INDOOR 3D MODEL RECONSTRUCTION TO SUPPORT DISASTER MANAGEMENT IN LARGE BUILDINGS

Project Abbreviated Title: SIMs3D (Smart Indoor Models in 3D)

PhD Research Proposal

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2015-2016

Promoter: Prof. Dr. Ir. George Vosselman
Supervisor: Michael Peter

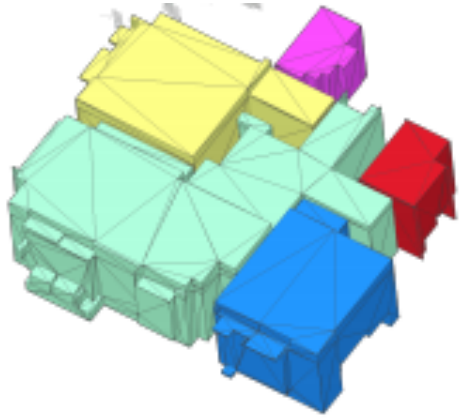
ITC UNIVERSITY OF TWENTE.

Smart Indoor Models in 3D (SIMs3D)

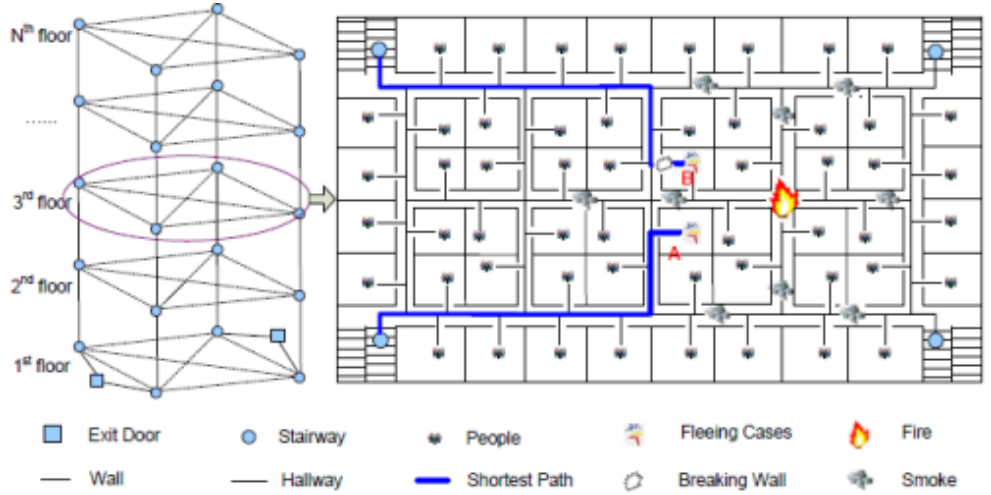
SIMs3D Project Goals

1. Indoor 3D reconstruction from point clouds
2. Emergency responses in public buildings

Point clouds



3D model



Emergency plan

Ikehata et al. 2015

www.igre.emich.edu

Indoor 3D Model Reconstruction to Support Disaster Management in Large Buildings

Data:

Mobile Laser Scanner (MLS) point cloud

Terrestrial Laser Scanner (TLS)

Images

Microsoft Kinect

Google's Tango

Zebedee handheld laser scanner (www.csiro.au)

NavVis M3 Trolley (www.navvis.com)

Related Work

3D reconstruction from pointclouds and images

Outdoor:

