3D indoor models for the fire department

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Smart 3D indoor models to support crisis management in large public buildings (SIMs3D)

- Management of large public buildings in emergency cases requires:
  - up-to-date 3D indoor models
  - detailed geometric and semantic information
  - automatic approaches for navigation

- Intelligent models of 3D indoor environments is largely missing

- Use (preparedness and response)
  - train the emergency response officers (BHV)
  - plan optimized evacuation routes
  - quickly built rough 3D models
  - provide context-aware navigation.

www.sims3D.net
Goal: reconstruct & subdivide

- point cloud
- cuboid shapes
- final model

- 3D model
- space subdivision
- network

IndoorGML concept!
Developments

- User investigations: what kind of 3D models are needed
- 3D reconstruction
  - Point clouds
- ‘Empty space’ construction
  - From point clouds
  - From vector model (BIM, CityGML, considering all details)
- Empty space subdivision
  - Voxelisation (master thesis)
  - Octree (master thesis)
  - ...
3D reconstruction
Scanning two buildings

- Fire brigade station
- ZEB1, Google Tango, Leica
User requirements

- Current maps
- Exploration of a building
- Objects (moveable and static)
User requirements

- 3D is important in all stages
  - Existing models
    - Function and condition (school, industrial, ..)
    - Form of rooms, doors, windows, floors/ceilings
    - Objects (material they are built of), obstacles
    - Installations
  - Models after the fire

Tom van der Meer
IndoorGML concept

- Cell is the most important unit
- Complete space subdivision
- Poincaré duality
Framework for space subdivision/union

- **Agent**: client in certain navigation
- **Activity**: task and navigation behavior performed by an agent.
- **Resource**: things that an agent can use in a sub-space or take from a sub-space.
- **Modifier**: define what event impacts which agents/resources/activities and on which aspects.

The space can be subdivided differently !!!

Semantic and geometric subdivision/union

Spatial Units, (the result of Semantic subdivision)

Activity
Agents
Partitioning (the result of geometric subdivision)
Modifier (on Elevator)
Identify navigable space excluding obstacles and functional areas

Box (objects and functional areas)

Available space

3D cell: navigable space
Some results

Abdoulaye A. Diakite
Identifying navigable space in indoor point clouds (unstructured data)

- Project Pointless: Identifying, visualising and pathfinding through empty space in interior point clouds using an octree approach (student project) (pdf)

Ivo de Liefde, Florian Fichtner, Erik Heeres, Olivier Rodenberg and Tom Broersen
Path finding: octree

- What kind of octree?
- How to make the path more precise?
- How to consider the size?

Olivier Rodenberg
Path finding: voxels

Distance field transform in 3D

Martijn Koopman
Path finding: voxels

Indoors with obstacles

Fangyu Li
Voxelisation of a closed polyhedron

Ben Gorte
Conclusions

- Navigable space can be extracted automatically (from unstructured and structured data)
- Space subdivision is a powerful concept for 3D: regular (voxel, octree) or irregular (convex spaces?) partitioning of space.

- Semantics of spaces is important
- Users, environment and different conditions can be taken into consideration