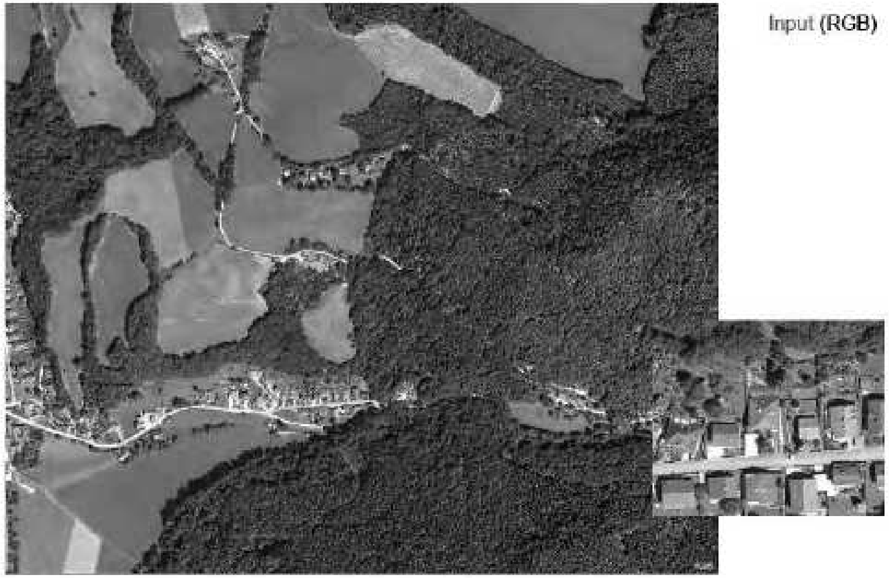


Results – Examples (742821)



Output
(Classification)

Results – Examples (742821)



Input **(RGB)**

Results – Accuracy & Next Steps

- 94,3 % for Buildings
- 96,1 % for Vegetation

Verification area: ca 200 km²;

Accuracy is the measure of "true" findings (true-positive + true-negative) divided by all test results

- Algorithm tested and works also on data
  - Australia (on 0.15m resolution, 1m dsm/dtm)
  - USA (on 0.25m resolution, 1m dsm/dtm)
  - Germany (on 0.15m resolution, 1m dsm/dtm)
  - South Africa (on 0.5m resolution, 2m dsm/dtm)!
  - Hungary (on 0.5m resolution, 2m dsm/dtm)!
  - ...

Building and Vegetation Extraction

"INPHO software allowed us to produce robust terrain models with virtually no manual interaction, enabling us to produce and manage digital terrains in a cost efficient, standardized and automated manner.

eCognition allowed us to concurrently analyze both the digital imagery and terrain models reliably extracting the land-cover and land-use information we were seeking. After testing commercially available software currently on the market, we discovered that only eCognition is able to efficiently accomplish this"

Criteria	Key Benefits	Software
Accuracy	Improved accuracy by combining optical, laser scanning and GIS data	eCognition
Costs	Manual analysis of one building accounted for 2 - 4 Euros ($3 - 6) Automated approach 0.1 – 0.2 Euros ($0.06 – 0.13), estimation depending on a classification accuracy of more than 90%	eCognition
Data Handling	Automated analysis of an area of 20,000 km² allowed for processing of large amounts of data in a timely and cost efficient manner, consequently allowing for the developement of land use models for large areas of land	eCognition

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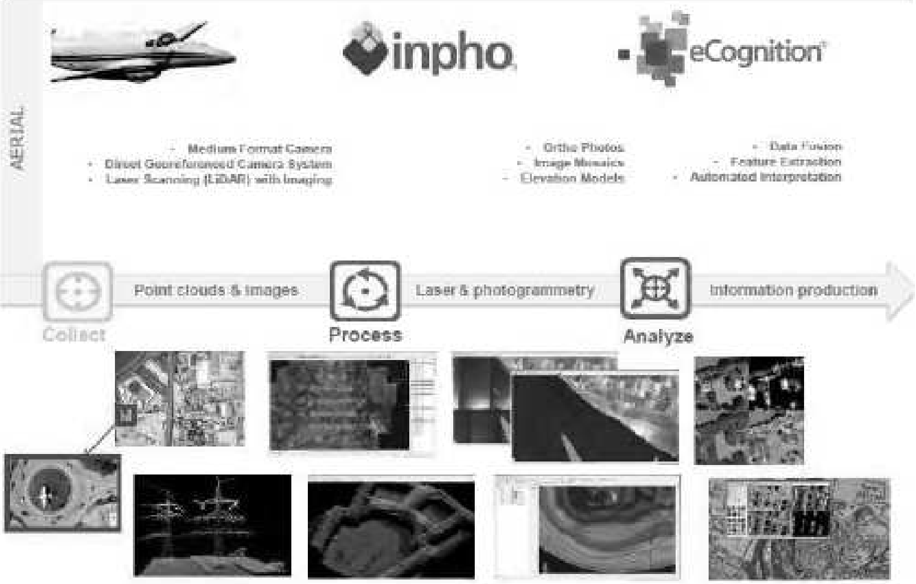
Aerial Workflows: field-to-finish



