Automatic Indoor 3D Surface Reconstruction with Segmented Building and Object Elements

Eric Turner and Avideh Zakhor
elturner@eecs.berkeley.edu
avz@eecs.berkeley.edu

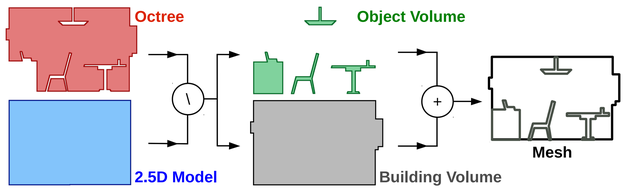
University of California, Berkeley
Electrical Engineering and Computer Sciences

Introduction

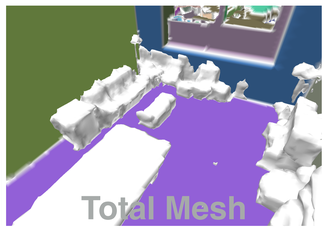
Problem Statement

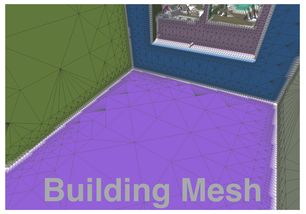
- Building interiors captured with mobile scanning system
- High-res meshes of indoor environments from laser scans
- Auto-segmentation of furniture from building structures

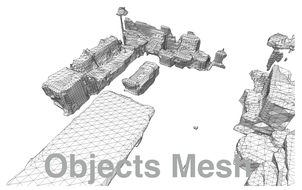
Overview



- Two methods used to model space:
  - *Dense 3D volume model, stored in octree*
  - *2.5D model generated by extruding auto-generated floor plan*
- Octree model contains full detail, 2.5D model contains only floors, walls, and ceilings.
- Performing a set-difference of the volume yields just the furniture, or just the building elements.





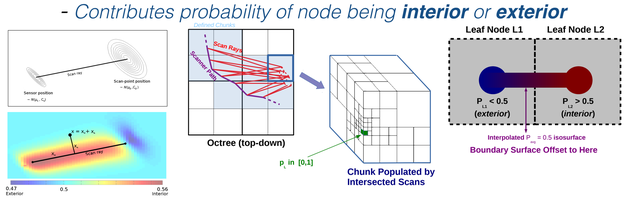


This research was conducted with Government support under and awarded by DoD, Air Force Office of Scientific Research, National Defense Science and Engineering Graduate (NDSEG) Fellowship, 32 CFR 168a

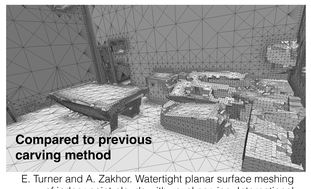
Algorithm

Probabilistic Octree Carving

- Each scan ray intersects node of octree
  - *Contributes probability of node being **interior** or **exterior***



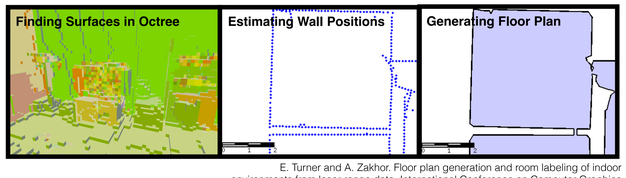
- Probabilistic volumetric model gives accurate surface position even with sparse scans



E. Turner and A. Zakhor. Watertight planar surface meshing of indoor point-clouds with voxel carving. International Conference on 3D Vision, June 2013.

Creating a Floor Plan

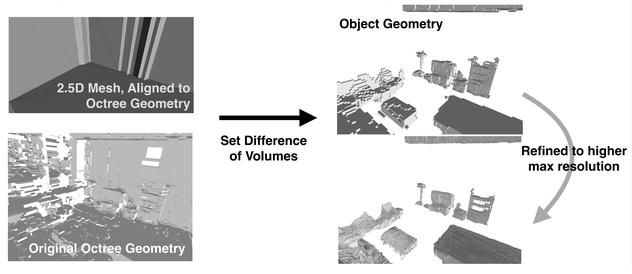
- Vertical surfaces are discovered in octree isosurface, used to define wall positions for creating a floor plan



E. Turner and A. Zakhor. Floor plan generation and room labeling of indoor environments from laser range data. International Conference on Computer Graphics Theory and Applications, (9), January 2014.

