FAKULTÄT FÜR !NFORMATIK

Faculty of Informatics

Diplomarbeitspräsentation

Interactive Shape Detection in Out-of-Core Point Clouds for Assisted User Interactions

Masterstudium:
Visual Computing

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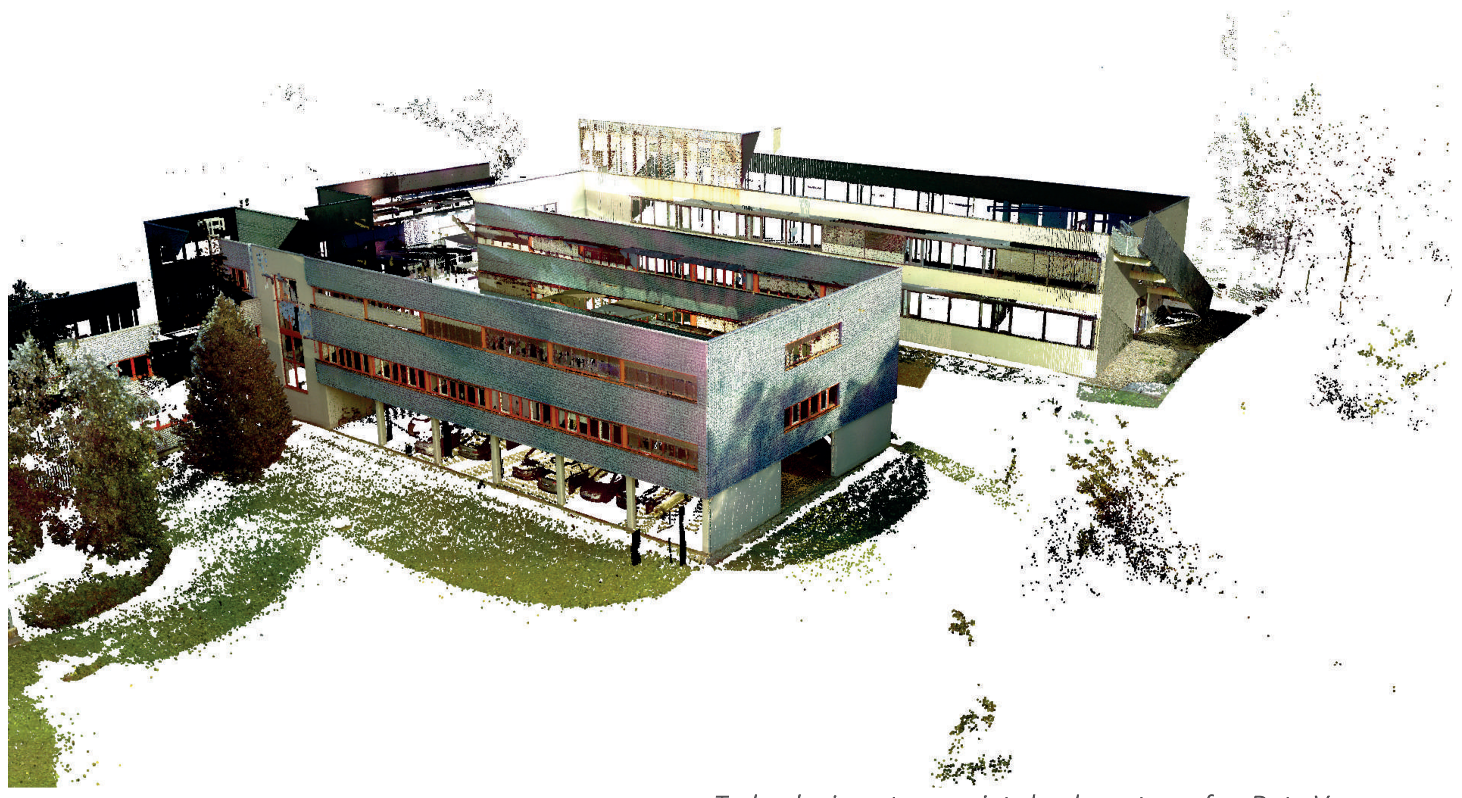
Introduction

When using classic 2D interaction metaphors (e.g. mouse) in a 3D environment, the third dimension (i.e. depth) of the interaction is ignored or must be controlled separately. To achieve the desired interaction result, multiple views are often necessary in order to counter occlusion and depth ambiguities.

