

Semantic enrichment of a point cloud based on an octree for multi-storey pathfinding

F.W. Fichtner, 2016-06-28

MSc Thesis Geomatics

P5: Public presentation and final assessment

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Delegate of Board of Examiners: Ulf Hackauf

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1. Background & Research question
2. Methodology
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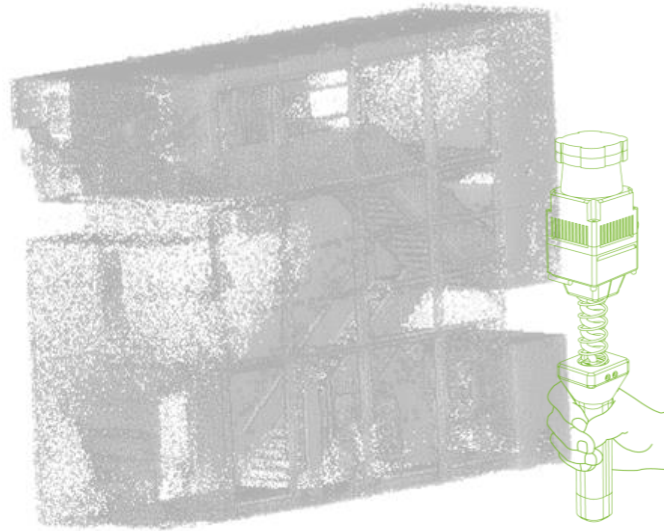
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- Need for pathfinding
- Floor plan out-of-date
- 3D modelling expensive & time consuming





- Acquiring point clouds of indoor spaces became increasingly easy & cheap
 - Unstructured
 - Pathfinding (*Indoor Navigation*) requires additional information

Objectives

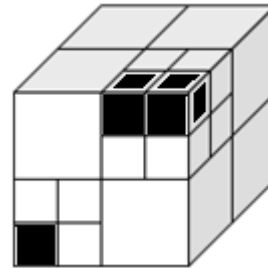
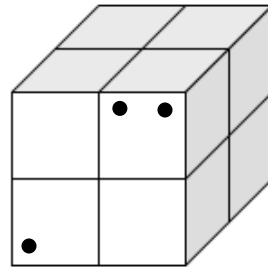
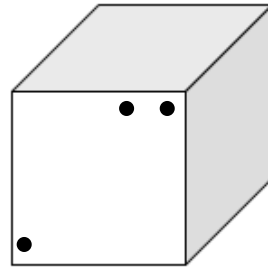
Workflow which semantically enriches an indoor point cloud of a building with the use of an octree