- Medium Format Camera
- Direct Georeferenced Camera System
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- Ortho Photos
- Image Mosaics
- Elevation Models

- Data Fusion
- Feature Extraction
- Automated Interpretation

Roof Type and Roof Subarea Detection

eCognition Community

Christian Weise

Input Data

Used System

Trimble Aerial Camera

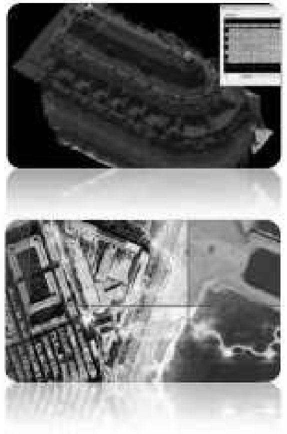
Compact, high-performance 80 MP medium format aerial camera, trouble-free operation, and advanced features such as forward motion compensation

Trimble Harrier

Combines a wide-angle full waveform digitization laser scanner with a Trimble Aerial Camera (TAC)

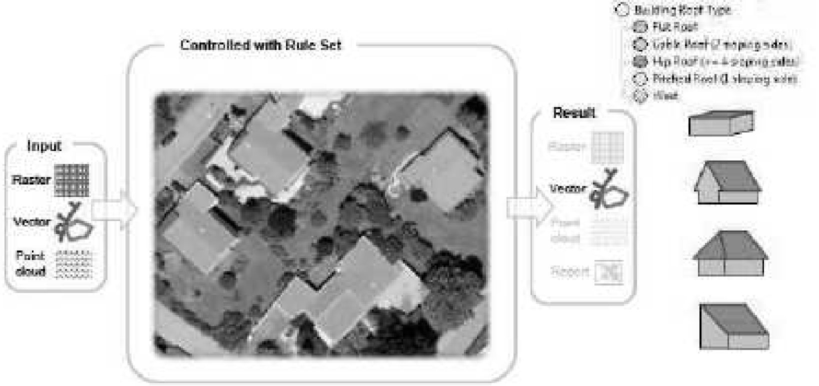
Inpho – Data Processing

- Complete high level photogrammetric workflow
- Automatic high density surface models from imagery
- Automatic city modeling
- Mass production of seamless true ortho-photo maps



Methodology

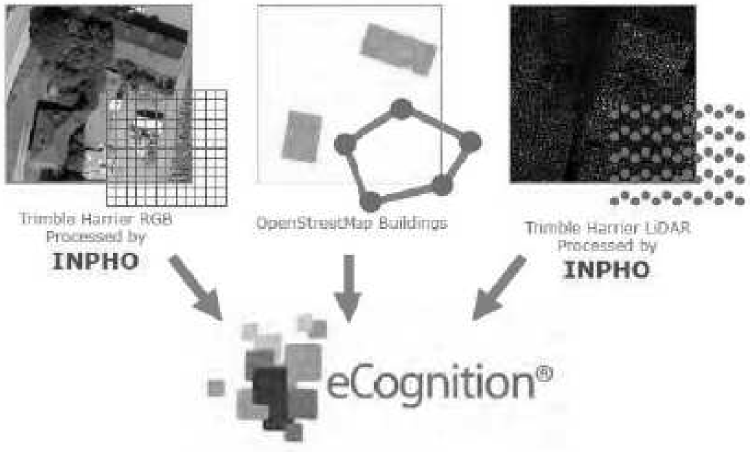
Dynamic analysis process (Rule Set)



- fuses raster, vector and point cloud data stacks for processing
- uses pixels, objects and object networks for superior analysis
- leverages context rules
- allows dynamic object transforming (building blocks → object of interest)

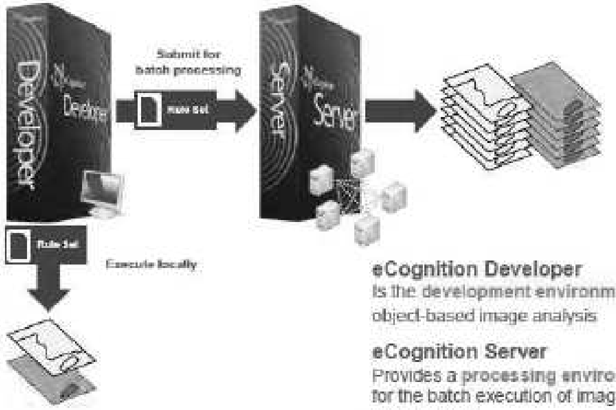
Input Data

Data Fusion



Methodology

Flexible workflow



eCognition Developer
Is the development environment for object-based image analysis

eCognition Server
Provides a processing environment for the batch execution of image analysis jobs

