

# 3D POSE ESTIMATION VIA POINT PAIR FEATURES IN OPENCV

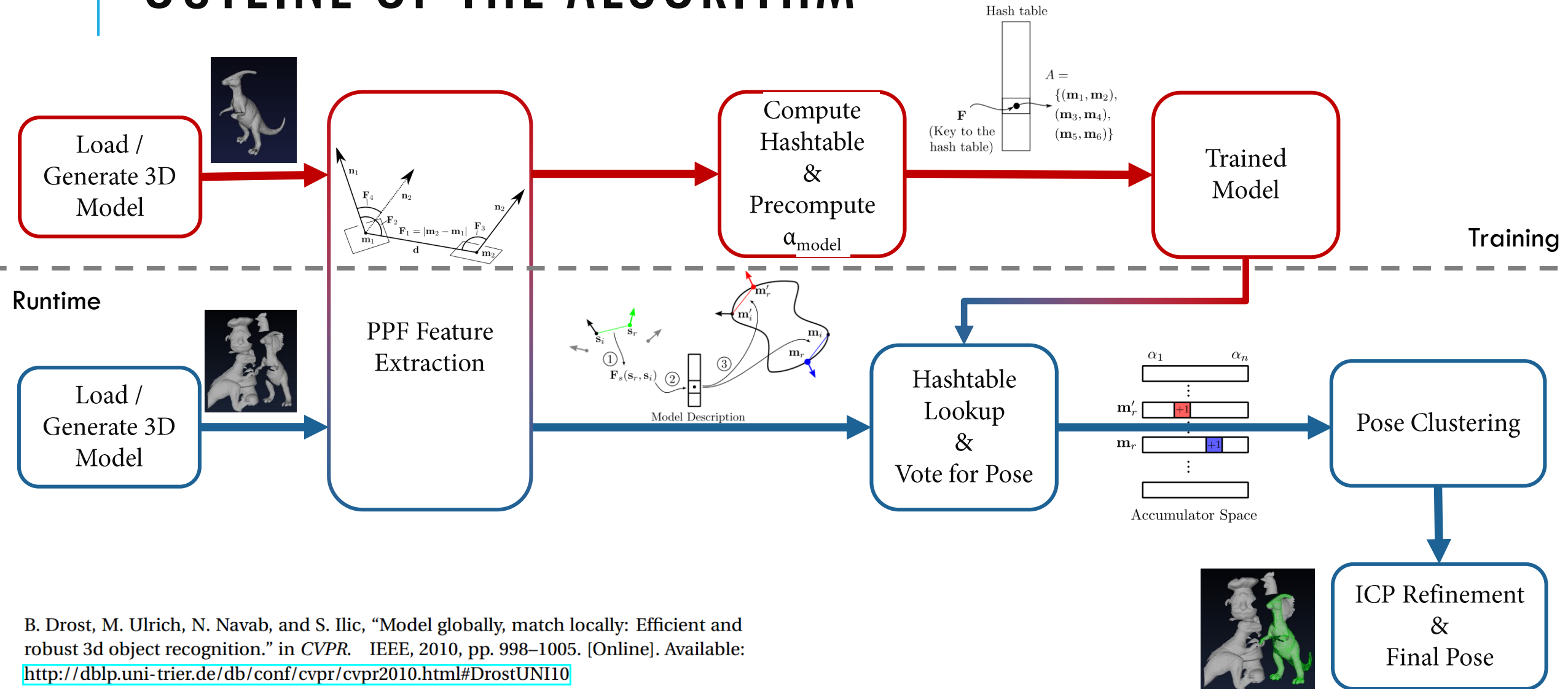
Tolga Birdal  
GSoC 2014

Google

TENTH  
2014  
YEAR



# OUTLINE OF THE ALGORITHM





# REGISTRATION USING POINT PAIR FEATURES - LASER

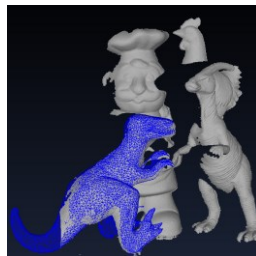
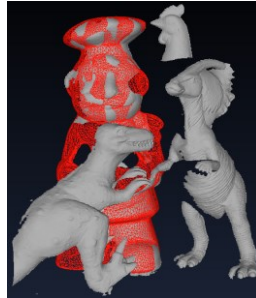
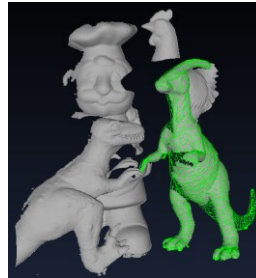


Input 3D Models



