3D POSE ESTIMATION VIA POINT PAIR FEATURES IN OPENCV
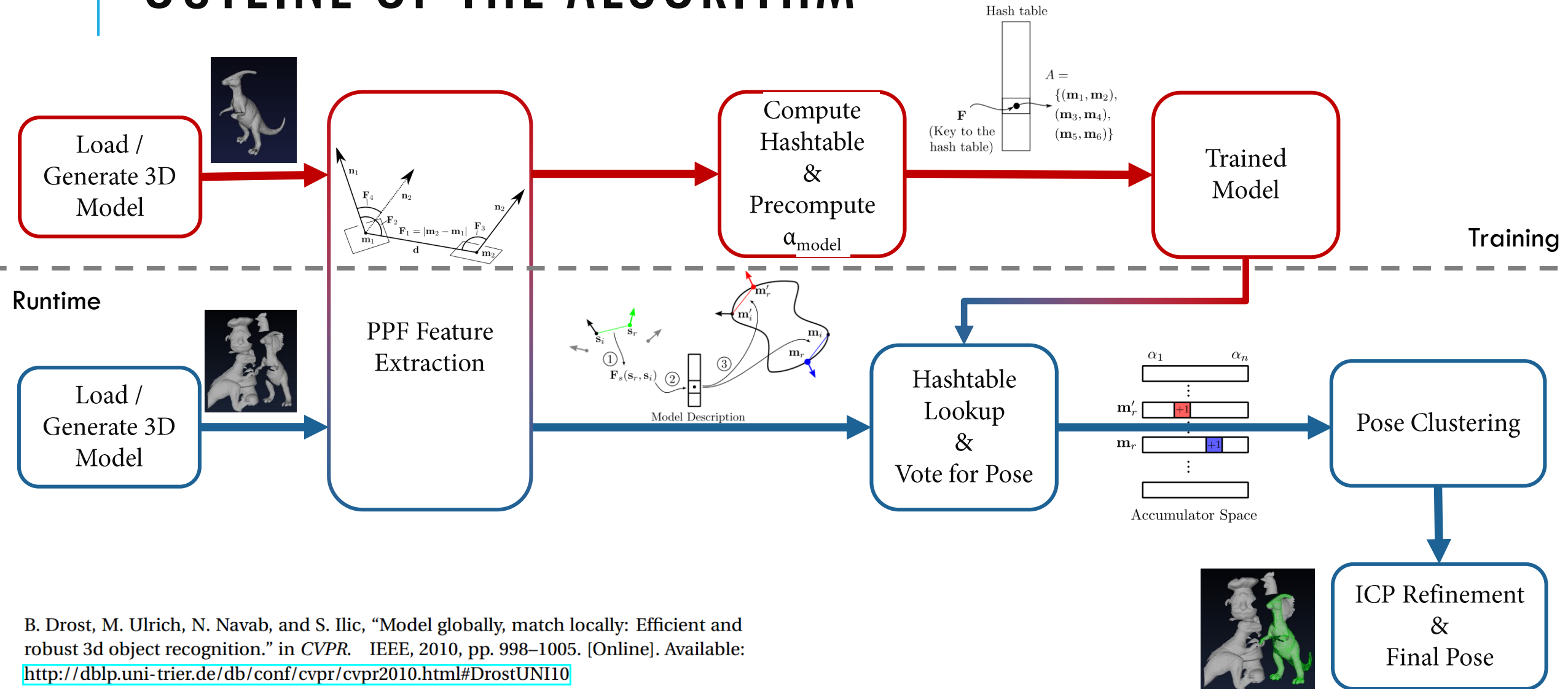
Tolga Birdal
GSoC 2014

