A Constraint Based System to Populate Procedurally Modeled Cities with Buildings

Johannes Scharl
Supervisor: Daniel Scherzer

Institute of Computer Graphics and Algorithms
Vienna University of Technology
Motivation

- Results of my ongoing master thesis
- A tool/framework that helps artists and designers to plan and create urban environments and cities for interactive applications
Motivation

- Modern games: **highly detailed environments**
- Typically modeled in 3DS Max, Maya
- Very **time-consuming task**
- Many revisions and changes
Basic Ideas

- => Create and edit parts of the environment procedurally to simplify development!
- Create street network using L-Systems
- Tessellate network to create street geometry
- Subdivide blocks to get building parcels
Basic Ideas

- Assign buildings to parcels
Creating the Street Network

- Extended L-Systems [Parish et. al.]
- Control maps and parameters: (Terrain, obstacles, population density, street patterns…)
- Major roads created first
- Convex, widened hull to create city shape
- Minor streets created inside quarters
Tesselating the Street Geometry

- Junctions may connect 2, 3, 4, ..., n street segments
- Offsetting from street centerline
- Junctions assembled by street heads

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Problem: Junction geometry must be in a single plane
- If flat: unrealistic steps and extreme slopes
- Rotate junction into tangent plane of terrain
Street Geometry Results
Parcel Generation
Building Properties

- **Footprint**: convex hull of all vertices projected on ground plane
- Sides that must face a street (Street Access Sides)
- Sides that must not face a street (Inaccessible Sides)
Selecting a Building

- Constraint based system
- Previously modeled buildings sorted by footprint area size: largest => smallest
- Discard larger buildings
- For every Parcel, starting with largest remaining building:
Selecting a Building

- Move building to center of parcel
Selecting a Building

- Align largest Street Access Side to largest street side
Selecting a Building

- **Rotate** until all Street Access Sides and Inaccessible Sides are **aligned correctly**.
Selecting a Building

- Move **building to streets**

- Check if all **points are inside** the parcel

- If any test failed, **repeat** with smaller building.
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Conclusion and Future Work

Results:

- Procedurally created urban environments
- Constraint based system that chooses „best fitting“ building for every parcel
- Robust method to create 3D street geometry
- More realistic city shapes

Future Work:

- Better control over building assignment process
- More flexibility to interactively change environment
Thank you for your attention!

Questions?