Guided Real-Time Scanning of Indoor Environments

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Motivation

Advances in 3D acquisition devices provide opportunities for scanning complex indoor environments. Such raw scans, however, are often noisy, incomplete, and significantly corrupted. Unfortunately, in most existing workflows, scan quality is assessed after the scanning stage is completed, making it cumbersome to correct for significant missing data by additional scanning. We present a **guided real-time scanning setup**, wherein the incoming 3D data stream is continuously analyzed, the data quality automatically assessed.

Problem Definition

Pre-processing

3-D Database of models from Google 3-D warehouse

Input

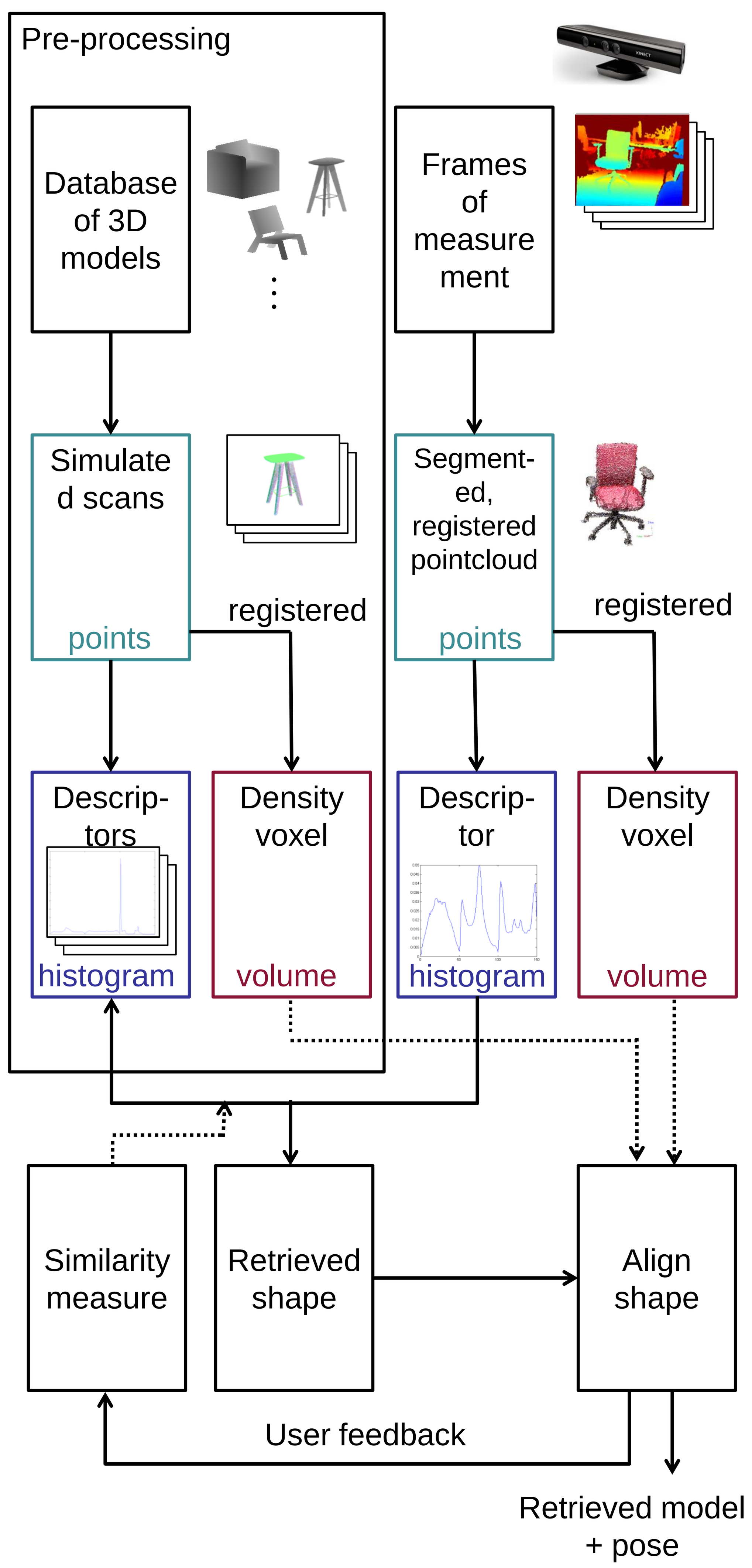
Pointcloud frame: depth + color, assume that the segmentation is solved