OUTLINE OF THE ALGORITHM

Training

Runtime

B. Drost, M. Ulrich, N. Navab, and S. Ilic, "Model globally, match locally: Efficient and robust 3d object recognition." in *CVPR*. IEEE, 2010, pp. 998–1005. [Online]. Available: http://dblp.uni-trier.de/db/conf/cvpr/cvpr2010.html#DrostUNI10
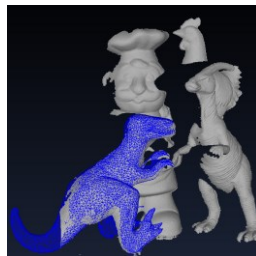
REGISTRATION USING POINT PAIR FEATURES - LASER
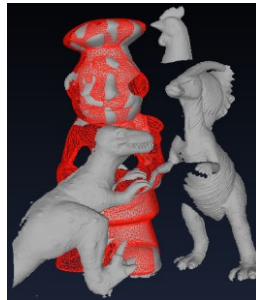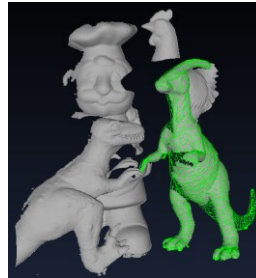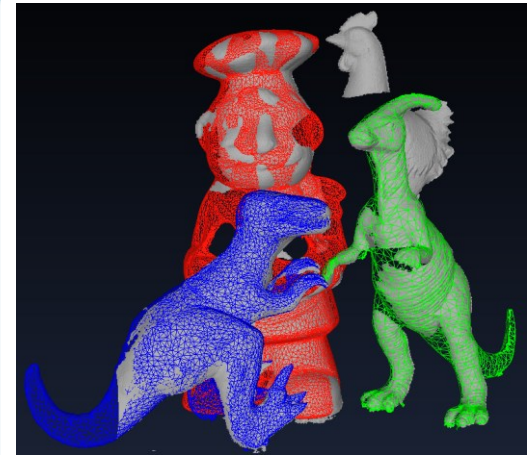

Input 3D Models

Input 3D Scene
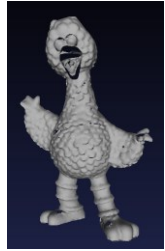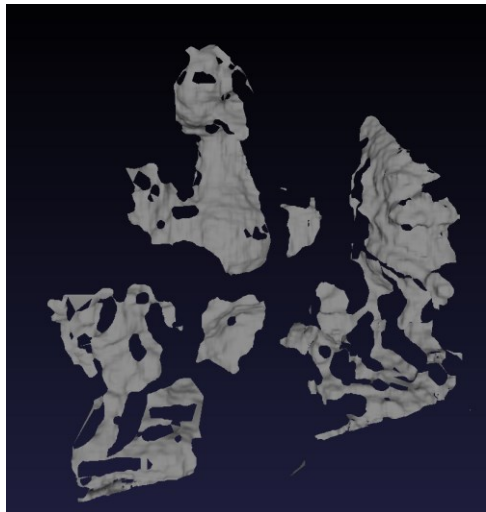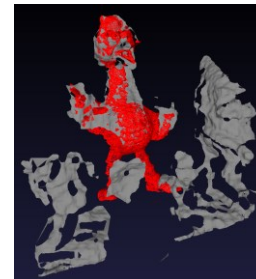
PPF + ICP

Registrations

All Models

Full Pose Estimation
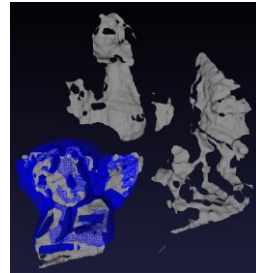
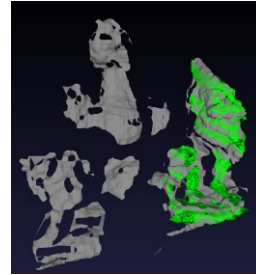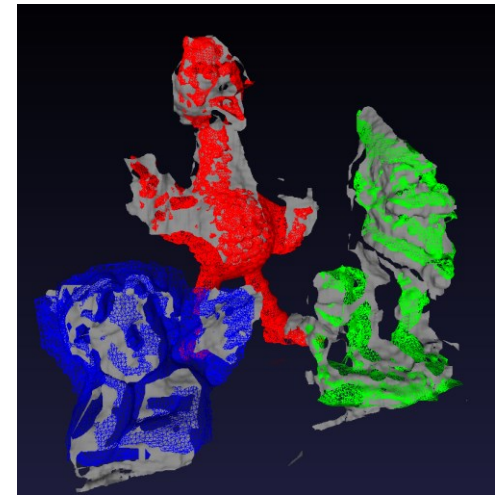# REGISTRATION USING POINT PAIR FEATURES - STEREO