Results

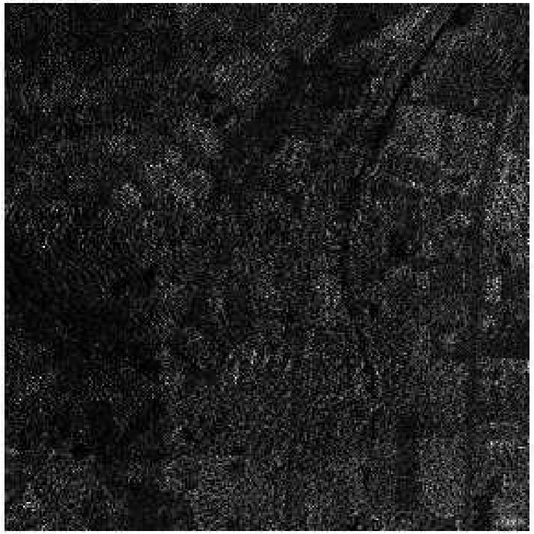
Trimble

Input RGB

Results

Trimble

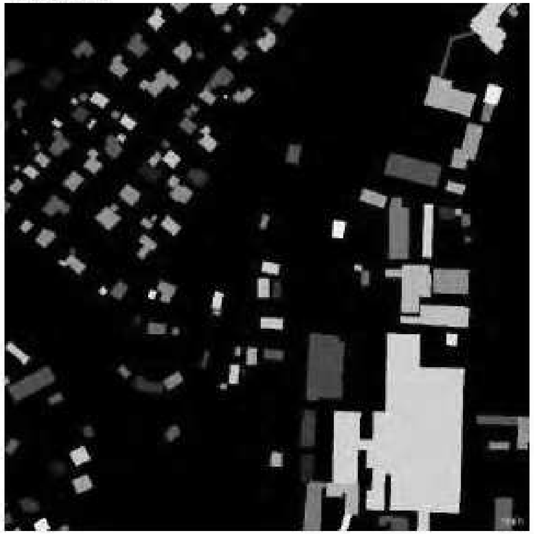
Input LiDAR



Results

Trimble

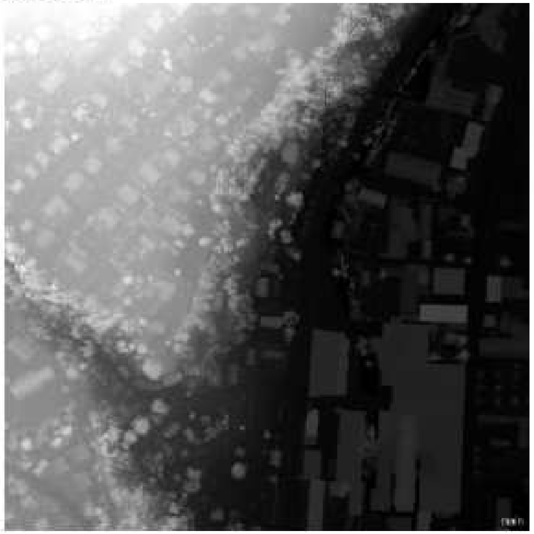
Input Vector



Results

Trimble

Output DSM



Results

Output Roof Subareas

Results

Output Roof Types

Download

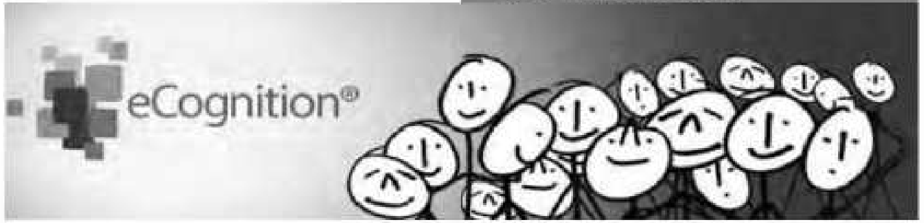
Rule Set & Data available at the eCognition Community

(Download Link)

eCognition Community

- Part of the eCognition website (http://www.ecognition.com)
- Provides an Integrated environment for
  - Discussions
  - Upload & Download Rule Sets and Guided Tours (Rule Set Exchange)
  - Product Feedback (eCognition Ideas)
  - Prototypes (eCognition Labs)
  - User Guide (Wiki)

  along with social networking facilities
- 7000+ Registered Users



Thank You