1. Building 3D reconstruction
2. Roof reconstruction
3. Façade reconstruction

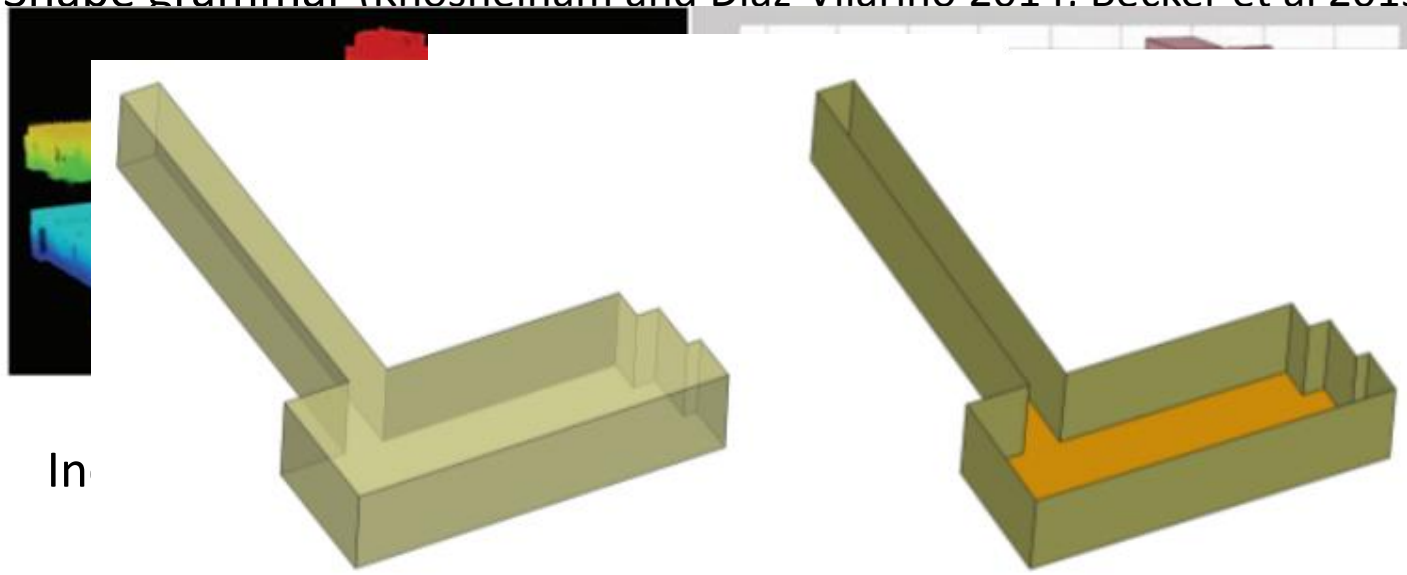
Indoor:

1. Indoor 3D reconstruction
2. Scene understanding
3. Opening detection
4. Indoor routing

Related Work

Indoor 3D reconstruction methods

1. Planar-based reconstruction (Okorn et al 2010; Sanchez and Zakhor 2012)
2. Volumetric-based reconstruction (Jenke et al 2009; Xiao and Furukawa 2014)
3. Shape grammar (Khoshelham and Diaz-Vilarino 2014; Becker et al 2015)
4. In



Khoshelham and Diaz-Vilarino (2014)

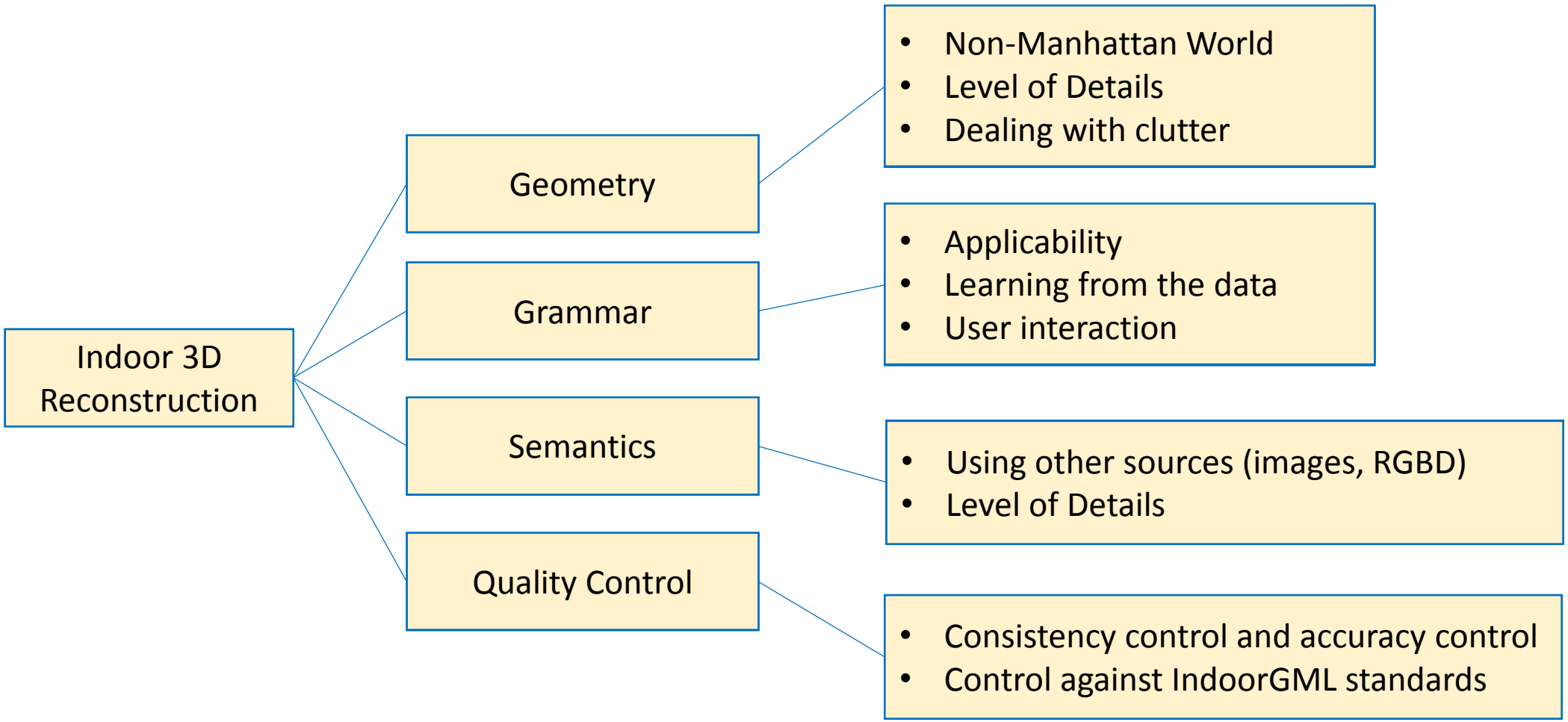
Adan and Huber (2011)