Shape detection aims to detect large geometric structures (e.g. plane, sphere, etc.) in point clouds. This thesis introduces a technique to perform shape detection on the fly and utilizes the detected shapes such that only points that are approximated by a selected shape are interacted with.



Technologiezentrum point cloud courtesy of rmData Vermessung

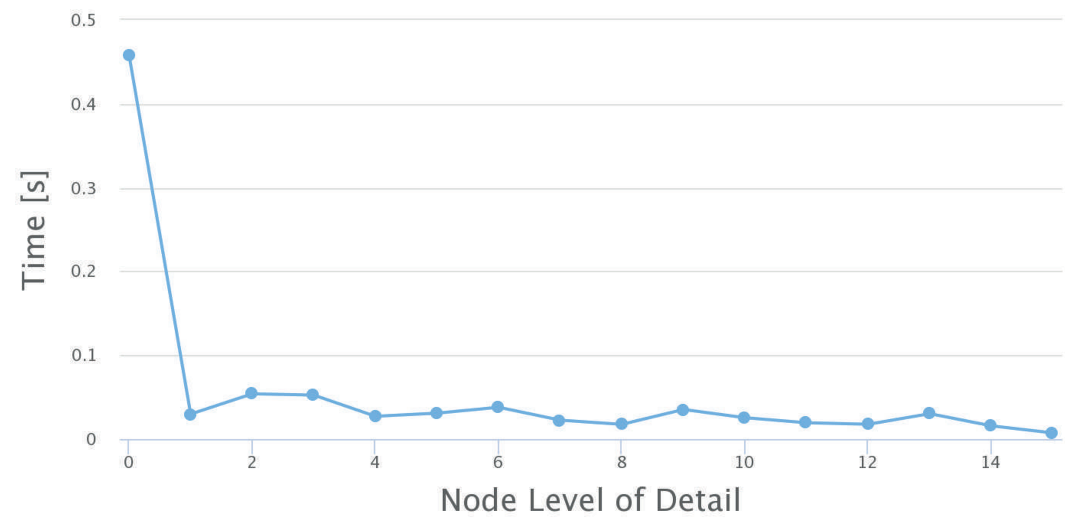
Out-of-Core Octree

The point cloud is stored at multiple resolutions in an octree structure. The leaf nodes contain the exact model, whereas the intermediate nodes contain a random subset of points from its children. To accelerate point queries, the point set within each node is stored in an rkd-tree [1]. The structure is suitable not only for rendering but also for fast processing on multiple levels of detail.