semantics support multi-storey pathfinding

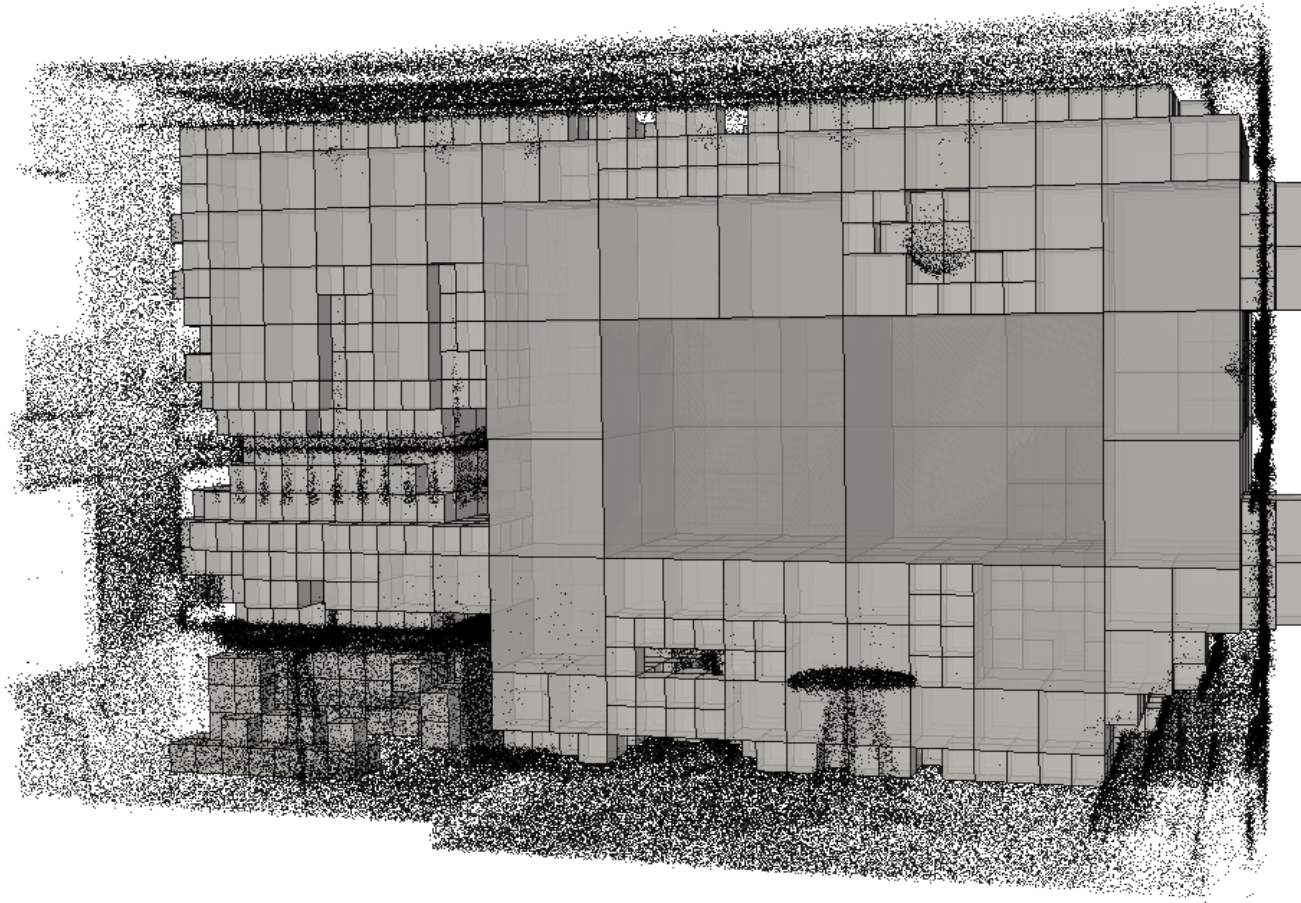
path follows constraints of humans

Can help emergency responders to navigate through a building

Octree

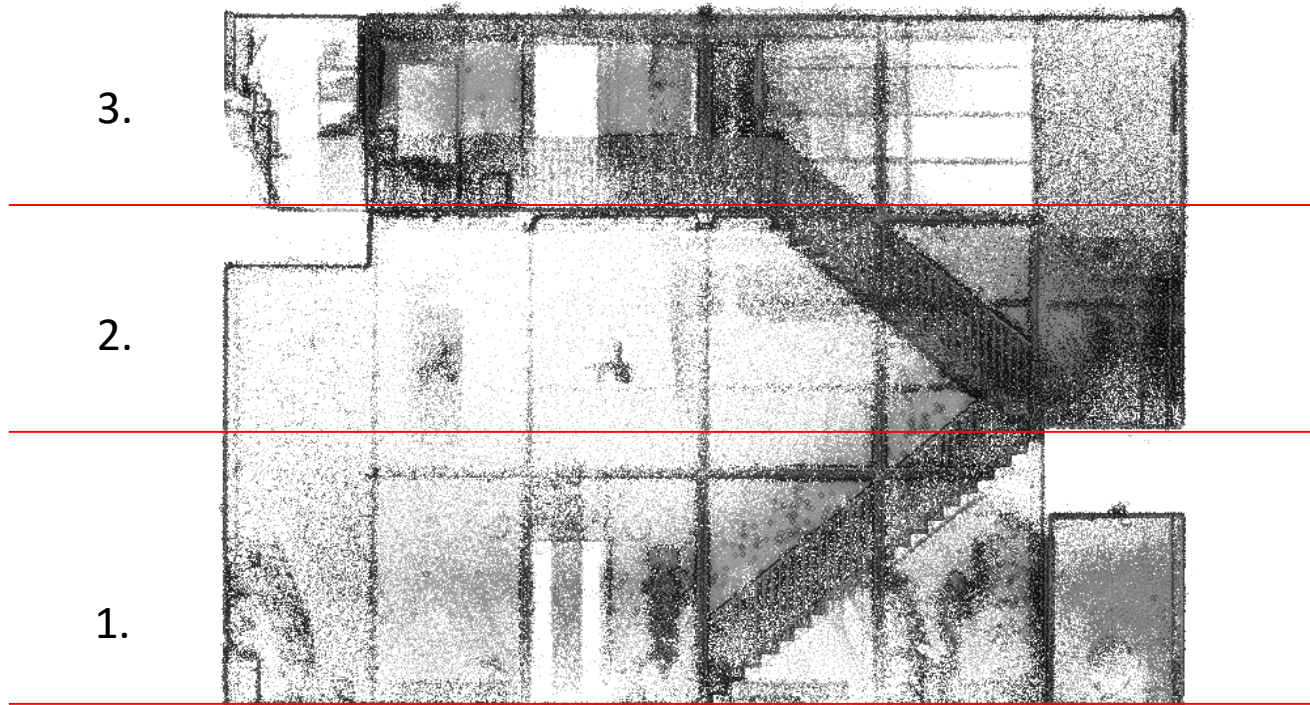


Octree data structure of empty space



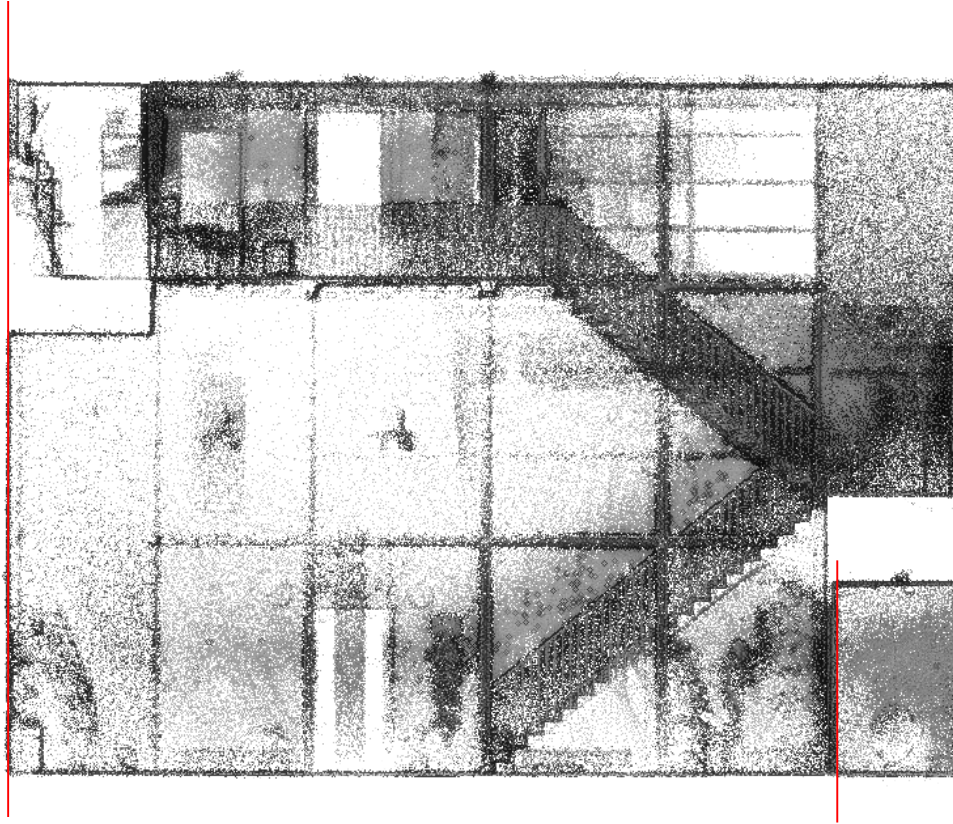
Objectives

- floor and storeys



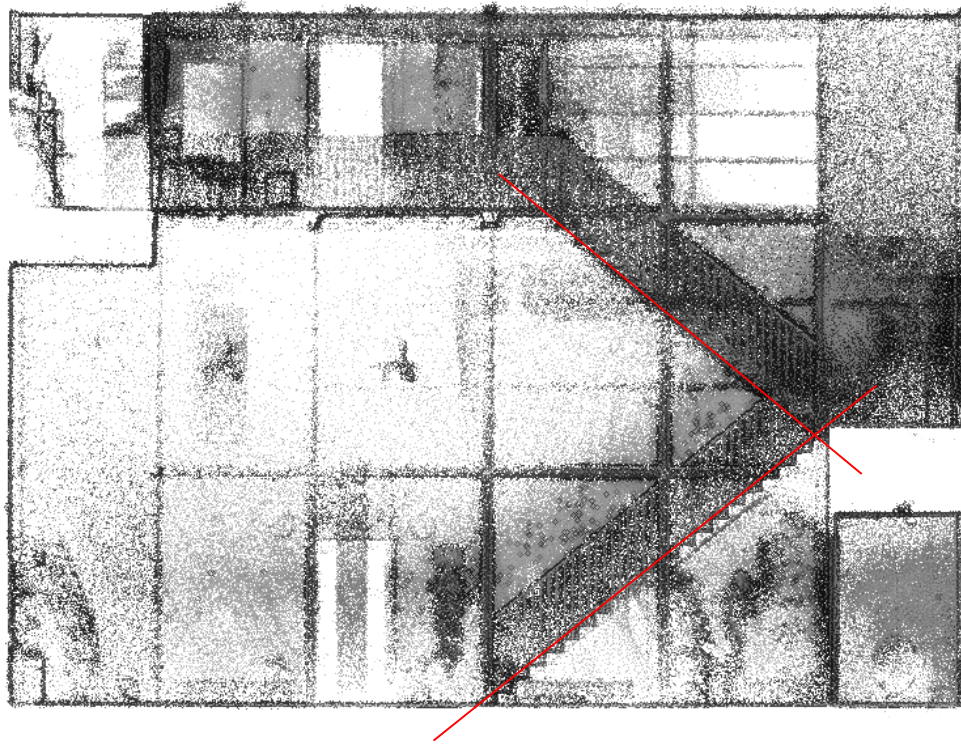
Objectives

- walls



Objectives

- stairs



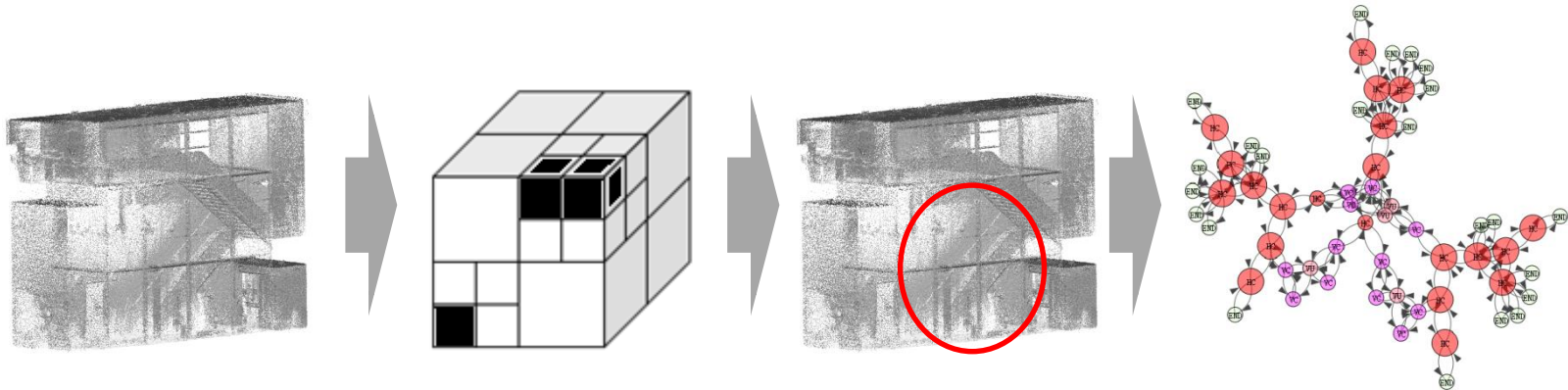
Objectives



- obstacles (for example furniture)