Becker et al (2015)

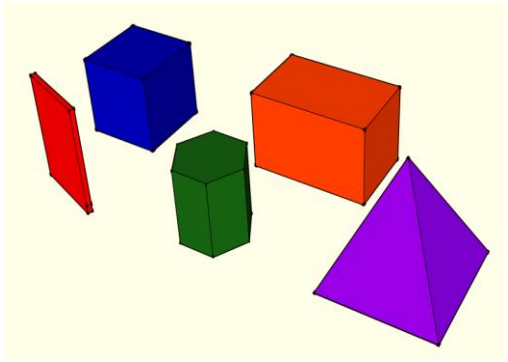
Motivation and Problem Statement

1. Indoor 3D models have applications in disaster management, facility management and indoor routing
2. Tedious work is demanded to generate a precise indoor 3D model from 2D plans
3. 2D plans are not up-to-date or not available for old buildings
4. Indoor data acquisition is rapid via mobile laser scanners, Microsoft Kinect and GoogleTango
5. Current indoor 3D models are simple, not scalable and data has no clutter (e.g. furniture)
6. Limited research has been conducted on grammar-based approaches for indoor 3D reconstruction
7. Limited research has been conducted on quality control of the generated model

Problem Statement



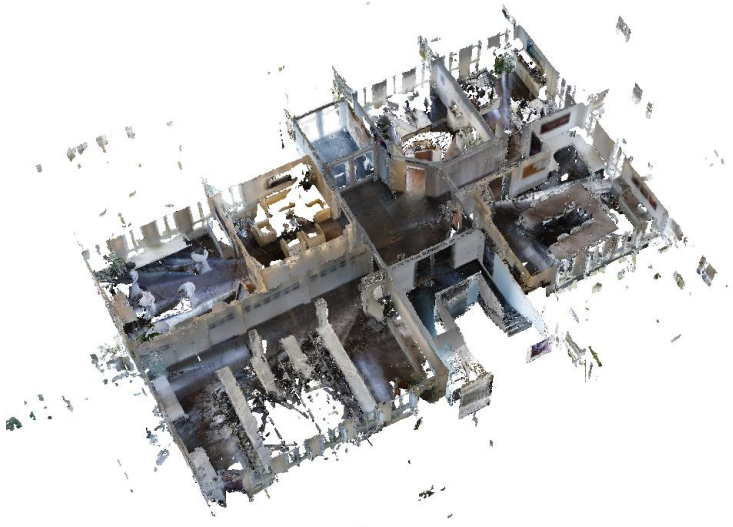
Problem Statement



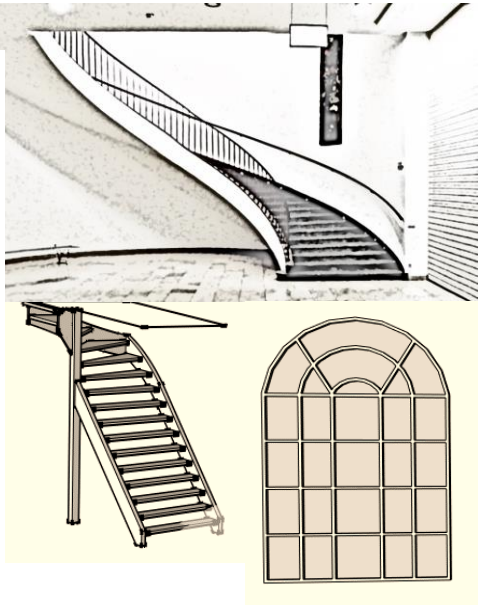
a. Geometry primitives and solids

c. Non-Manhattan World

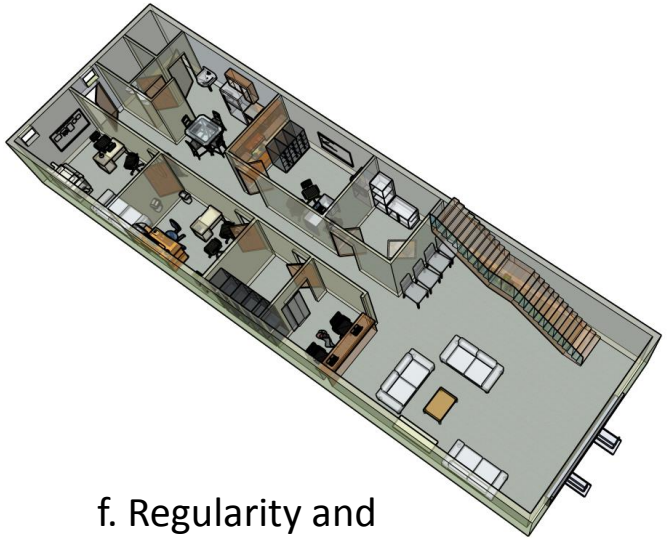
e. Level of details



b. Cluttered data



d. Complex shapes



f. Regularity and repetitiveness

Manhattan World vs non-Manhattan World example:

Manhattan Financial Center

Non-Manhattan World facade

Objectives

Indoor 3D reconstruction objectives

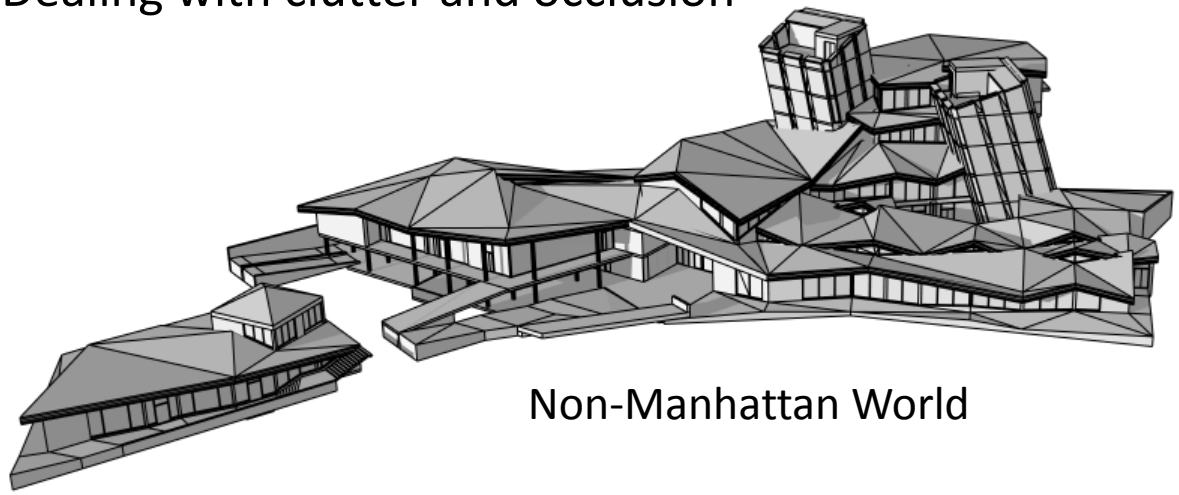
1. Geometry reconstruction
2. Designing the grammar
3. Semantic labeling
4. Consistency and accuracy control