Input 3D Models

Input 3D Scene

PPF + ICP
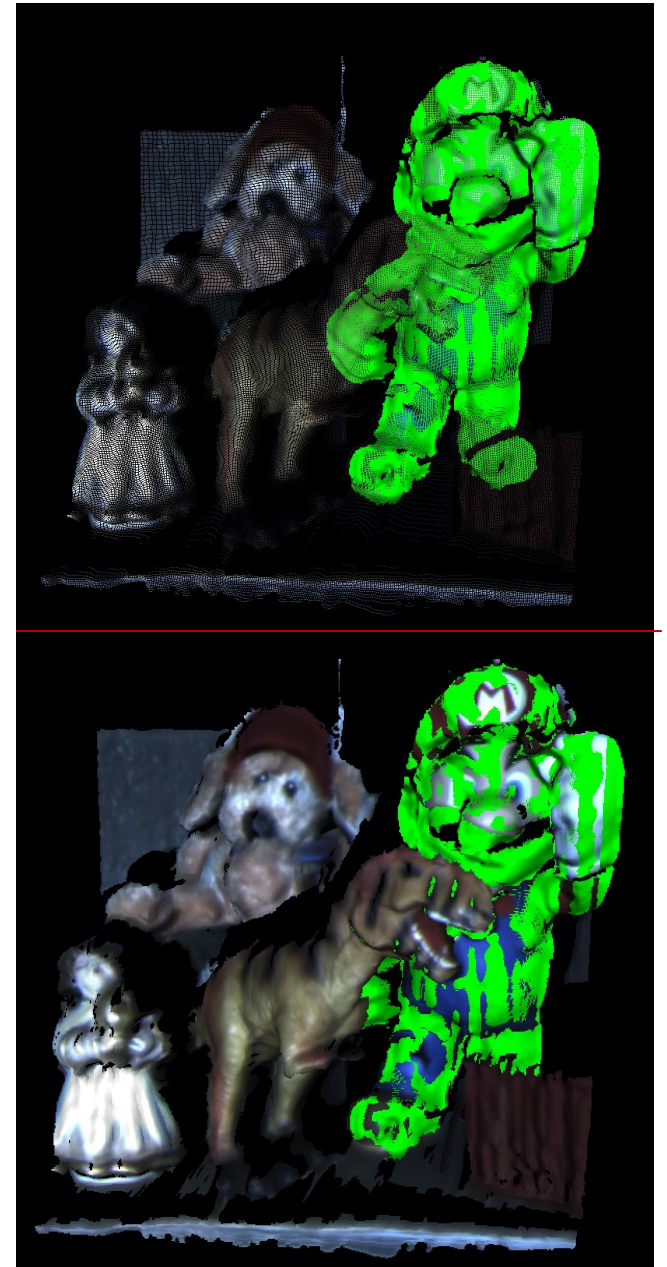
Registrations
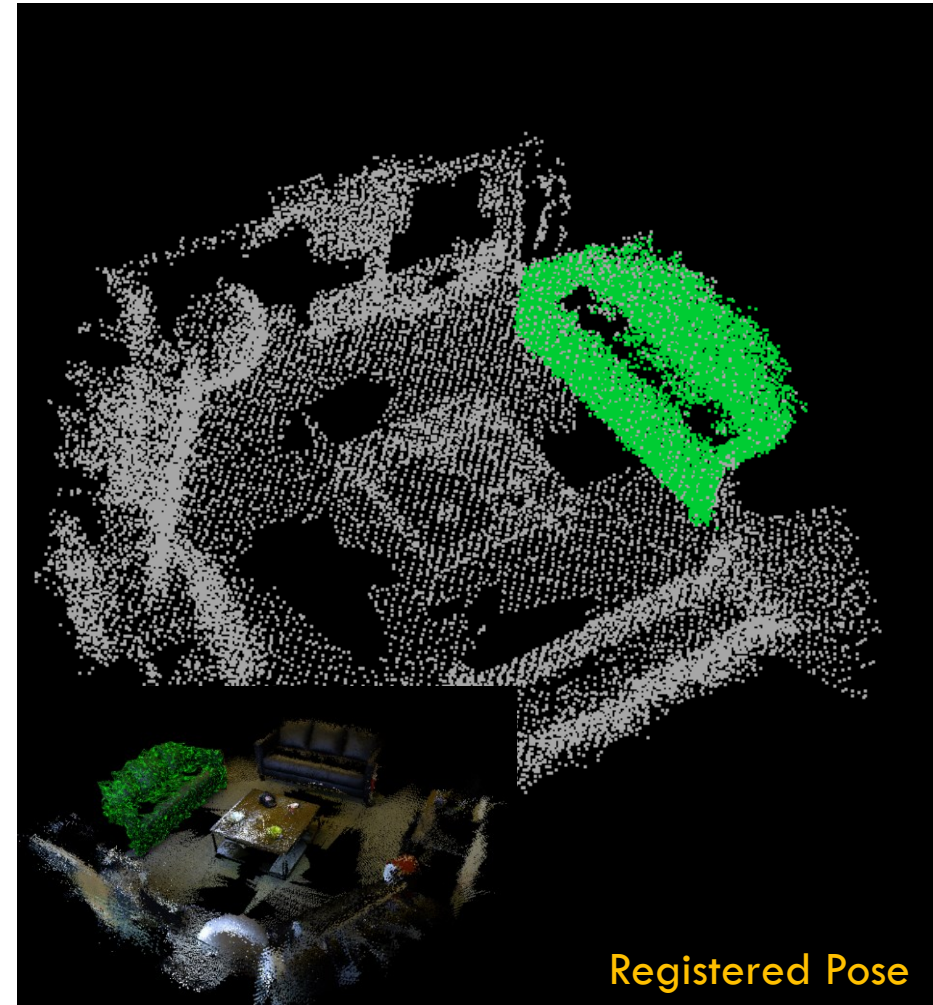
All Models