Research question

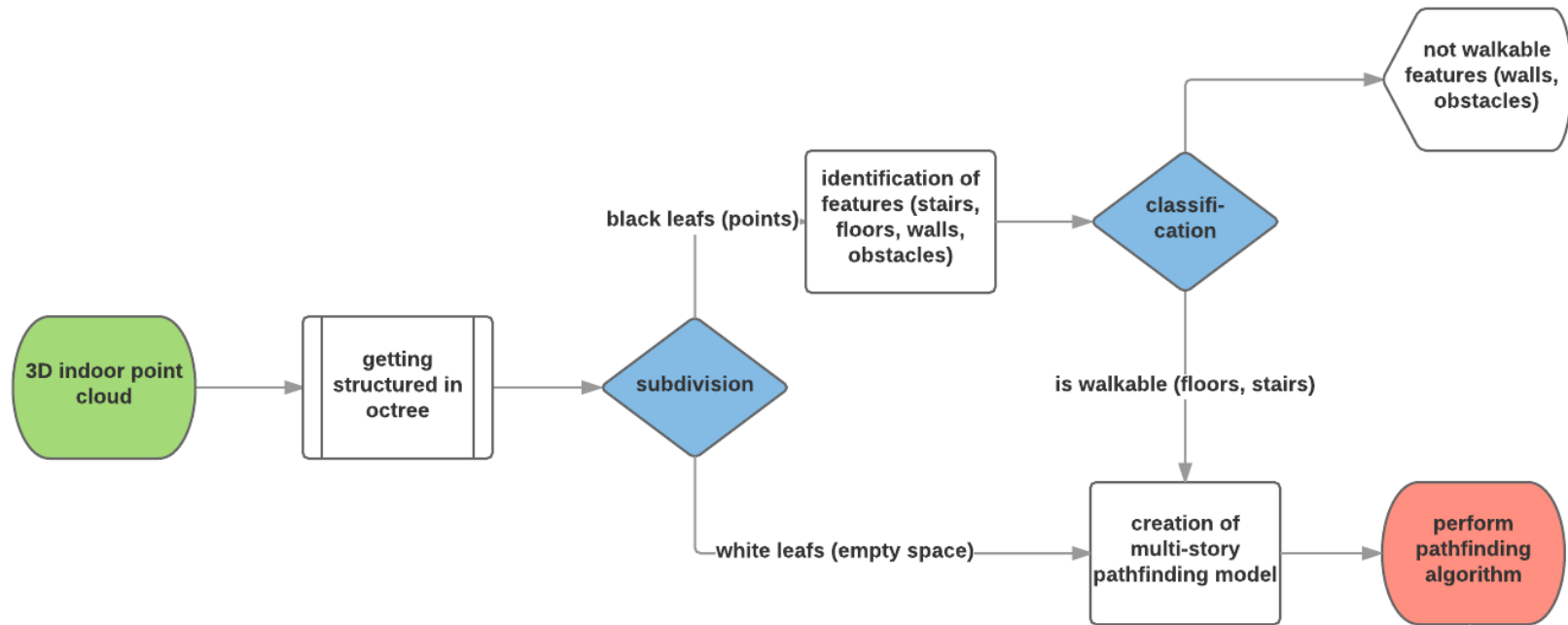
To what extent can an octree support semantic enrichment of point clouds for the purpose of multi-storey pathfinding?



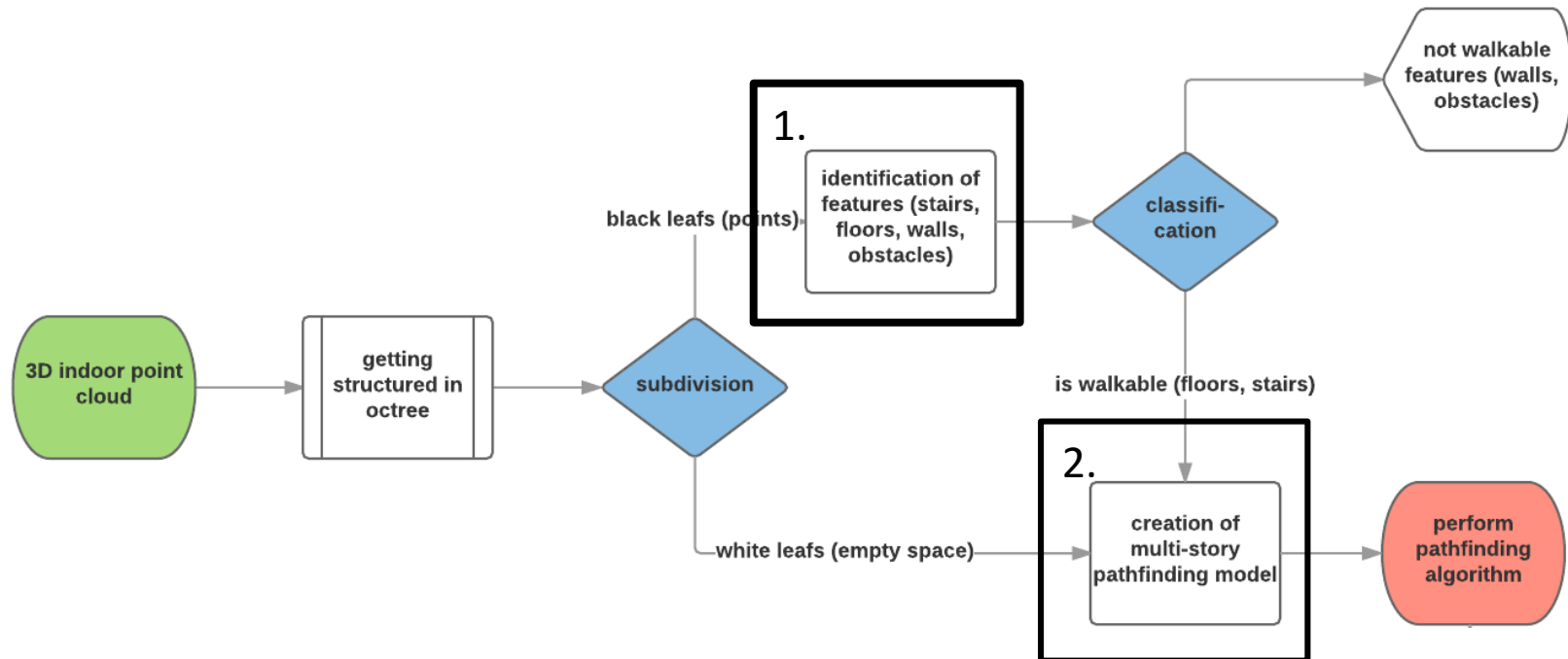
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Methodology