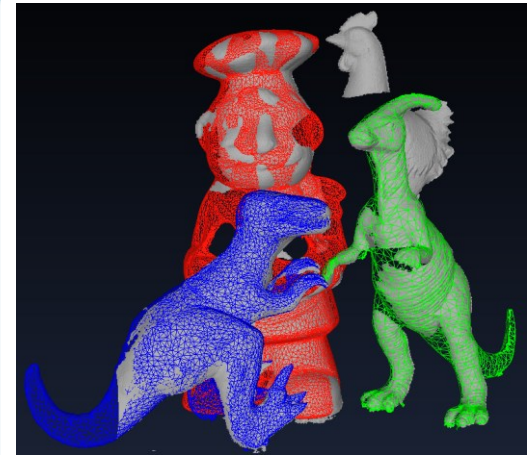
Input 3D Scene

PPF + ICP



Registrations

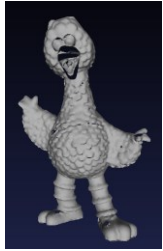
All Models



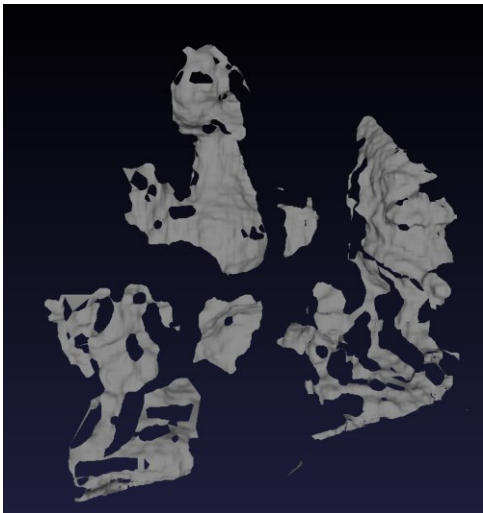
Full Pose Estimation



# REGISTRATION USING POINT PAIR FEATURES - STEREO

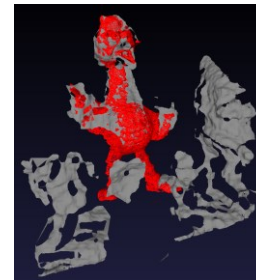
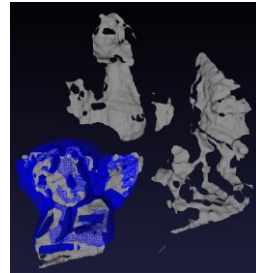
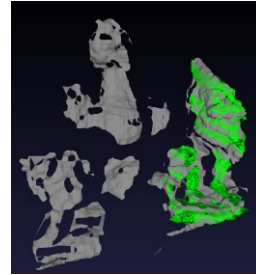