REGISTRATION ON SPACETIME STEREO

Model

Scene

Registered Pose

REGISTRATION ON SLAM DATASET - 1

Arbitrary SLAM Scene

Exact Sofa Model

PPF + ICP

Registered Pose

REGISTRATION ON SLAM DATASET - 2

3D Reconstruction

Cropped &
Processed Chair Model

PPF + ICP

Model Matched to Reconstruction

FAILING CASES

1

Arbitrary Sofa Model

2

Scaled and ReMeshed

3
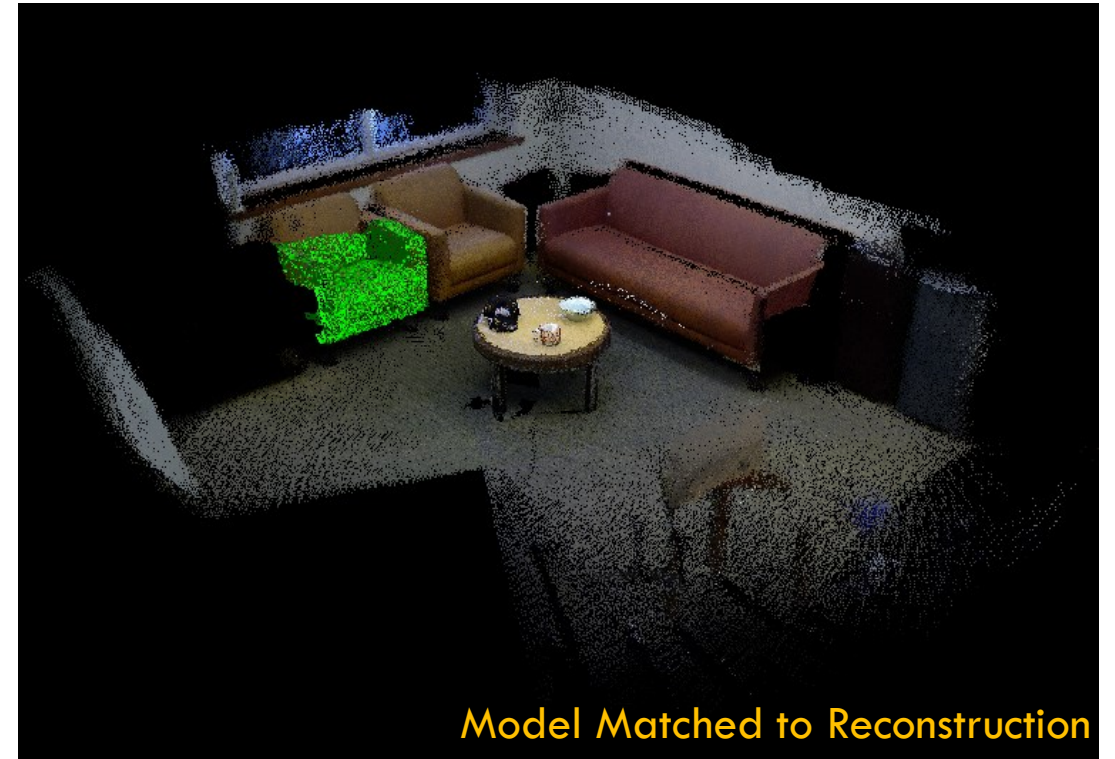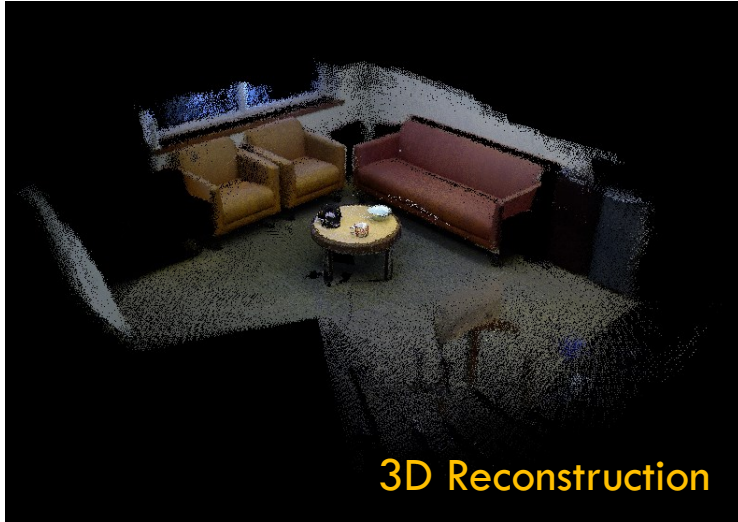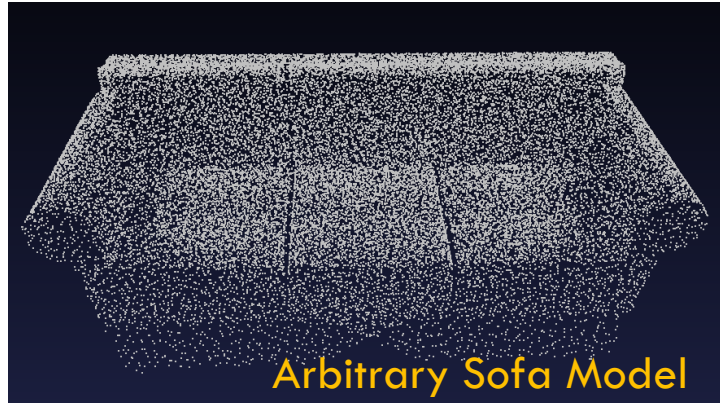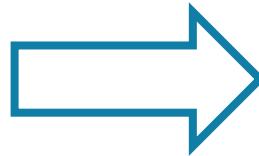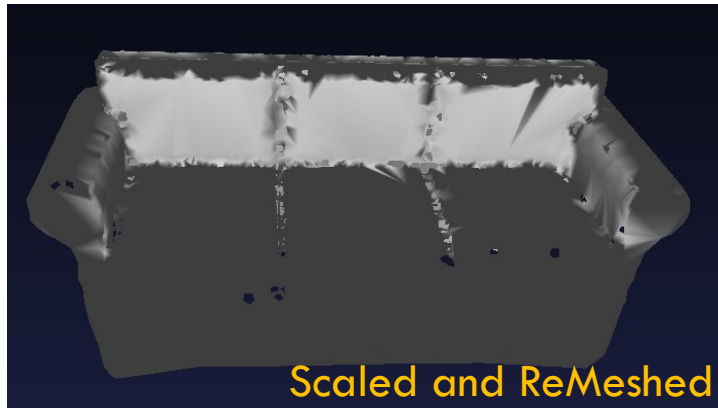
Non-Uniform Sampling
& Normals Computation

