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

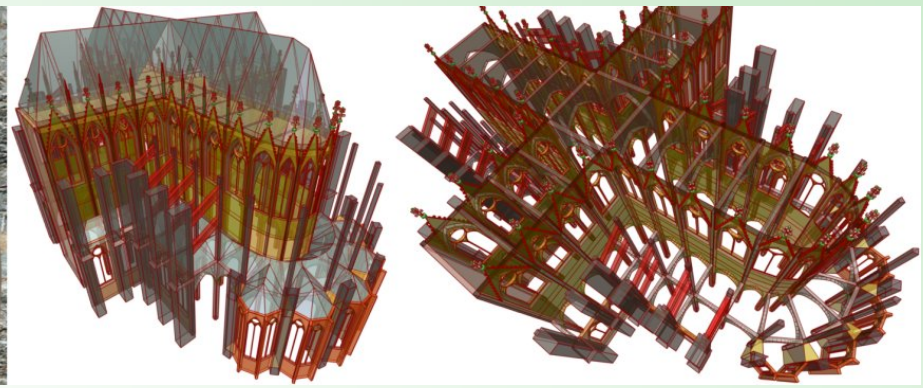
Input Data

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

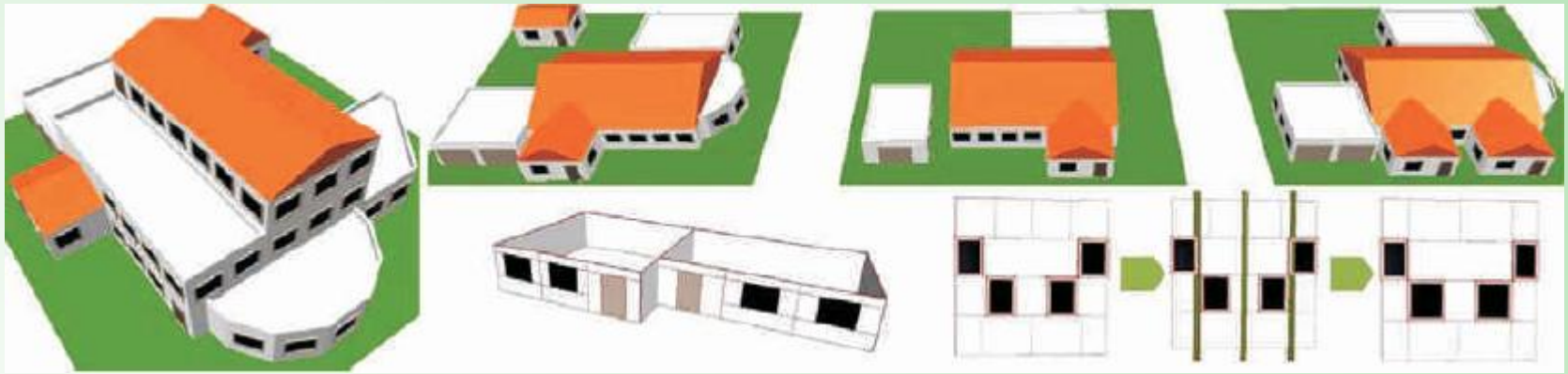
- Non-Terminal Symbols
- Terminal Symbols
- Based on Generative Modeling (GML)
  - Script Language
  - Formal description of parametric 3D models
  - Encodes construction process (not result)
  - Compact data representation



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

- [1] T. Ullrich and D. W. Fellner. *Robust shape fitting and semantic enrichment.* CIPA 2007
- [2] A. Klaus, J. Bauer and K. Karner. *Metropogis: A semi-automatic city documentation system.* ISPRS 2002
- [3] P. Müller, G. Zeng, P. Wonka, and L. Van Gool. *Image-based procedural modeling of facades.* SIGGRAPH 2007

www.cgv.tugraz.at/cityfit

www.generative-modeling.org