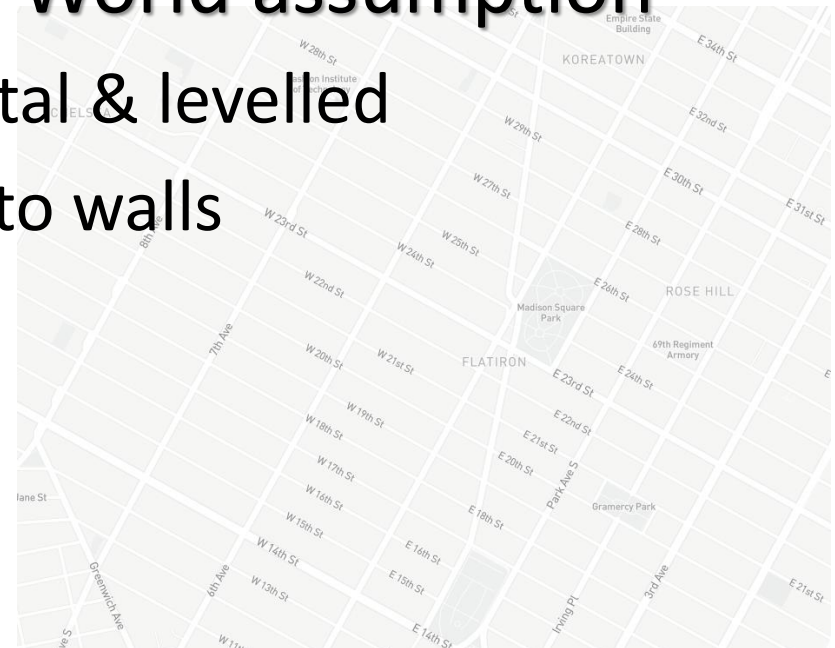


Methodology



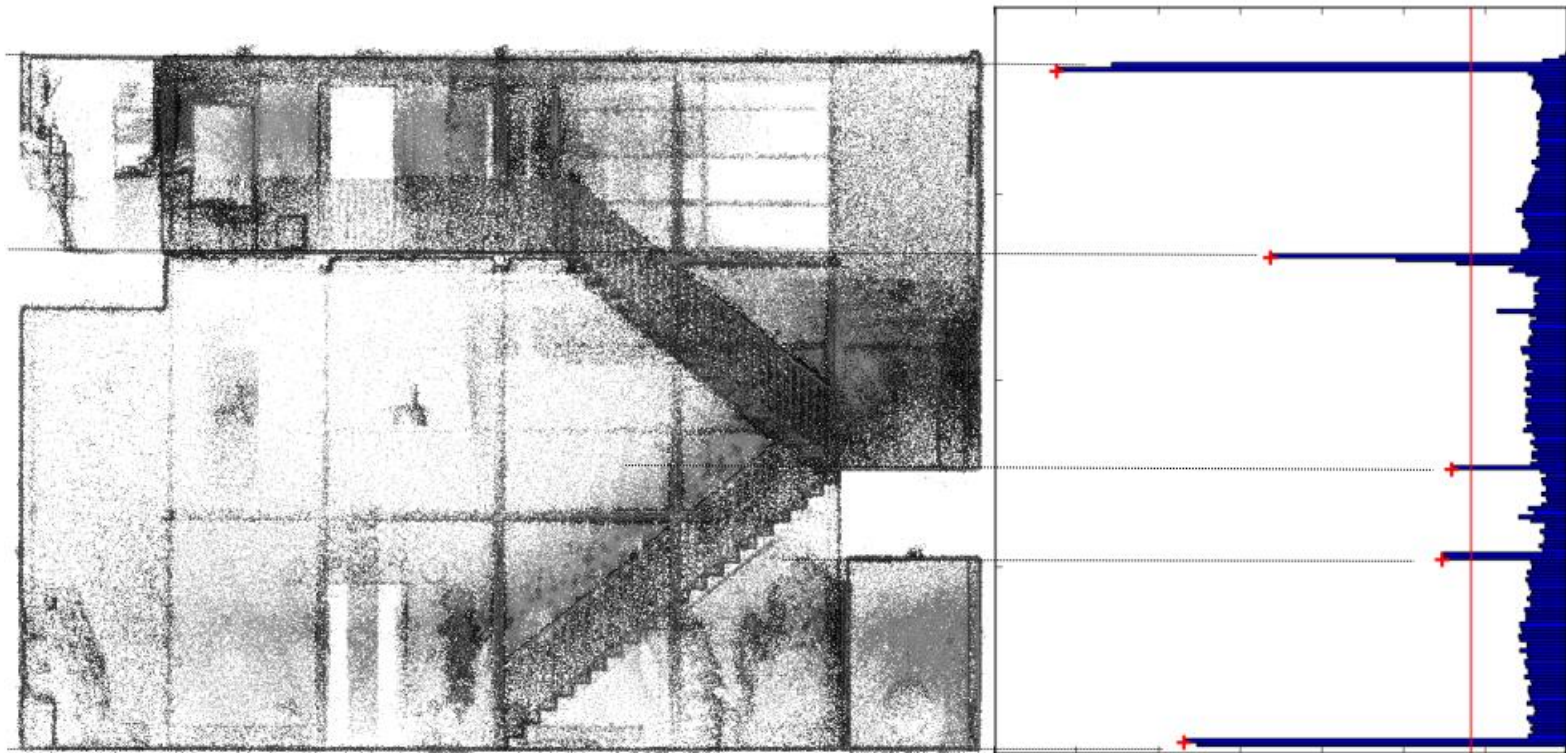
Preconditions

- Point cloud should be clean
- Rooms can be furnished
- Walls follow Manhattan-World assumption
 - Floors should be horizontal & levelled
 - Stairs are perpendicular to walls



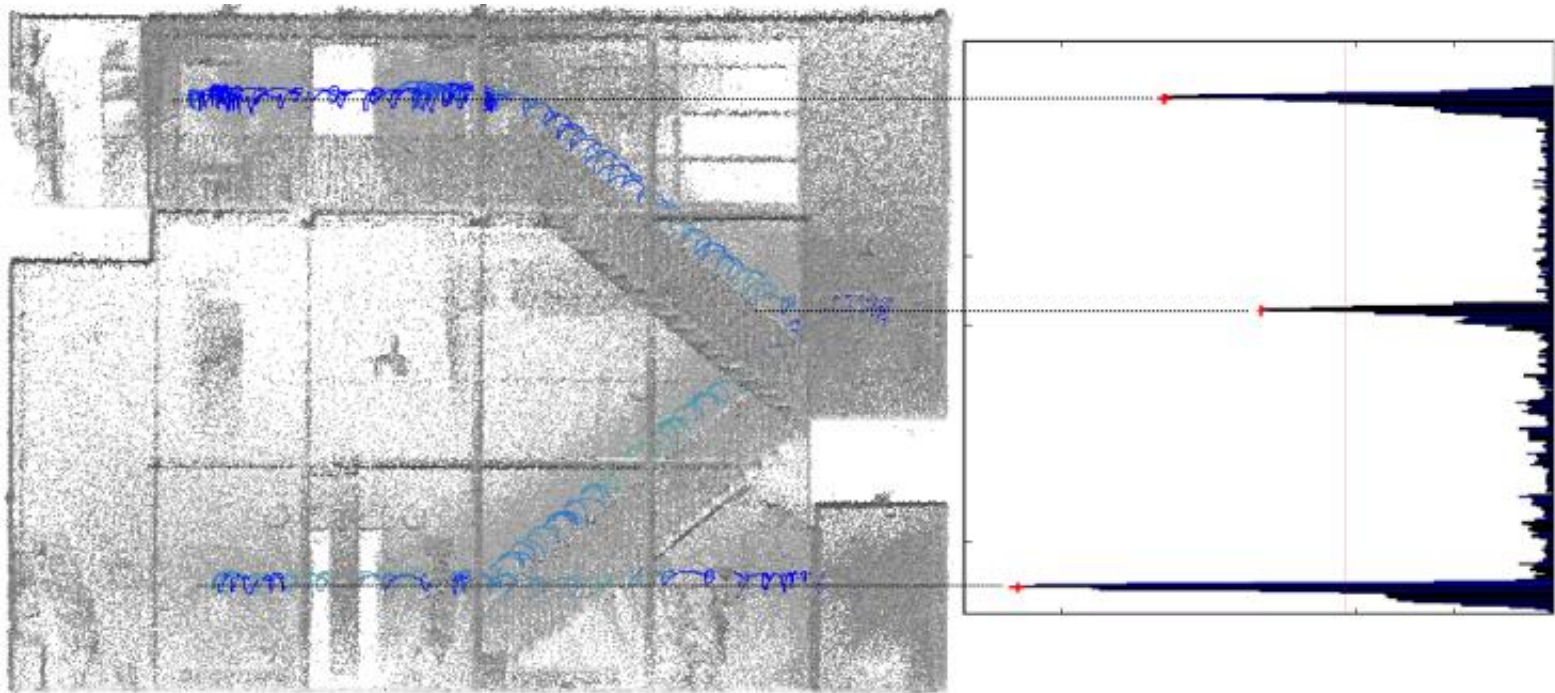
<https://www.mapbox.com/maps/light-dark/>

1D histograms for storey separation

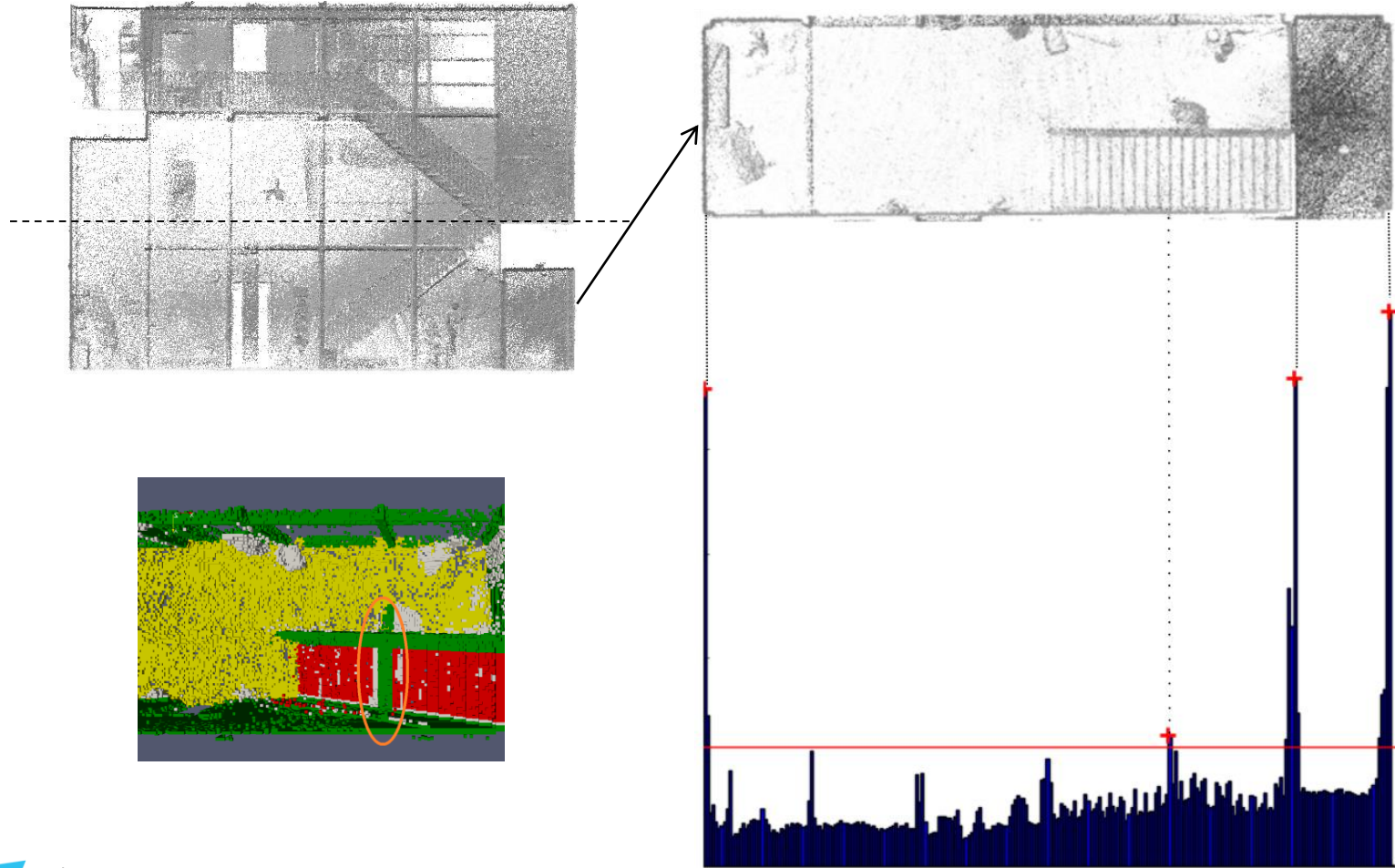


Okorn et al. (2010) & Khoselham et al. (2014)