Input 3D Models



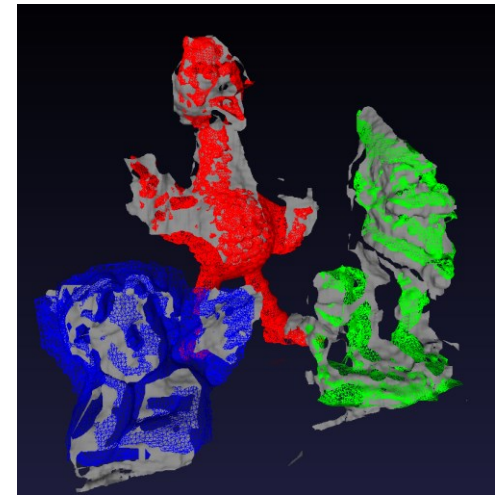
Input 3D Scene

PPF + ICP



Registrations

All Models





# REGISTRATION ON SPACETIME STEREO



Model



Scene



Registered Pose

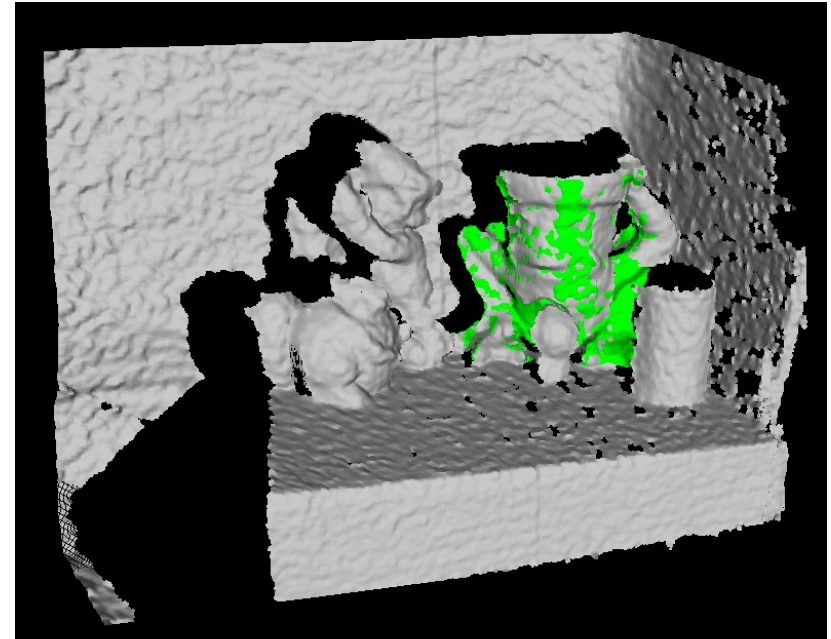
# REGISTRATION ON KINECT



Model



Scene

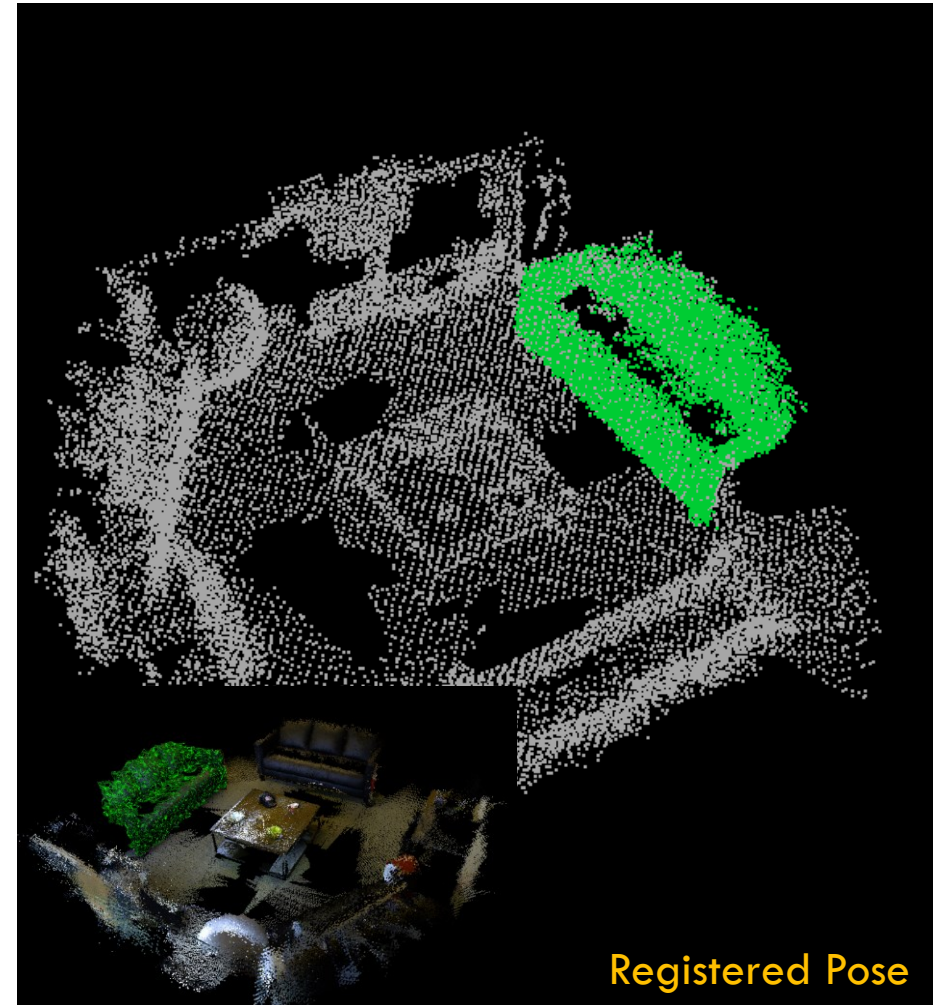
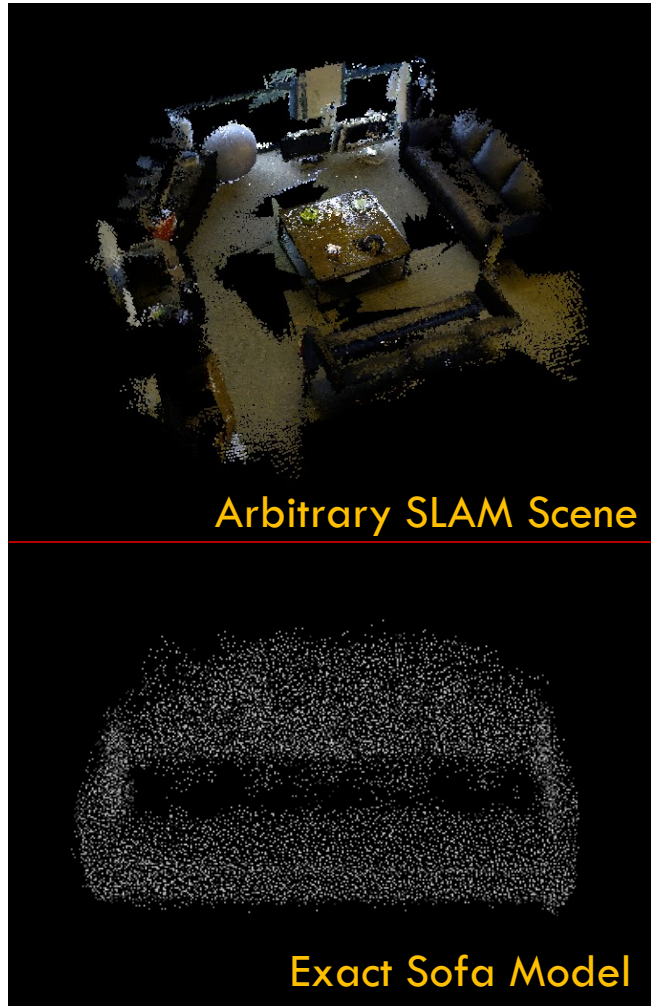


