From 2D plans to 3D models

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Motivation
3D semantic models. Pipeline
2D plans to 3D models. Modules
Who could use the application?
What does a user have to do?
Summary
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Motivation

- CityGML: model for 3D urban objects
- CityGML includes information about structure
  - (Floors, rooms, walls, doors, windows, etc.)
- Growing networks of 3D models
  - Useful for viewing urban models
  - Not suitable for managing (indoor) information
  - Example: Google Earth (anonymous contributors)
- Models combining geometry and structure needed
3D semantic models. Pipeline

- CAD floor plans
- Other sources (footprints, maps...)
- Manual modelling
- 3D extrusion of geometry
- CityGML

Other formats (COLLADA, X3D...)

2D plans to 3D models. Modules

- Each module is under research
- Modules are independent and integrated in the final application

- Detecting walls
- Placing doors and windows
- Finding corners to close rooms
- Processing geometry for each room
- Putting up 3D building
Basic knowledge of AutoDesk® DXF © format

- Floor plan drawings structured into layers
  - Each layer contains different aspects of the building (walls, openings, furniture, electricity, etc.)
- Drawings made up mainly by lines, arcs and blocks.
  - Each block is used to draw compound items: doors, windows, pieces of furniture, bathroom fittings, etc.
Assumptions

- Walls are drawn as single *lines* (mandatory)
  - Layers that contain walls cannot contain anything else (mandatory)
  - There will be only *one* layer that stores all the lines (recommended)

- Openings (doors and windows) are drawn as *blocks* (mandatory)
  - There will be only *one* layer for openings, no containing anything else (recommended)
Step 1 / 5: Wall detection
Step 2/5: Placing doors and windows
Step 2/5: Placing doors and windows. Algorithm

- Determine the bounding box
- Determine longitudinal and transverse directions of the opening
  - Difficult if the bounding box is square-shaped
  - Compute the transverse axis, and 9 control points
Find the two closest points from the wall segments to the control point $P_2$
- Constraint: each point must lie in different sides from the transverse axis (green)
- Closest points are not necessarily $P_1$ and $P_3$
Step 3/5: Finding corners to close rooms

- Find clusters of points
- Constraint: only final points from polylines are considered

- “Smart” centroid computation
- L-shape, T-shape, X-shape, I-shape
Step 4/5: Processing geometry for each room

- Segments from the wall layer are assigned to the room containing them (or outdoor)
- For each room, a grid is made up with lines containing each segment, and intersection points
Step 4/5: Processing geometry for each room (2)

- Segments non-enclosed by two points from the grid are removed.
- Finally, opening lines are projected onto the interior polygon.
Step 4/5: Processing geometry for each room (3)
Step 5/5: Putting up 3D building

- Extrusion of each piece of wall
- Export: citygml4j library for Java
- [http://opportunity.bv.tu-berlin.de/software/projects/show/citygml4j](http://opportunity.bv.tu-berlin.de/software/projects/show/citygml4j)
Who could use the application?

- One of the main goals of the application is its usability
- Basic knowledge of CAD tools is enough
- Architectural or engineering knowledge is not required
- Flexibility
  - Canvas-based interaction
  - Operations can be undone/redone
  - Operations can be applied to selected areas from the canvas
What does a user have to do?

- Get the input floor plans
- Floor plans could need some arrangements to fulfill the assumptions using a CAD tool (i.e., AutoCAD©)
- User has to experiment with different parameters to get the 3D model
- In general, one work session is enough to process one drawing
Summary

- CityGML provides a model for representing city objects
- 3D models are needed
- A CAD tool to get 3D semantic model from 2D floor plans has been introduced
  - Usability
  - Flexibility
  - Scalability
Challenges

- Advance in the automation of the application
- Process plans not accomplishing the assumptions
- Obtain information from front-view models (work in progress)