JBs_Haus point cloud courtesy of rmData Vermessung

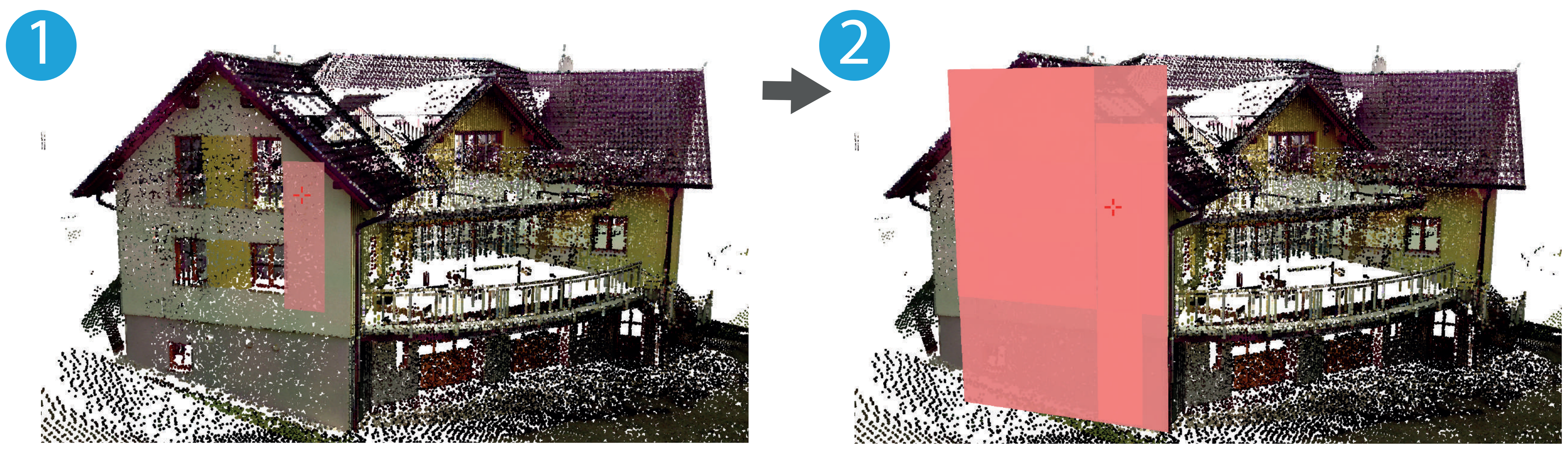
User-Guided Shape Detection

The shape detection algorithm [2] is performed on single octree nodes at a time selected by the user. The node with the highest level of detail closest to the camera under the cursor is selected. ~5000 points per node allow the shape detection to process a single node in ~60 milliseconds.



Shape-Assisted User Interactions

1. The user picks a primitive shape that was detected by the user-guided shape detection.
2. Since the size of a single shape is limited to the extent of its source node, a shape clustering algorithm creates a larger coherent shape from multiple matching primitive shapes from different levels of detail.
3. Using the selected cluster as support shape, the user then performs a shape-assisted interaction.



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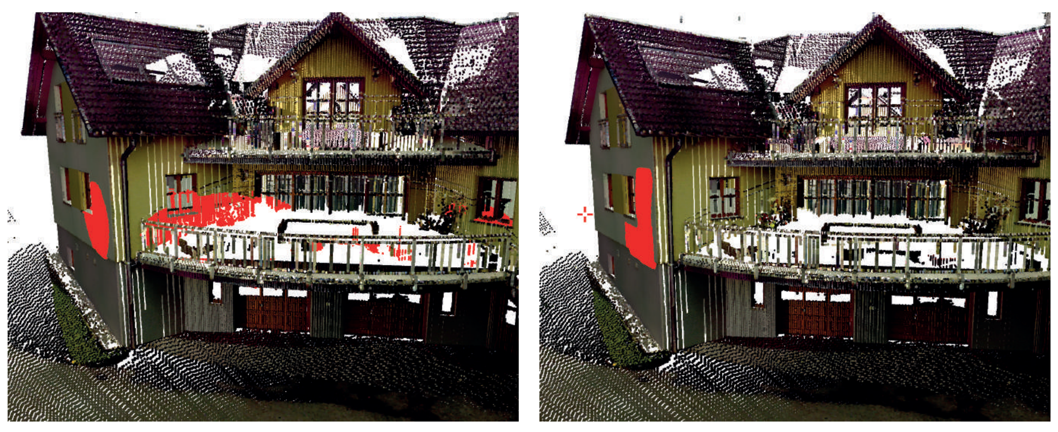
Shape-Assisted Region Selection

With the classic lasso selection (left) the user selects 'through' the point cloud and multiple view changes are necessary to perform the desired selection. When using a support shape (right), only points are selected that are approximated by the shape (e.g. the leftmost wall).



Shape-Assisted Point Picking

Usually, point picking selects the point closest to the cursor. The benefit of using a support shape for this interaction is that only points are pickable that are approximated by this shape. Picking points on edges is improved in particular since the cursor follows the edge of the shape rather than jumping to a point in the back.

Shape-Assisted Level-of-Detail Increment

Level-of-detail rendering displays the point cloud with a limited resolution to allow real-time frame rates. Points that are approximated by the support shape but were not rendered due to their higher level of detail are displayed in addition. The interaction provides the user with a more detailed insight into the particular structure.

vrvis

References:
[1] "The rkd-Tree: An Improved kd-Tree for Fast n-Closest Point Queries in Large Point Sets", Tobler R.
[2] "Efficient RANSAC for Point-Cloud Shape Detection", Schnabel R., Wahl R., Klein R.

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