Output

The best matching model from the 3-D database models given the pointcloud data

Uncertainty region as yellow boxes

Approach

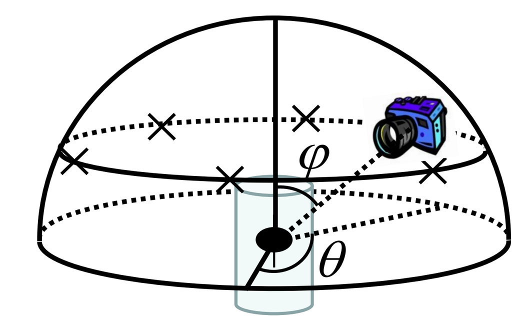


Two stage process

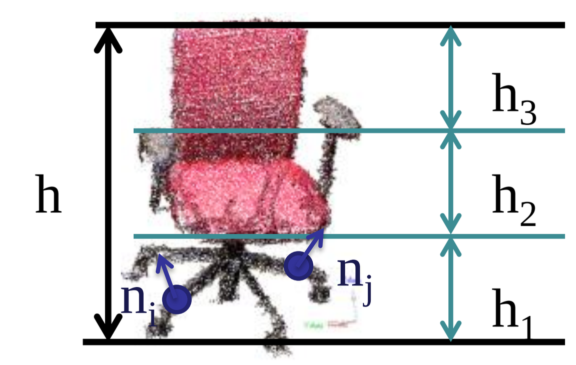
1) Quick similarity measure using histogram descriptors
2) More detailed volumetric comparison using density voxel

A2h Descriptor

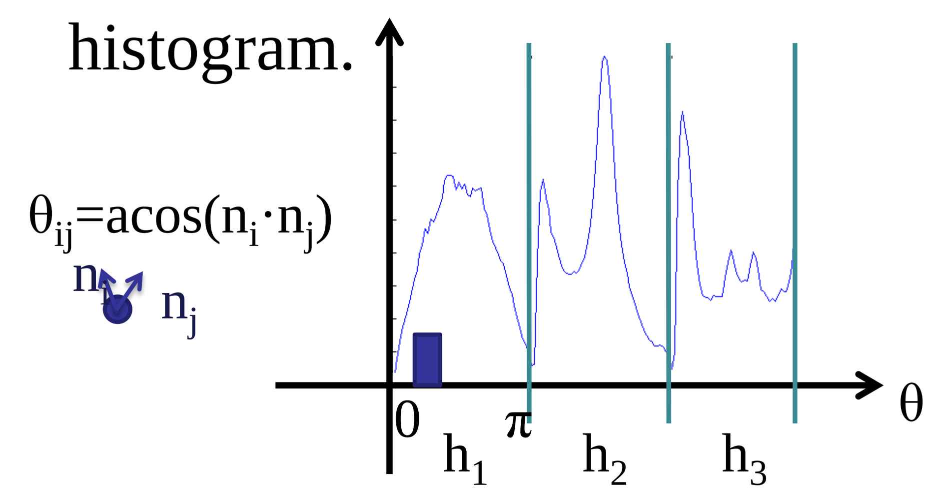
1) Gather points either from simulated scans or real scanner.



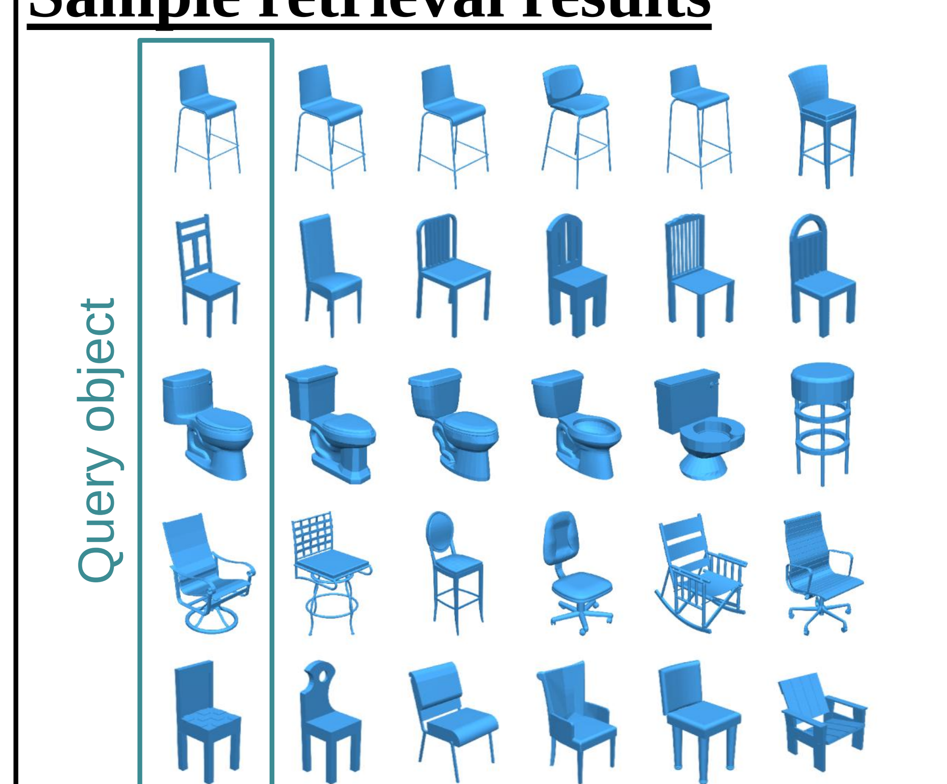
2) Divide the scan into different height sections.