Registered Pose





# REGISTRATION ON SLAM DATASET - 1



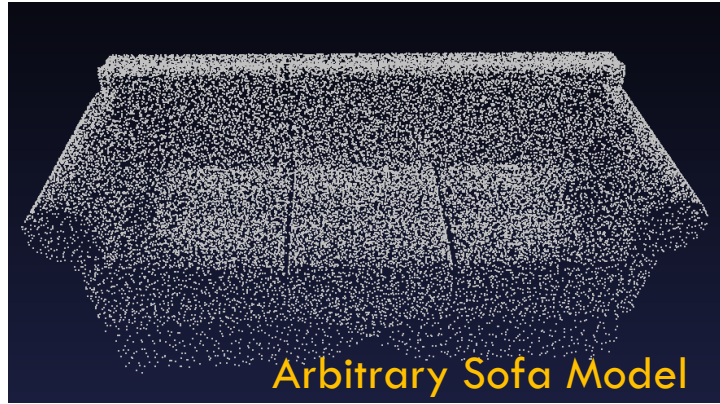
# REGISTRATION ON SLAM DATASET - 2



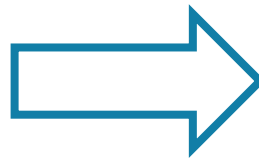
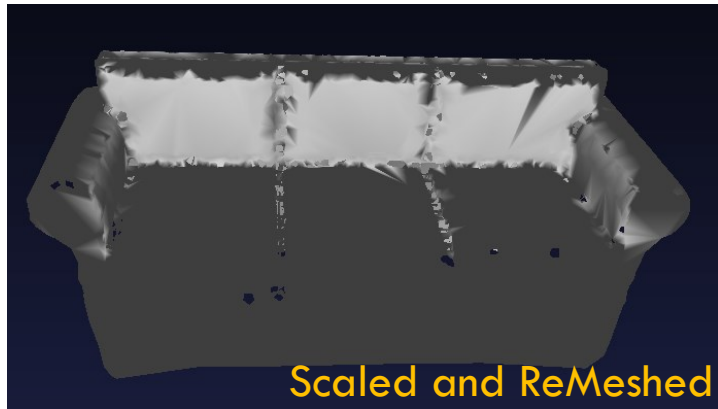


# FAILING CASES

1

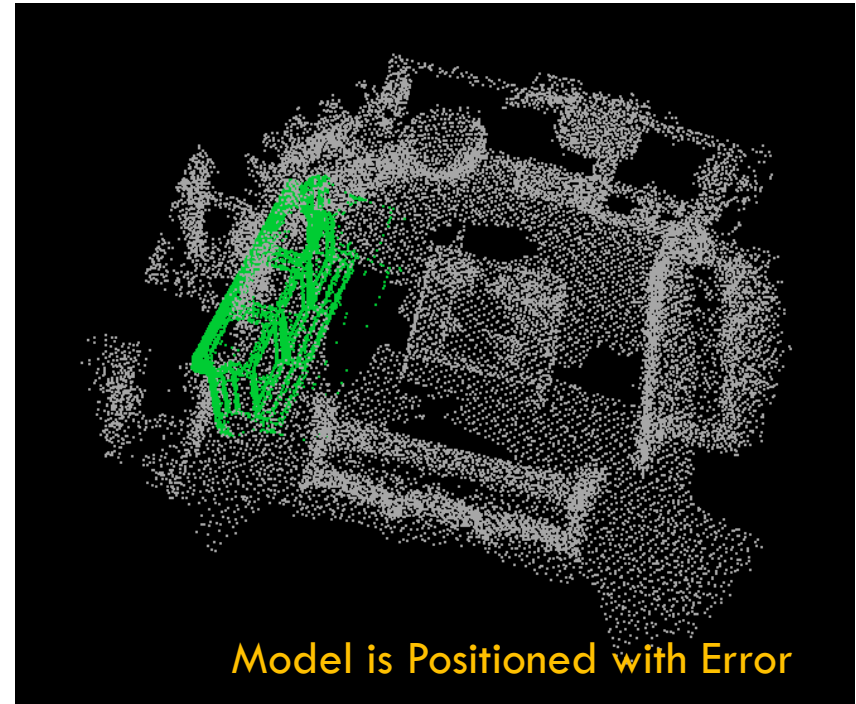
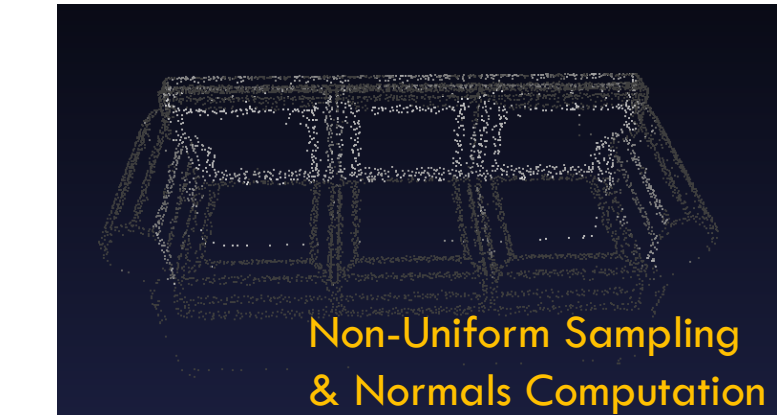


