CityFit

High-Quality Urban Reconstructions by Fitting Shape Grammars to Images and derived Textured Point Clouds
Motivation

• 3D City Models
• **Google Earth:**
  – User-generated buildings
• **Microsoft Virtual Earth:**
  – Scanning of populated earth in 15 cm grid
    (Vexcel Graz - now Microsoft Photogrammetry)
• State of the art:
  – Extruded ground polygons, fully automatically from aerial images
• Remaining problem: Detailed facades
Overview

• The Challenge
• Input Data
• Processing
• Shape Grammar
• Fitting
• Conclusion
The Challenge
The Challenge

- Graz as complex use case
- Ambitious Goal: Reconstruct 80%
- Analyze facade structure
The Challenge
Input Data

• Highly redundant road side photographs
  – 80% overlap, different orientations
• Road side LIDAR scans
  – 180° in 1° resolution, ~30cm spacing
• Preprocessing yields registered textured point clouds
Input Data
Processing

• Filter out obstacles
  – cars, trees, people or parking ticket machines
• Segmentation of facades
• Detection of
  – windows, doors and other structural elements
• Aim: classify and represent every detail down to a resolution of 50cm
Shape Grammar

• Non-Terminal Symbols
• Terminal Symbols
• Based on Generative Modeling (GML)
  – Script Language
  – Formal description of parametric 3D models
  – Encodes construction process (not result)
  – Compact data representation
Shape Grammar

- Convex polyhedra as geometric representation
- Extensive library of terminal elements
  - Windows
  - Doors
  - Balconies
  - Columns
  - Cornices/Ledges
  - Oriels
  - Risalits
Shape Grammar

- Hierarchical representation of facades: split hierarchy
- Parametrized buildings
- Analysis of facade structure:
  - building style
  - periodic sequences of elements
  - symmetries
Fitting

• Parametrize Terminal Symbols
• Fitting directly on 3D point cloud
• Hierarchical fitting
  1) basic parameters (width / height)
  2) sub-geometry (columns on balcony)
Conclusion

• Detailed facades
• Exploiting 2D + 3D highly redundant data
• Shape Grammar
  – Based on GML and Convex Polyhedra
  – Hierarchical parametrized representation
• Large Scale City Model
• Fully Automatically
References


www.cgv.tugraz.at/cityfit
www.generative-modeling.org