3) Sample points from each section and record the difference of normals into a histogram.



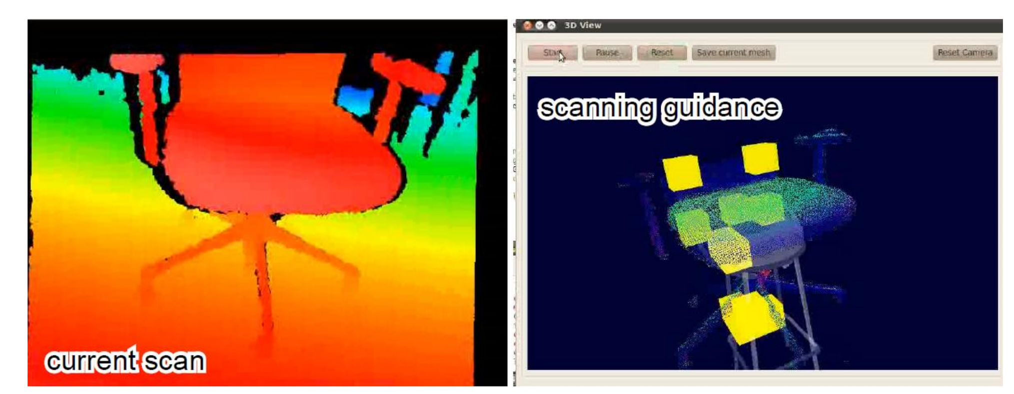
Sample retrieval results



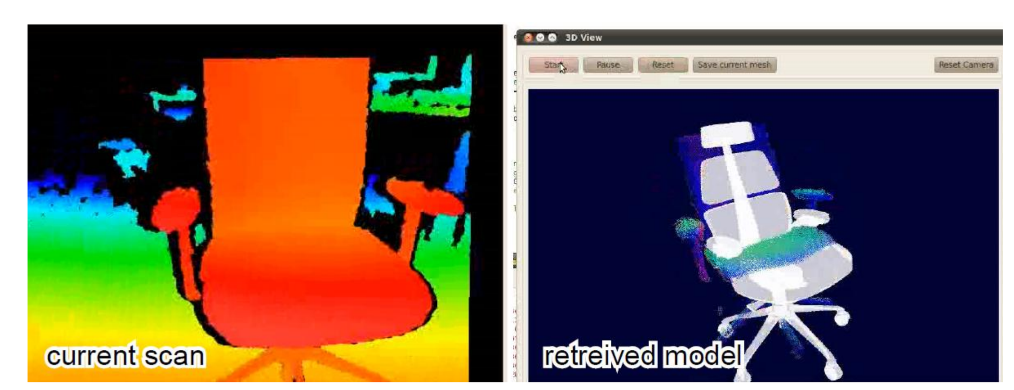
Real-time Pipeline

1) Start by pointing the sensor at the groundplane.

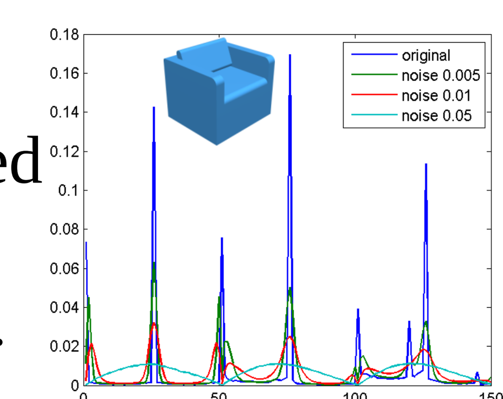
2) The best matching model is shown as transparent white, and the uncertainty region is shown as yellow boxes.