Path of scanner for storey verification



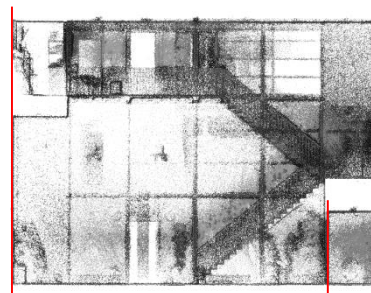
Identification of walls



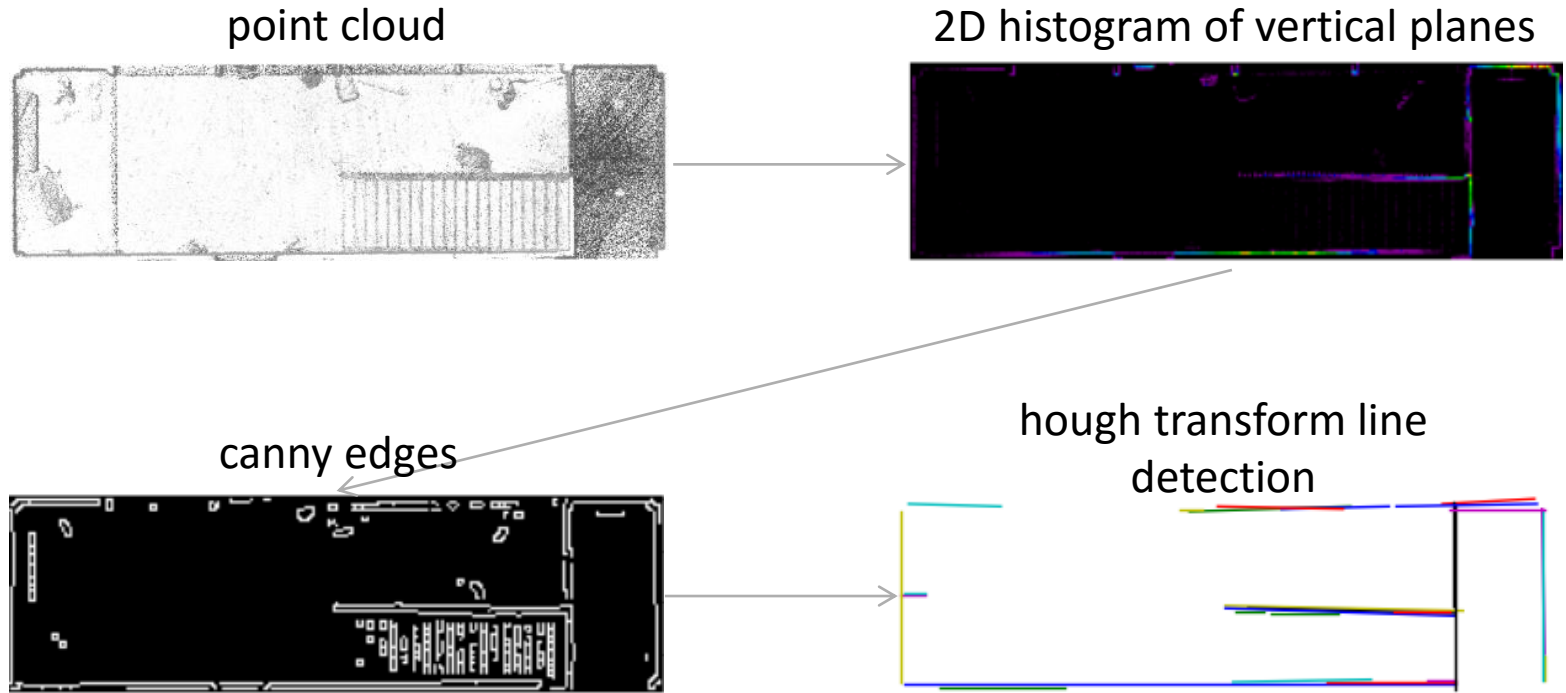
Identification of walls

Assumptions:

- Wall directions shared across multiple storeys
- First peak from either side of histogram is wall
- Peak close to main walls (but further apart than wall threshold) → obstacle

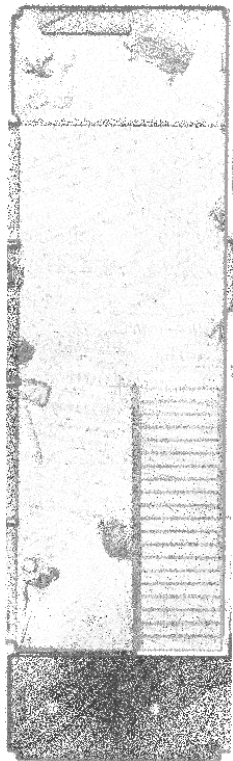


Wall verification

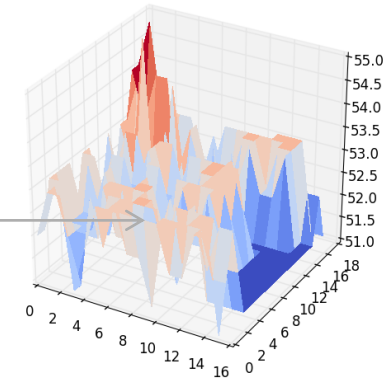
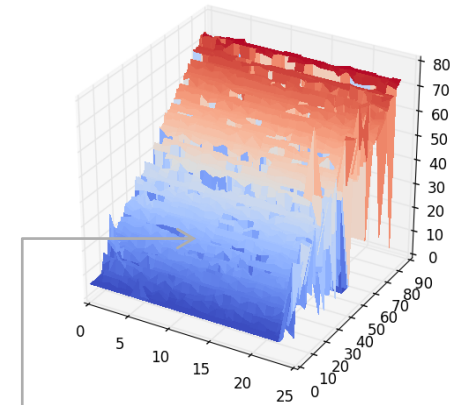
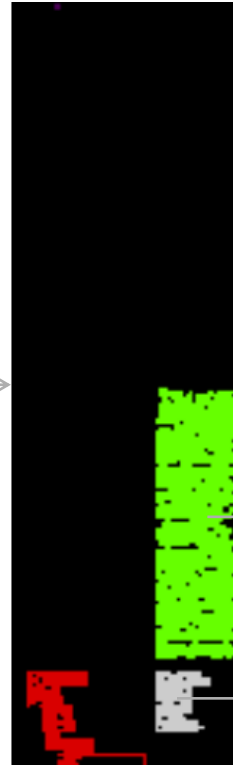
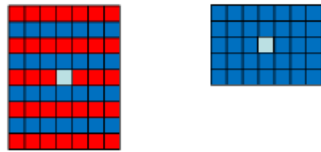


Okorn et al. (2010) & Oesau et al. (2014)

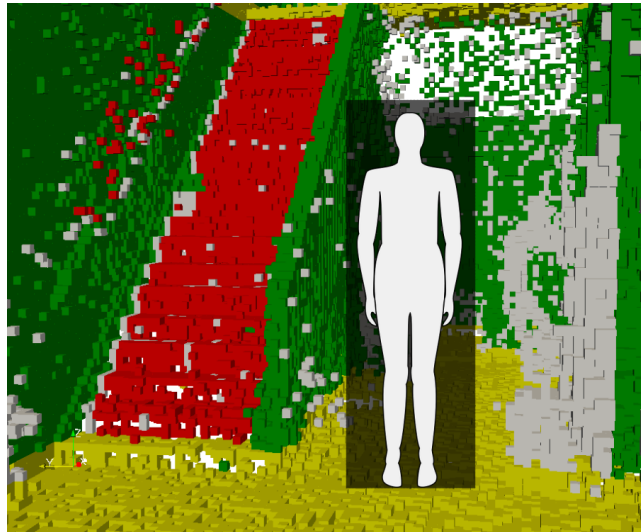
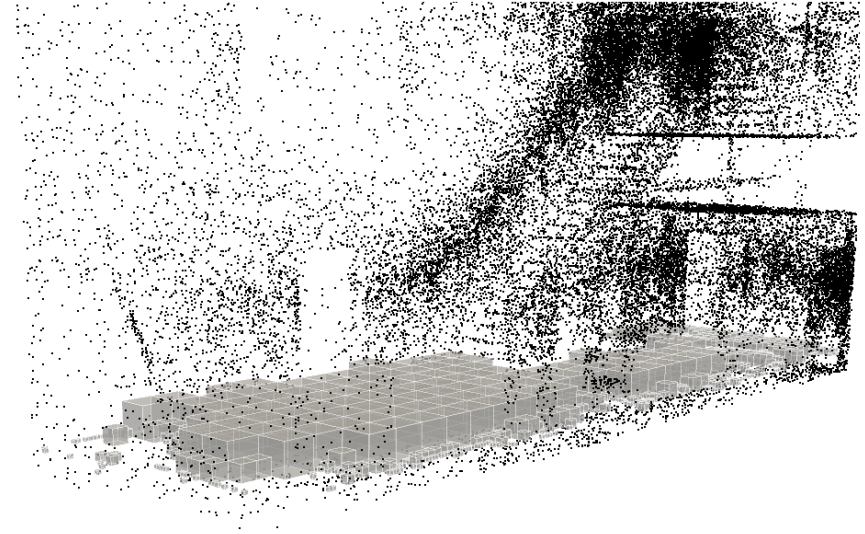
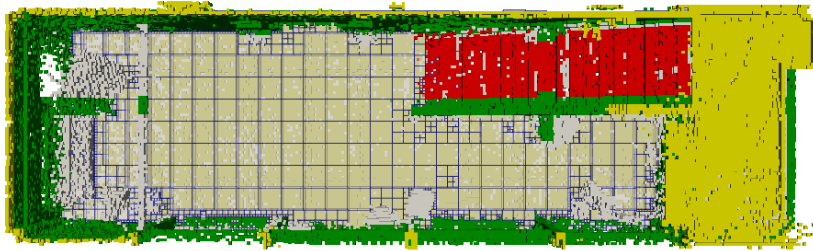
2D histograms & slope to find stairs