Current Work: First Objective

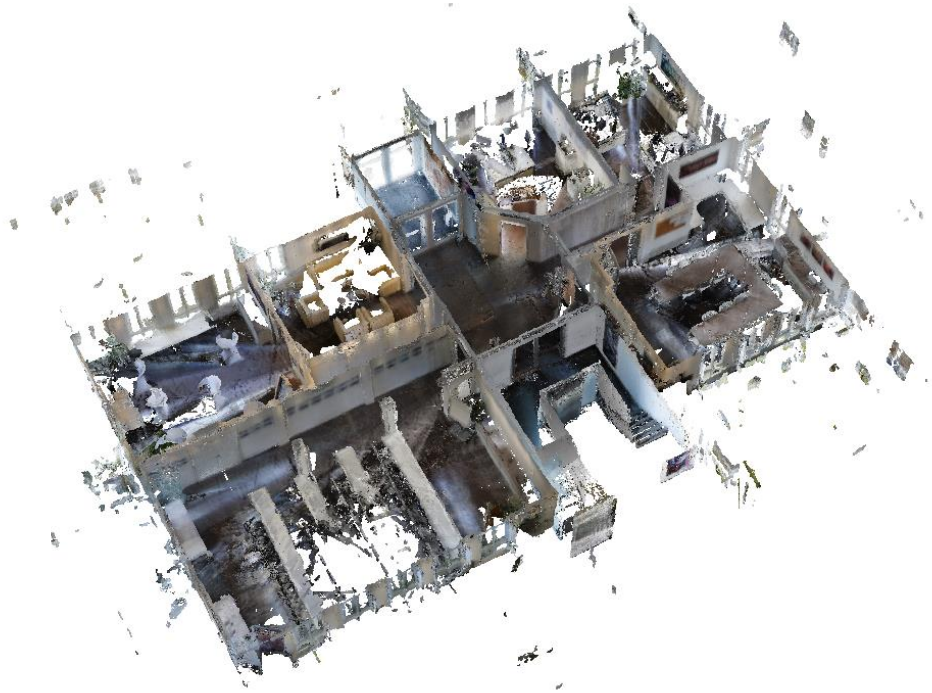
Geometry Reconstruction

1. Reconstructing non-Manhattan World structure
2. Extracting geometry details from the point clouds

   (walls, openings, stairs, clutter)
3. Dealing with clutter and occlusion



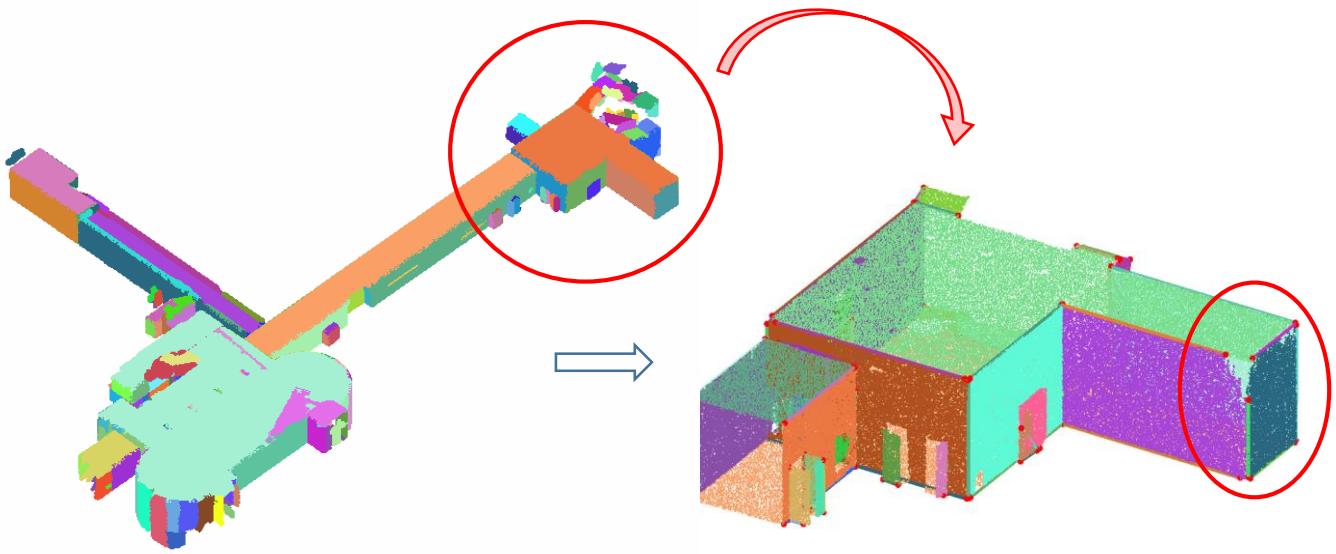
Non-Manhattan World



Clutter and occlusion

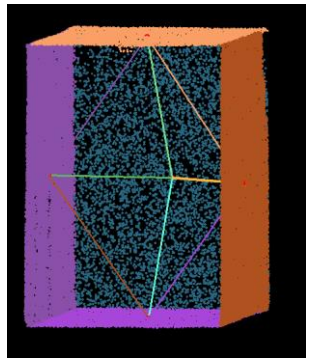
Work in Progress

This work is a development of “indoor data graph” by Oude Elberink, S.J., (2015).
The data accuracy is 3-5 cm and the subsampled data contains 1.5 million points.

