BuildingGenerator & DTMaster Building Add-On

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Content

- Introduction
  - Buildings

- Building Generator
  - Model-based approach
  - Automatic detection
  - Manual editing

- Integration in a workflow system and process control
  - novaFACTORY 3D
Buildings are easy, or?

INTRODUCTION
Construction World vs. Real World
Village

~ 80% automatic detection rate (LOD 2)
City

Construction

Special shapes

Complex building blocks

\(~ 40 - 70\% \text{ automatic detection rate (LOD 2)}\)
City – Complex Building Block

- How well are the individual buildings defined?
- Do we have for each building a footprint?
- Do we have dense LIDAR data?
What do you see?
What do you see?

- Complexity
  - Generalization challenging
  - High automation for generalization solved with model-based approach
Building Generator

MODEL-BASED APPROACH
Model-based Approach
Generalization
Generalization
Level-of-detail (LOD)

- Level-of-Detail
  - LOD2 from BuildingGenerator created
    - Buildings that cannot be created as LOD2, are created as LOD1
  - Option: Full set of LOD1

<table>
<thead>
<tr>
<th>LOD0</th>
<th>LOD1</th>
<th>LOD2</th>
<th>LOD3</th>
<th>LOD4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5D terrain model</td>
<td>bricks</td>
<td>generalized roof forms</td>
<td>Real roof forms</td>
<td>Includes interior model</td>
</tr>
</tbody>
</table>
Technology

BUILDING GENERATOR
BuildingGenerator

- **Input data**
  - Point cloud
  - Building footprints
  - Terrain model

- Automatic generation of generalized roof forms

- Input data
  - LIDAR point cloud
  - Building footprints
  - Terrain model

- Production database
  - Building structure lines
  - Building models

- Mono and Stereo editing
  - DTM
  - DSM
  - ALK
How works the BuildingGenerator?

- 3 step algorithm
  - Generalization of building footprints
  - Segmentation of roof parts
  - Modelling of buildings
BuildingGenerator

- **Step 1: Generalization footprint**
  - "Recognition" of generalized forms (rectangular, L-, U- or T-shape footprint)
BuildingGenerator

- **Step 2: Segmentation**
  - Selection of point cloud within generalized building footprint
  - Calculating for each point the normal vector
  - Clustering roof parts
  - Bounding segments (border lines definition)
BuildingGenerator

- **Step 3: Modelling**
  - Partitioning of complex buildings
    - Preset of possible partitioning methods based on generalized footprints
    - Selection of best partitioning
  - Independent modelling of the partitions with building roof forms

Example: Hierarchical partitioning of U-form

Example: Hierarchical partitioning of L-form
Step 3: Modelling

- 2D View – Footprint & Segments
- Selection of partitions
- Assignment of Segment-Partitions
- Calculation of probability values for partitioning

\[ p_i = \frac{\sum A^+ - \sum A^-}{\sum A} \]
Results – Data structure

- Ridge lines created through exact cuts of adjusted segment faces
  - No redundancy problems during cuts of segments
  - Only primary data stored in database
  - On-the-fly calculation of models, allows to introduce up-to-date DTMs
How does it work?

Overview

novaFACTORY 3D Pro

- Automatic generation of generalized roof forms
- Process- and job control + workflow control
- Building structure lines
- Building models
- LIDAR point cloud
- Building footprints
- Terrain model
- Input Data
- Mono and Stereo editing
- DTMaster
- Automatic supply of input data

novaFACTORY 3D GDI

- Data release
- Sales database
- ArcGIS® Server
- 2D + 3D GIS objects
- Metadata
- Data distribution
- Data delivery
- 3D buildings
- CityGML
- KML
- Presentation
- 3D buildings
- VRML
- X3D
Data
- Point cloud
- Terrain Model
- DB-Connection

Building structure lines
- Metadata
- Optional
  - Aerial Images (recommended)
  - Orthophotos
Direct DB-connection
  - Quality control
    - graphical
    - numeric
  - Object-ID
    - Attributes remain and are enhanced with additional information
  - Multi-User capability
    - Lock only on current building. Multiple users can work on the same project
Video

- **Link**: (D:\_Produkte\DTMASTER_BUILDING-ADDON\Camtasia\novaFACTORY\novaFACTORY_1024x768)
novaFACTORY 3D Pro

- **Object-ID**
  - **Attributes**
    - Data source: Height extracted from LASERSCAN, NUMBER OF FLOORS, DEFAULT, PHOTOGRAMMETRIC, MANUAL, UNKNOWN
    - Ground height: All LOD1 And LOD2 buildings are cut with the terrain model. Lowest point of cut will be introduced into DB
    - Roof height: Highest point of building will be introduced into DB
    - Building height: Difference between ground height and roof height
    - Reference Roof: RIDGE, EAVE, MEDIAN, …
    - Roof form: FLAT, PITCHED, SADDLEBACK, HIP, …
    - Creation Time: Time when building has been automatically created with BuildingGenerator first time
    - Quality: see quality value
    - Last Editor: User who edited last the building
    - Last Change: Time when building has been changed
    - Changed: Value that shows which building has been manually edited
    - Release Date: Date when building has been released for sales database
Export Formats

- **CityGML 1.0**
  - Like most virtual 3D city modeling efforts, these services provide only graphic or geometric models, neglecting the semantic and topological aspects of the buildings and terrain being modeled. These models can only be used for visualization purposes but not, in most cases, for thematic queries, analytical tasks or spatial data mining. Another problem with these and other city 3D modeling efforts is lack of interoperability. CityGML offers a solution for it. ([http://www.directionsmag.com/articles/citygml-an-open-standard-for-3d-city-models/123103](http://www.directionsmag.com/articles/citygml-an-open-standard-for-3d-city-models/123103))

- **VRML**
- **KML, KMZ**
- **3D DXF**
- **3D SHP**
  - Includes only triangulated surfaces with knowledge of material (with/without texturing) and Metadata
  - Detailed grouping (roof, wall, ground floor) is not supported with 3D-Shape
  - 3D-Shape files (.shp) describe the 3D-Model as MultiPatch features
  - 3D Shape can only store triangle lists and attributes per feature

- **MDB**
  - Material information for MultiPatch features can only be stored with the usage of a geo database
  - MDB (or GDB) needed to successfully keep this information