Train & Match

4

Model is Positioned with Error
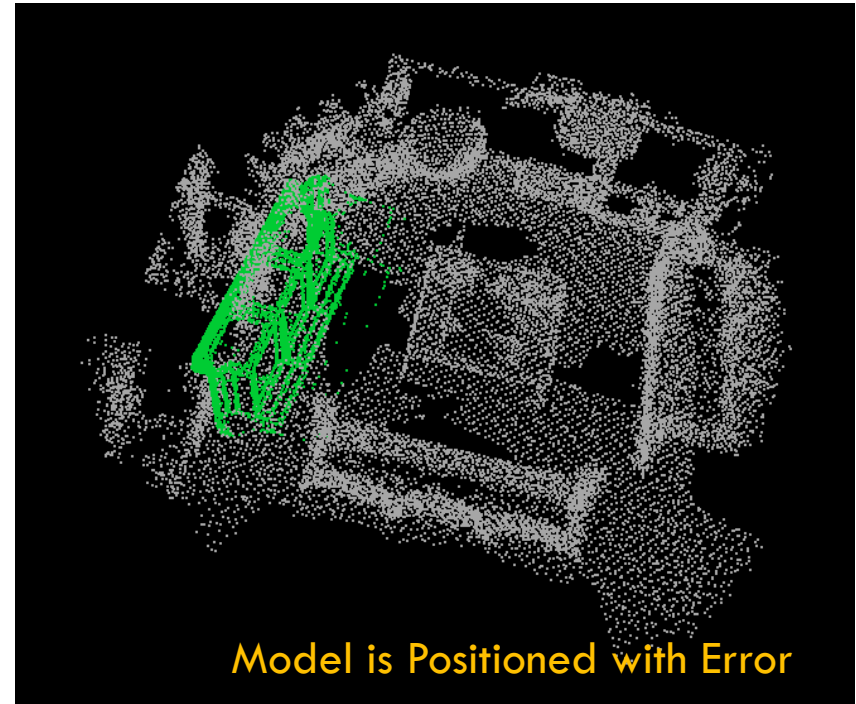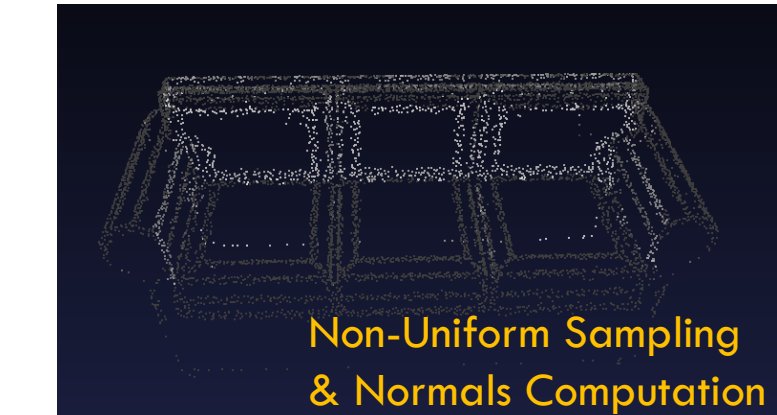
FAST ICP REGISTRATION