1. plane fitting
2. filter plane direction
3. region growing



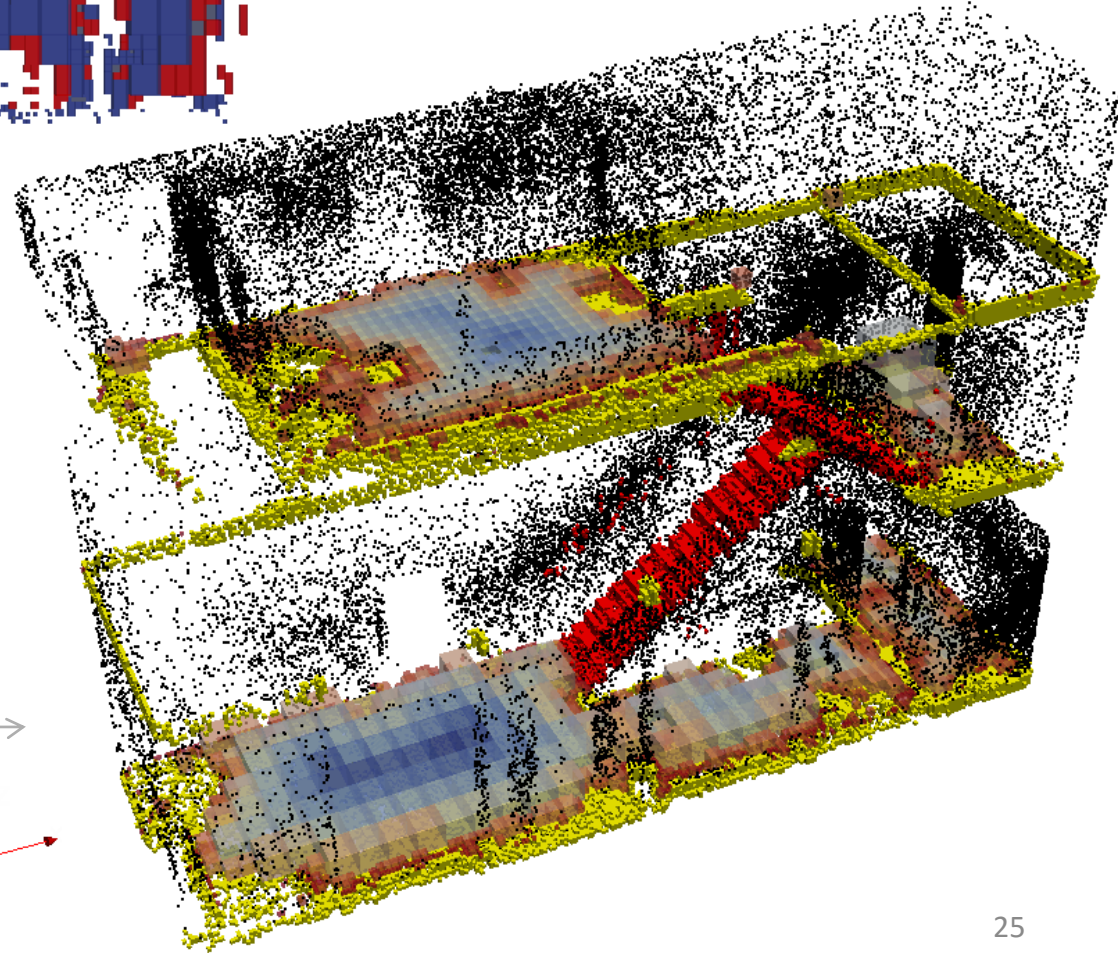
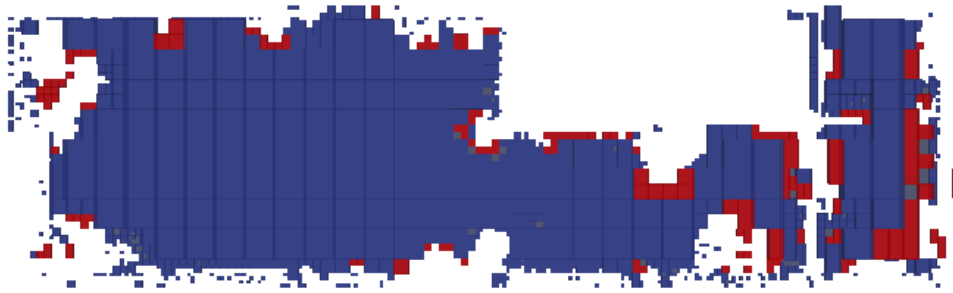
Graph derivation: grid



- octree cut
- path for human

Hornung et al. (2012)

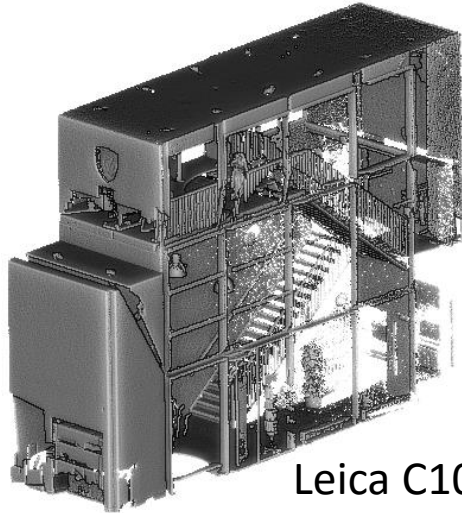
Graph derivation: clearance map



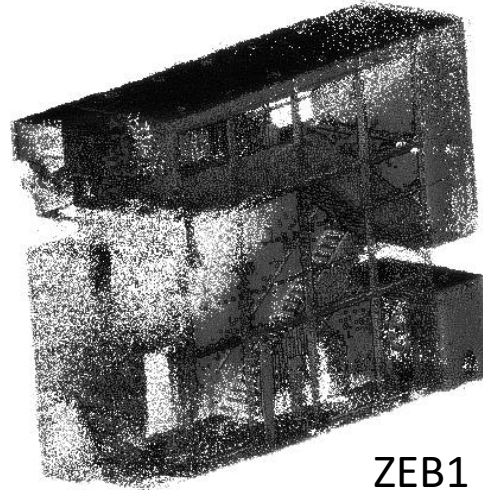
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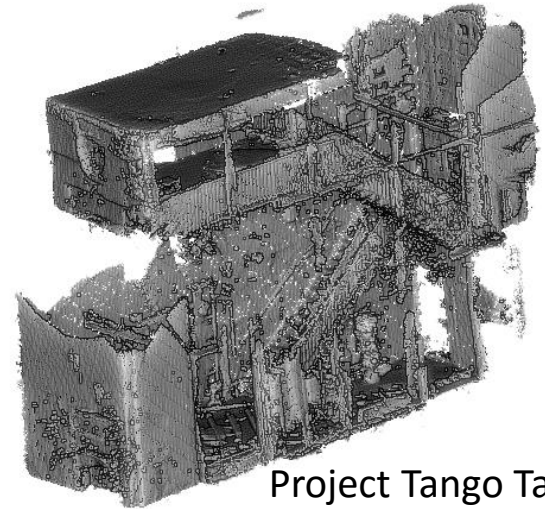
Different kind of scanners