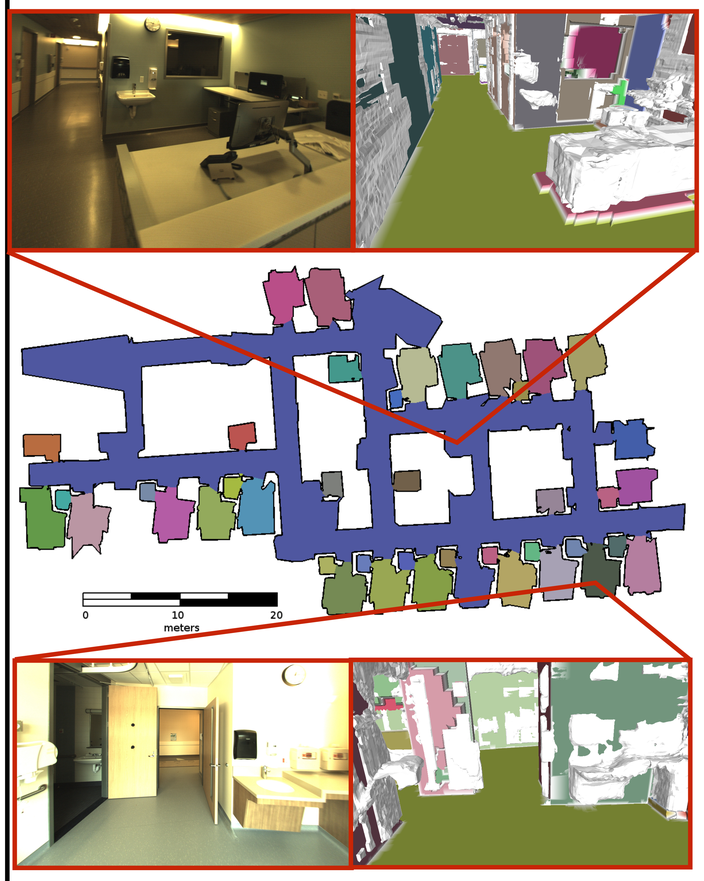
- Floor plans are used to create a 2.5D extruded mesh containing only floors, walls, and ceilings

Segmenting and Refining Objects

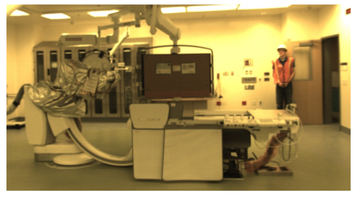


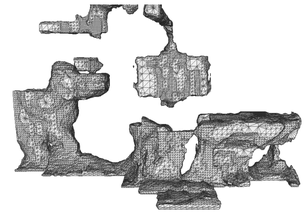
Results

- Processing scans creates a floor plan and a detailed 3D model with furniture segmented from building geometry
  - *Furniture and objects represented at a refined resolution*
  - *Building Geometry meshed with large, planar elements*
  - *Object geometry meshed with dual-contouring, preserving detail*
  - *Floor plan quality improved from previous methods*



- Object geometry can be complex or unusual, and will still be modeled correctly

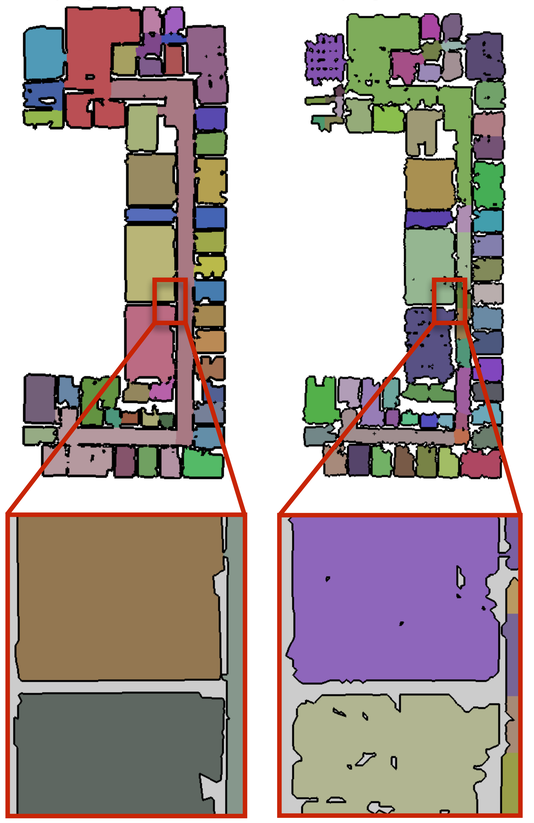




Floor Plan Quality

Floor plan generated using our method

Floor plan generated from raw scans



Mesh Quality

- Example Large-Scale Model
  - *14,000 sq. ft.*
  - *Offices, Hallways, Public Spaces*