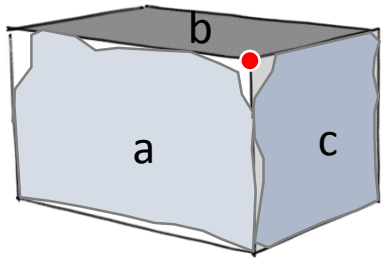


Segmentation

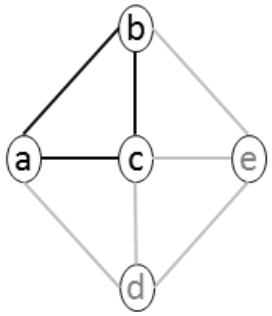
Plane Topology Graph



Primitive Extraction



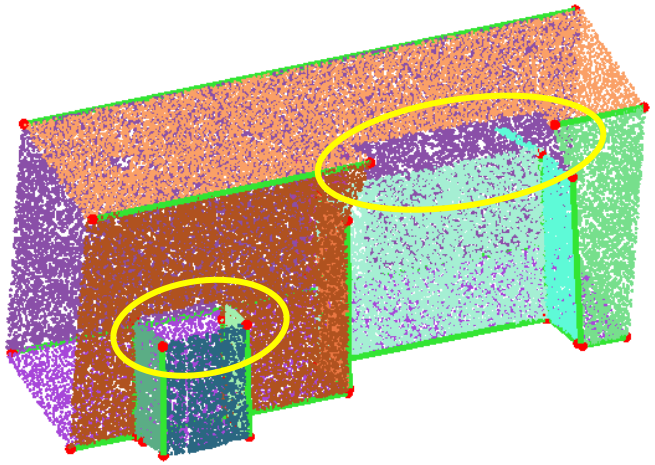
Primitive Reconstruction



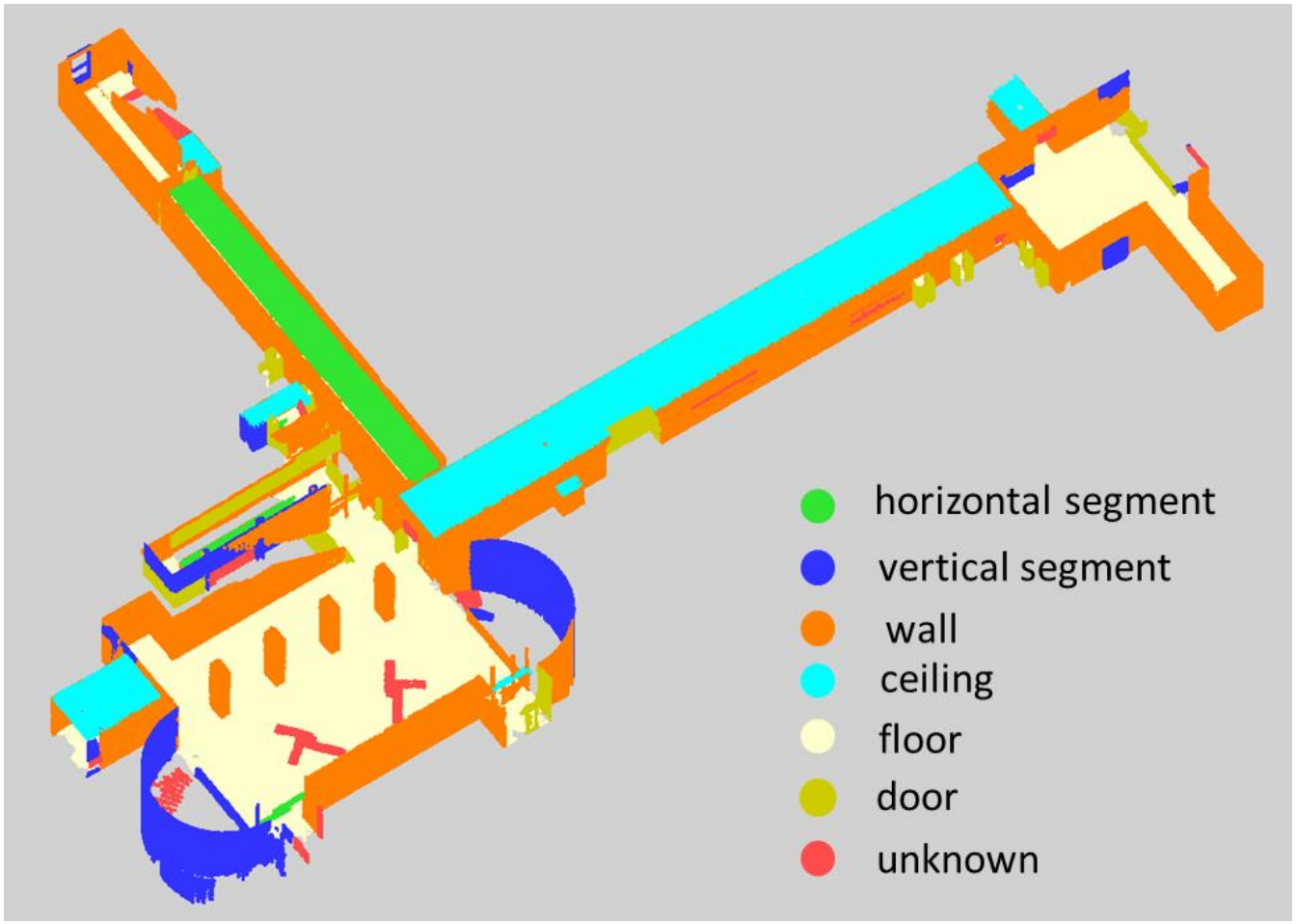
Minimum Cycle Graph

The data is captured by NavVis M3 Trolley
from Technical University of Munich’s campus.
Link to the web viewer