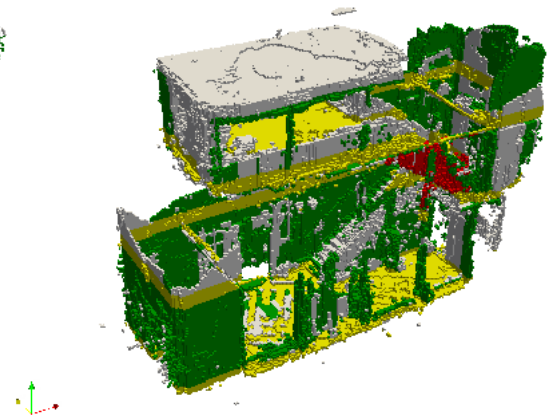
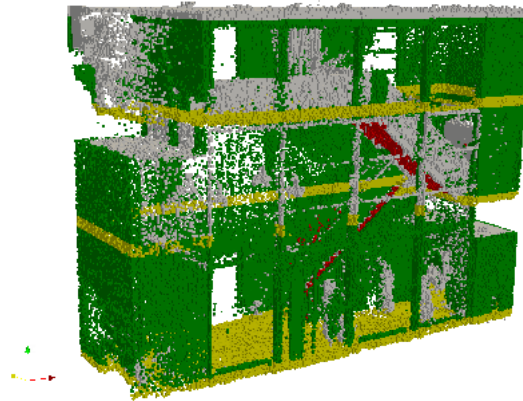
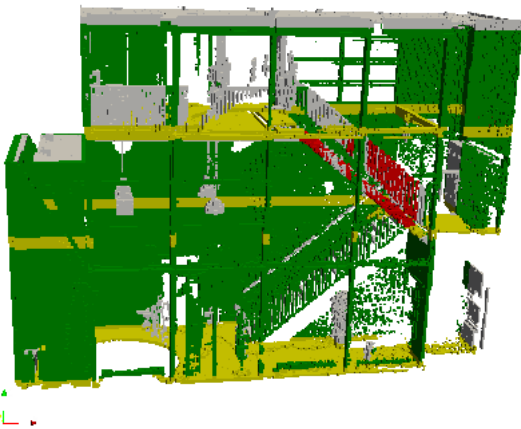
Leica C10



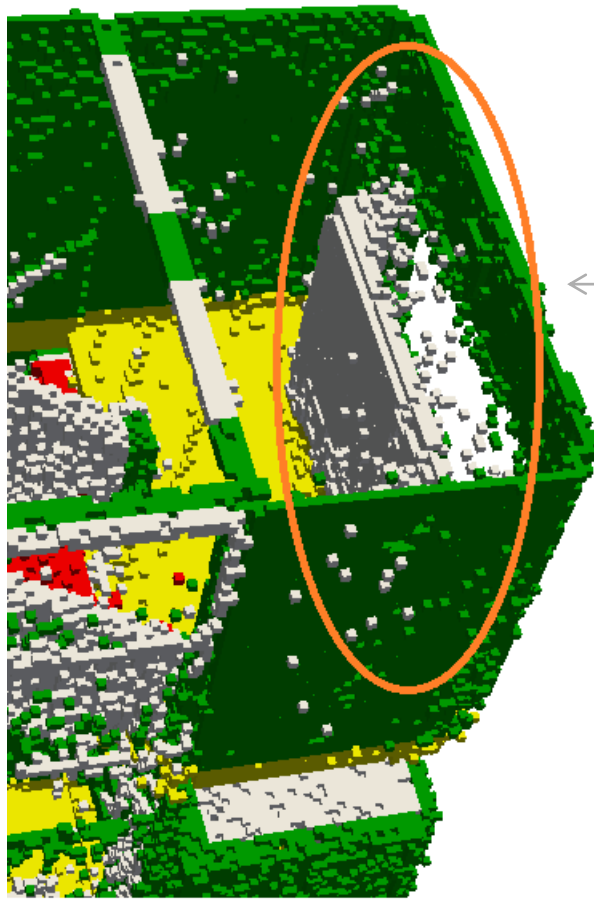
ZEB1



Project Tango Tablet

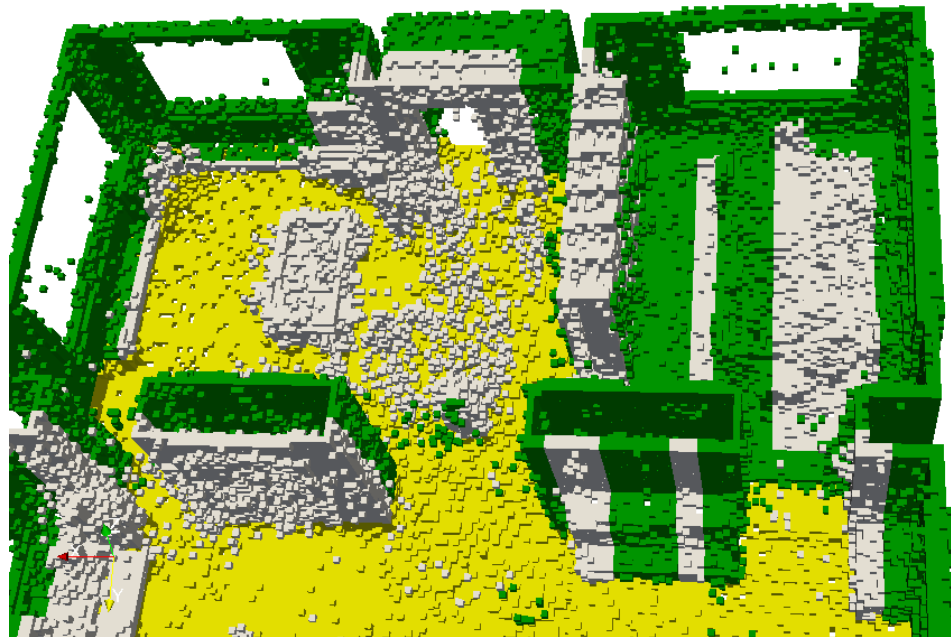


Floor & Walls

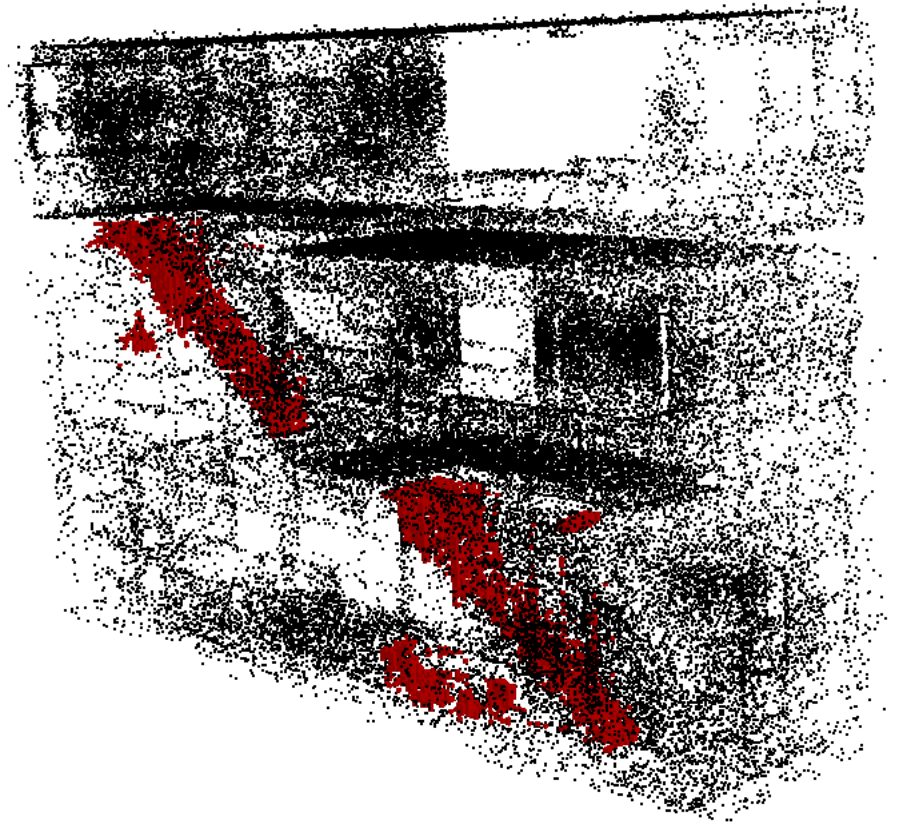
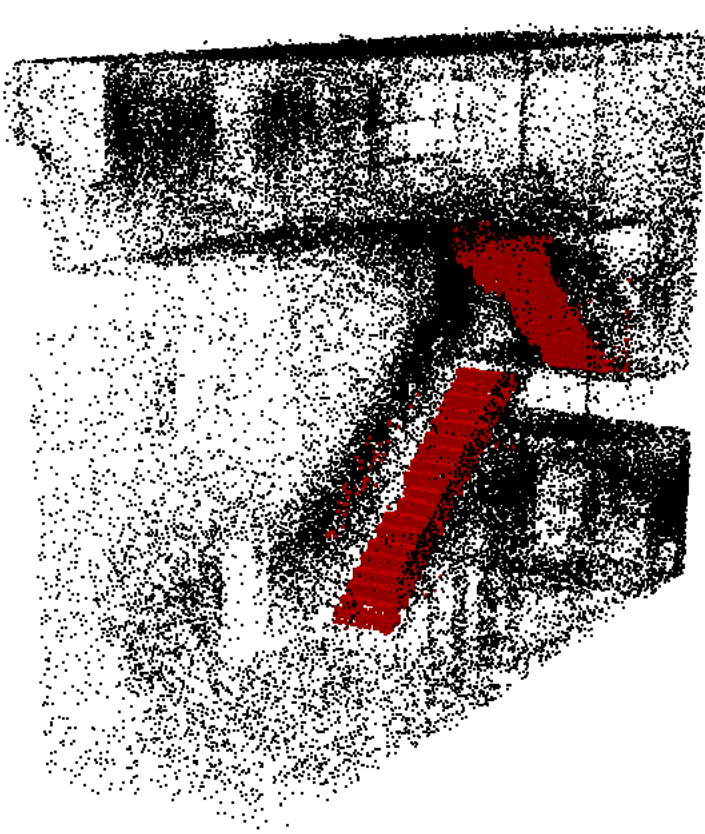