- ✓ Point Cloud Normalization

- ✓ Robust Registration: Median Absolute Deviations

- ✓ Coarse to Fine Registration

- ✓ Linearized Point to Plane Metric

- ✓ Duplicate Assignment Resolution: Picky ICP

Registration in ~300 ms
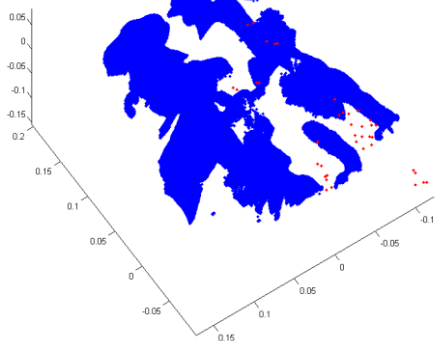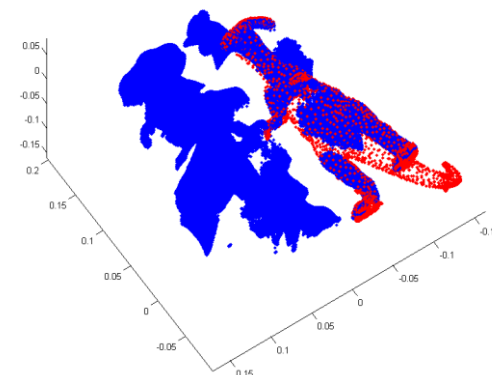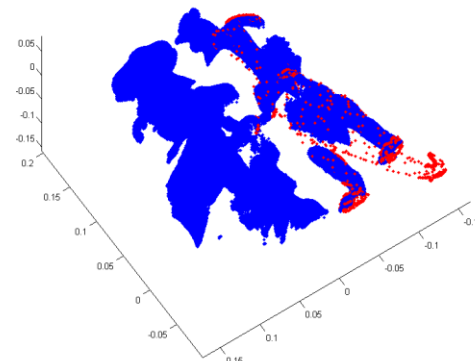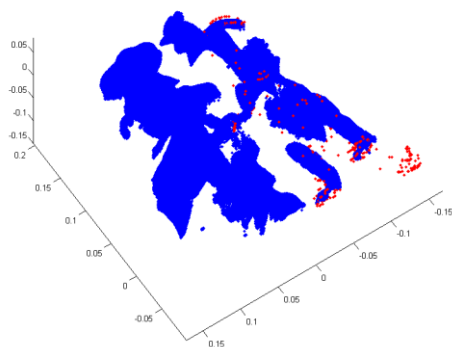
Coarsest Level ———————————————————→ Finest Level

OTHER GAINED FUNCTIONALITIES

- ✓ Bounding Boxes

- ✓ Voxel Based Quantization of Point Clouds

- ✓ Fast Normal Computation of Point Clouds

- ✓ PLY Reading / Writing

- ✓ Naïve Hashtable and Various Hashfunctions

PC Normals

Octrees

REFERENCES

[1] B. Drost, M. Ulrich, N. Navab, and S. Ilic, "Model globally, match locally: Efficient and robust 3d object recognition." in *CVPR*. IEEE, 2010, pp. 998–1005. [Online]. Available: http://dblp.uni-trier.de/db/conf/cvpr/cvpr2010.html#DrostUNI10