Work in Progress

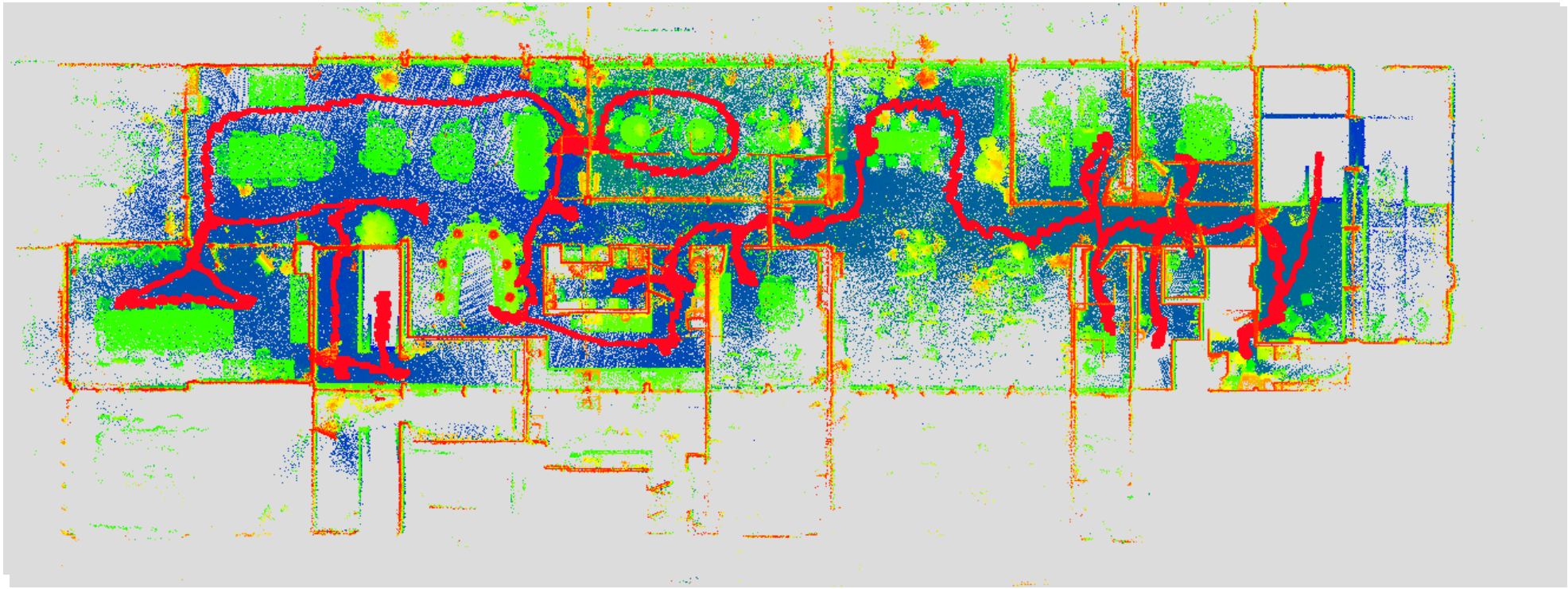


Intersection problems



Segments labeling

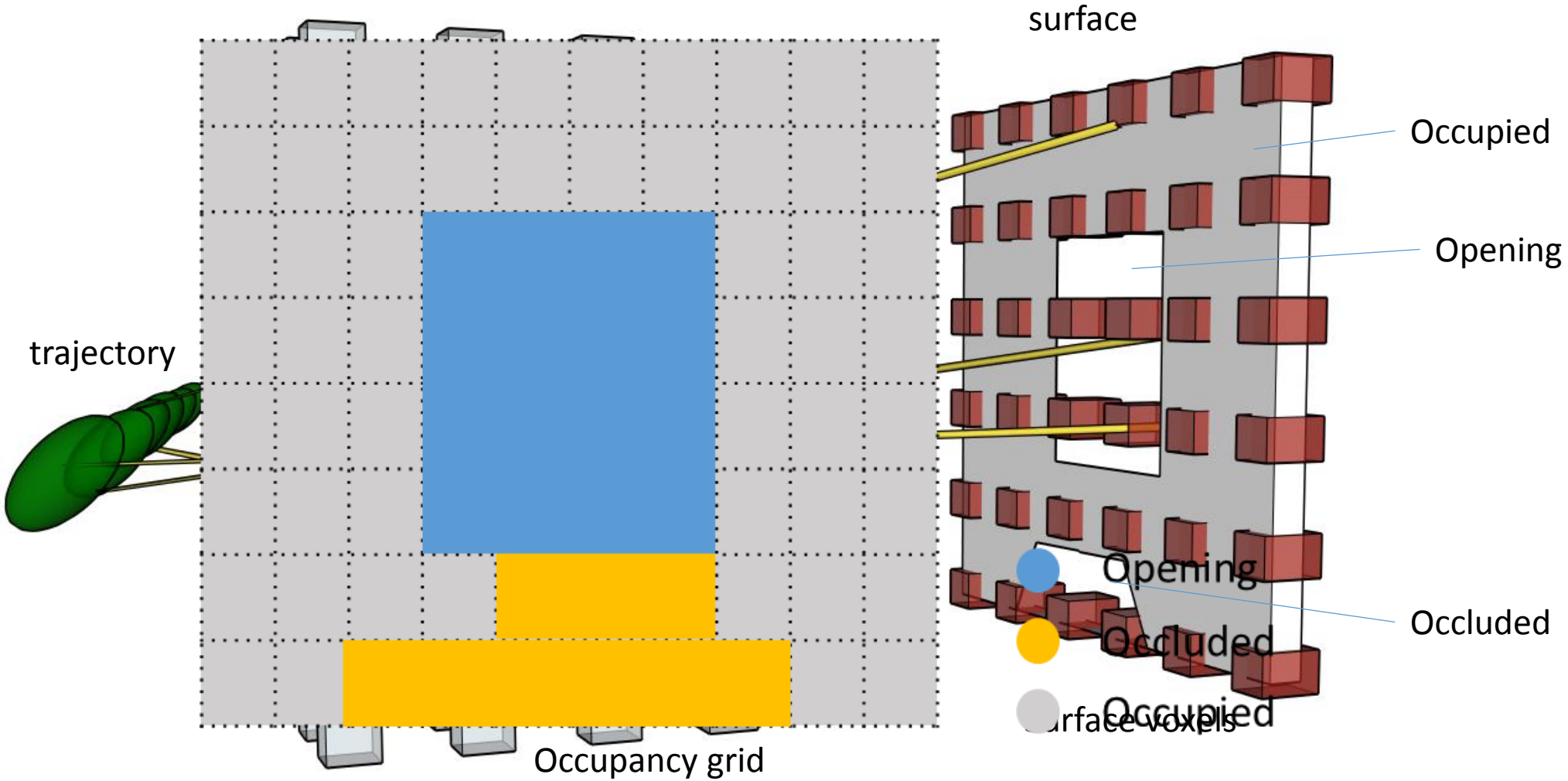
Reconstruction under clutter:



3rd floor of fire brigade building- Point cloud

Reconstruction under clutter:

Ray casting method for surface reconstruction



MSc Topics

Indoor MSc topics for 2016-2017

1. Extraction of regularity and repetitiveness from images and point clouds for indoor scenes
2. Extraction of navigable and non-navigable spaces from indoor point clouds and generating navigation graph

Future Work: second and third objective

Designing the Grammar

1. Applicability of grammar for indoor 3D reconstruction
2. Learning the grammar components from the data
3. User interaction for active learning of the rules

Semantic Labeling

1. Using images for more semantic (opening detection)

2. Adding more details to the coarse 3D model(navigable, non-navigable areas)

Time Schedule

Year	2015		2016				2017				2018				2019	
Year Quarter	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Proposal Writing																
Geometry derivation																
Designing the grammar																
Semantic labeling																
Quality control																
Adding level of details to the model																
Meetings with the project partners																
Conference and journal publications																
Writing Dissertation																

Thank You for your Attention

Questions?

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