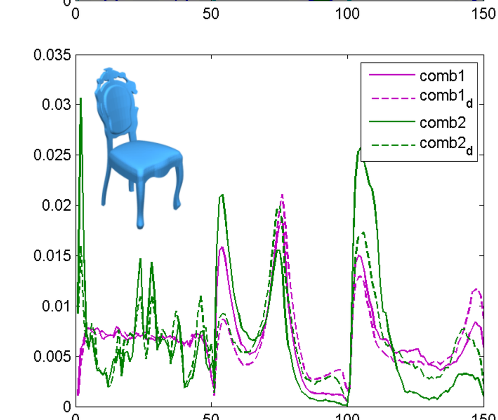
3) Finish when the retrieved model is close enough.



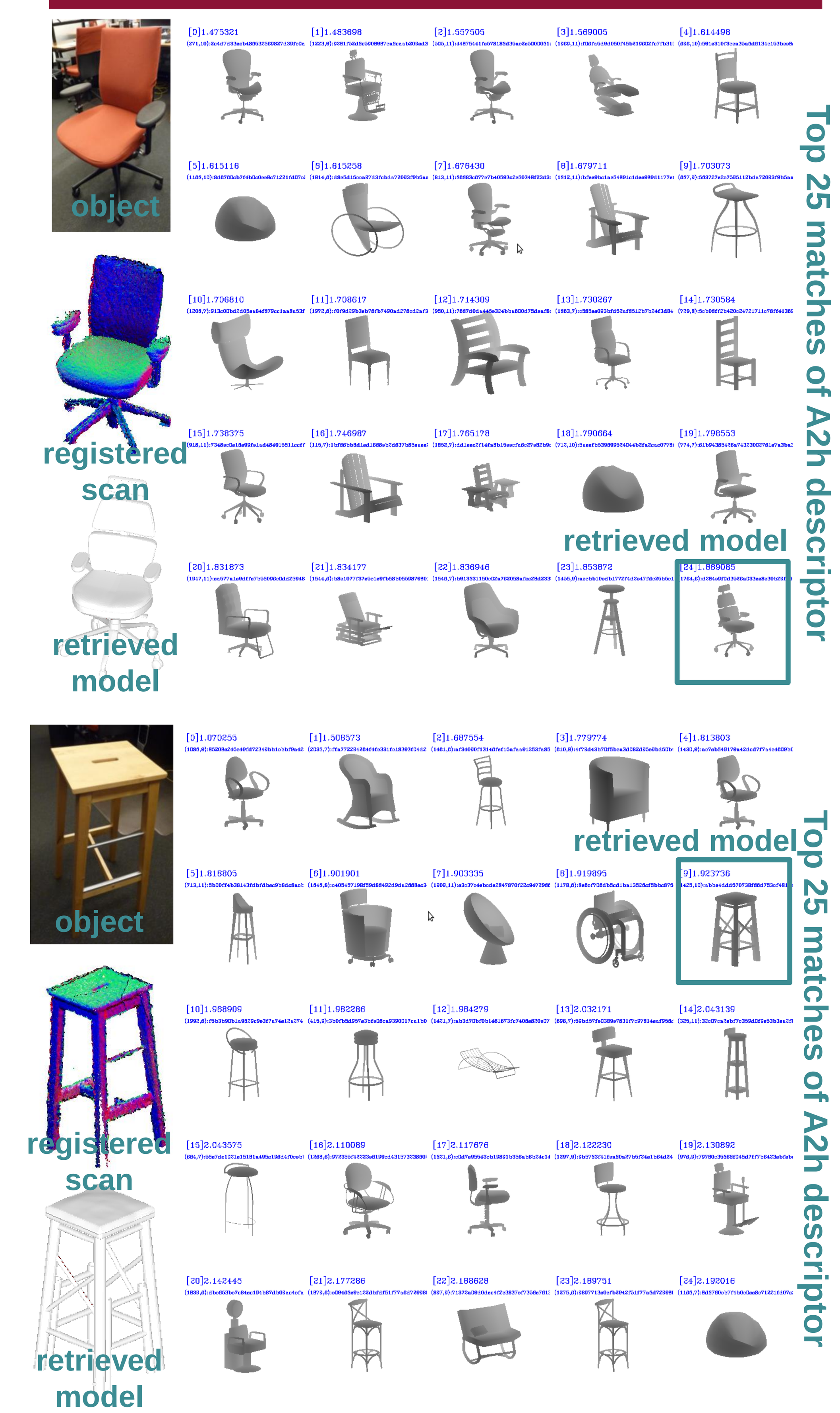
Effects of sensor noise is minimized using earth mover's distance.



Effects of view-point variation is minimized by density-aware sampling.



Results with Real Data



Conclusions

We used commonly available 3D model sets to assess the quality of scans and predict the missing data from real-time scans. We proposed a robust and effective comparison pipeline using a descriptor based on the distribution of relative local orientations in the scans.