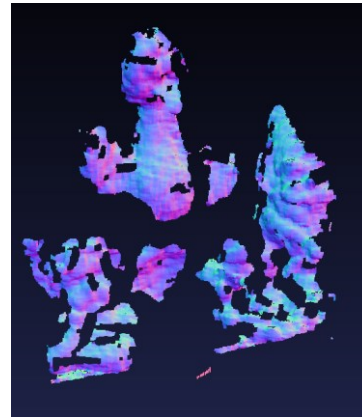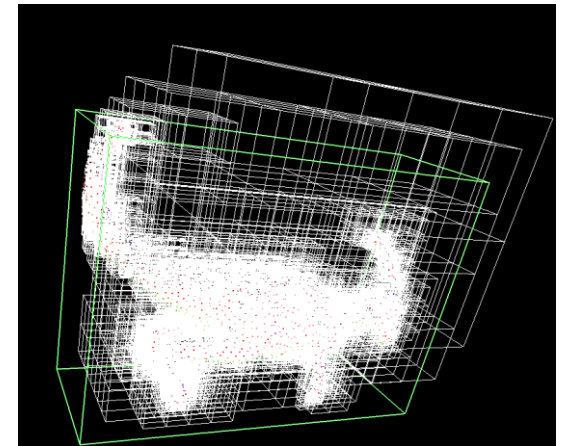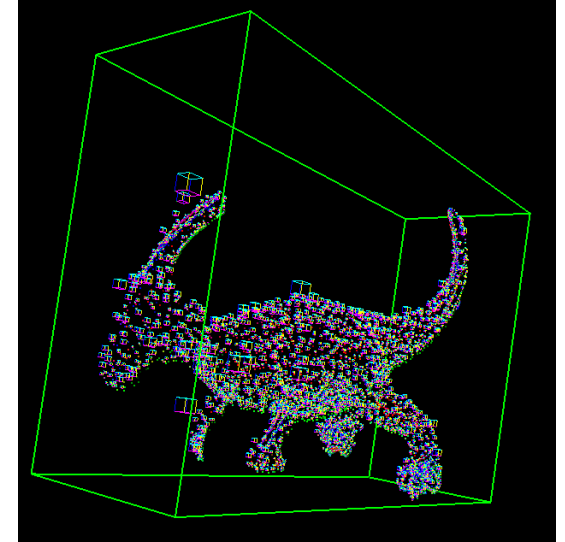[2] P. J. Besl and N. D. McKay, "Method for registration of 3-d shapes," in *Robotics-DL tentative*. International Society for Optics and Photonics, 1992, pp. 586–606.

[3] S. Rusinkiewicz and M. Levoy, "Efficient variants of the icp algorithm," in *3-D Digital Imaging and Modeling, 2001. Proceedings. Third International Conference on*. IEEE, 2001, pp. 145–152.

[4] N. Gelfand, L. Ikemoto, S. Rusinkiewicz, and M. Levoy, "Geometrically stable sampling for the icp algorithm," in *3-D Digital Imaging and Modeling, 2003. 3DIM 2003. Proceedings. Fourth International Conference on*. IEEE, 2003, pp. 260–267.

[5] T. Zinßer, J. Schmidt, and H. Niemann, "A refined icp algorithm for robust 3-d correspondence estimation," in *Image Processing, 2003. ICIP 2003. Proceedings. 2003 International Conference on*, vol. 2. IEEE, 2003, pp. II–695.

[6] L. Zhang, S.-I. Choi, and S.-Y. Park, "Robust icp registration using biunique correspondence," in *3D Imaging, Modeling, Processing, Visualization and Transmission (3DIMPVT), 2011 International Conference on*. IEEE, 2011, pp. 80–85.

[7] K.-L. Low, "Linear least-squares optimization for point-to-plane icp surface registration."

Many thanks to OpenCV Team and Google for makıng this an ingenious experience.