Storeys & walls challenges

- Width of walls in building differs
- Preconditions important
- Windows

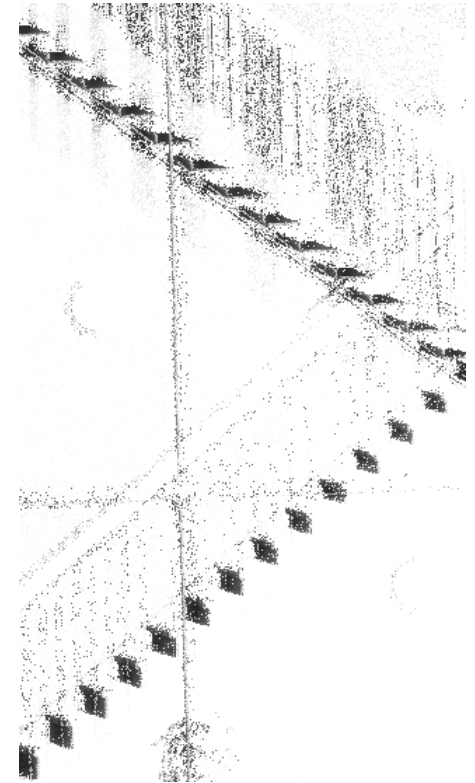


Stairs

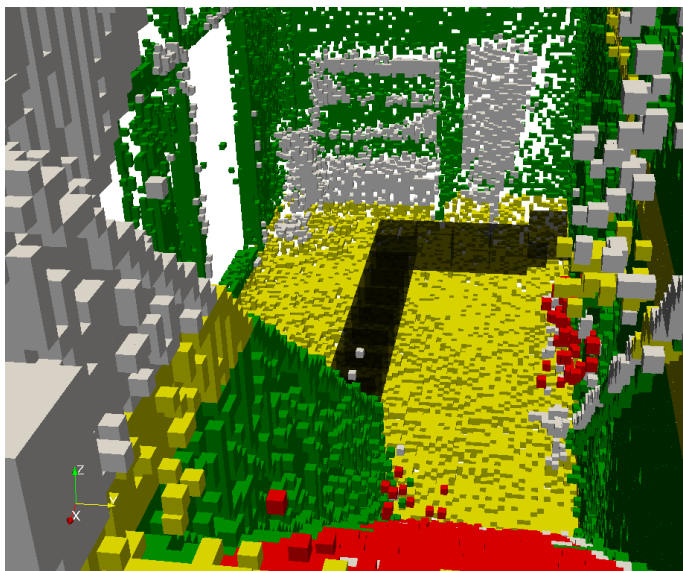
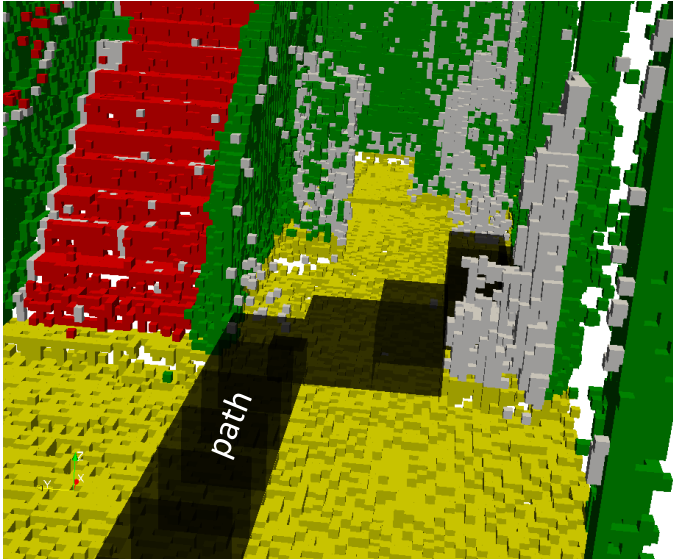


Stairs challenges

- Appearance depending on scanner
- Not all stairs have vertical riser
- ...

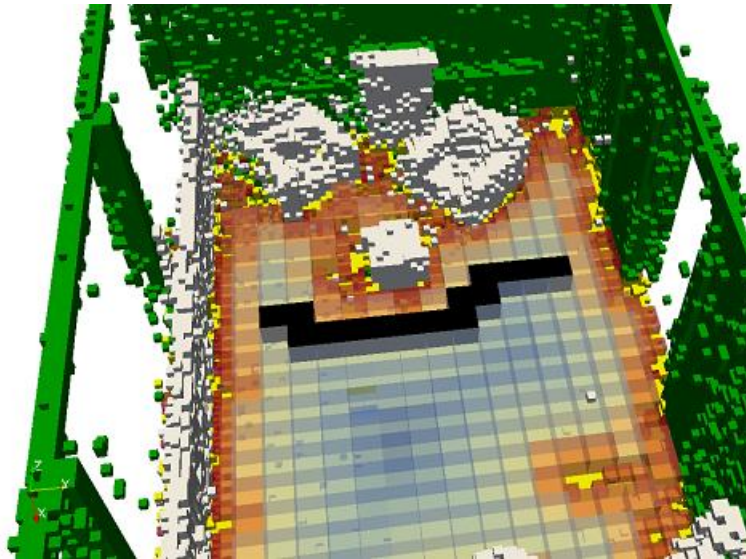


Real world comparison



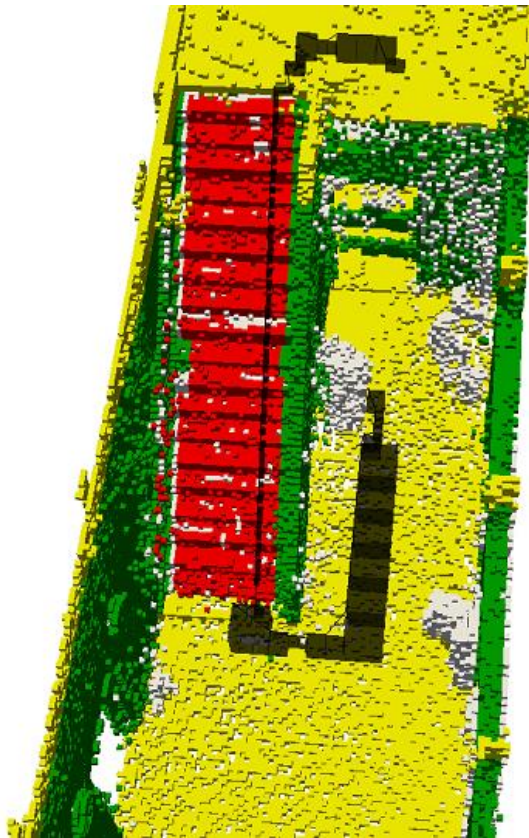
Path: clearance

- Keeps distance



Path: multi-storey

- Implementation on stairs to be improved



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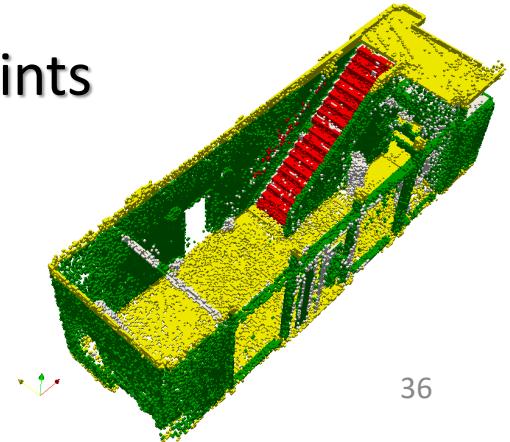
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Research question

To what extent can an octree support semantic enrichment of point clouds for the purpose of multi-storey pathfinding?

Octree...

1. structures points and empty space
2. enables workflow to be less dependent on laser scanner
3. facilitates fast access to points (addressing) & allows neighbour finding
4. enables path to be more detailed close to points



Conclusion

1. Storeys & walls can be found in a 3D point cloud of an indoor scene
2. stairs can be identified
3. a multi-storey graph can be derived, following constraints for humans
4. indoor environments differ strongly → challenge to find a workflow for semantic enrichment
 - point clouds acquired by different kinds of scanners
 - wide range of architectural scenes

Recommendations

1. Extend current workflow to non-Manhattan-Worlds
2. Extend identification of stairs to more cases
3. Graph needs to be improved and distance transform on stairs implemented
4. Results of this research could be combined with development of other works of *SIMs3D* project

References

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Questions?

Many thanks to my supervisors:

- Dr. Abdoulaye Diakité
- Prof. Dr. Sisi Zlatanova
- Robert Voûte
- Edward Verbree