2



Train & Match

Non-Uniform Sampling  
& Normals Computation



4

3

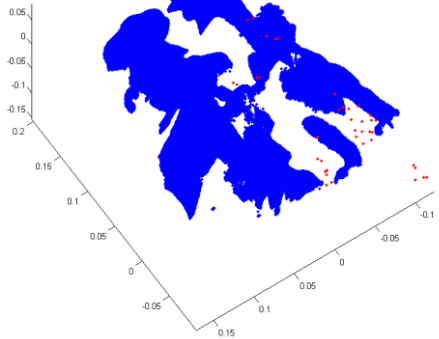




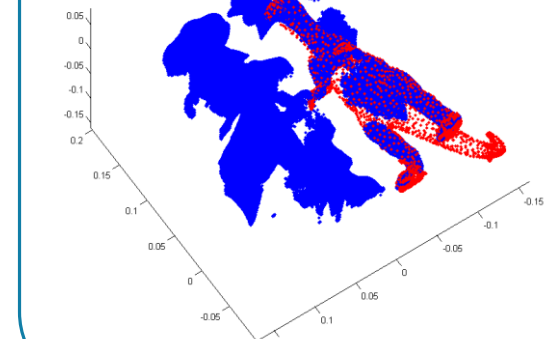
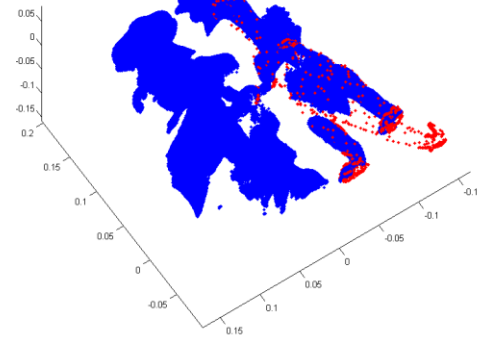
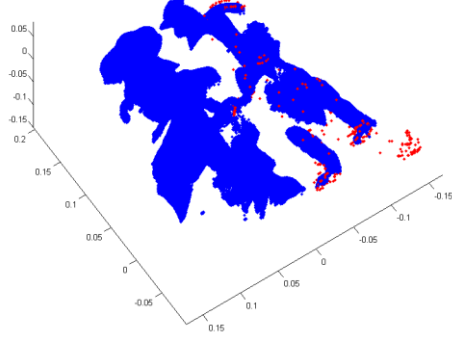
# FAST ICP REGISTRATION

- ✓ Point Cloud Normalization
- ✓ Robust Registration: Median Absolute Deviations
- ✓ Coarse to Fine Registration
- ✓ Linearized Point to Plane Metric
- ✓ Duplicate Assignment Resolution: Picky ICP

*Registration in  $\sim 300$  ms*



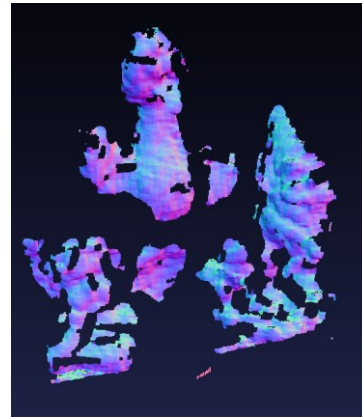
Coarsest Level



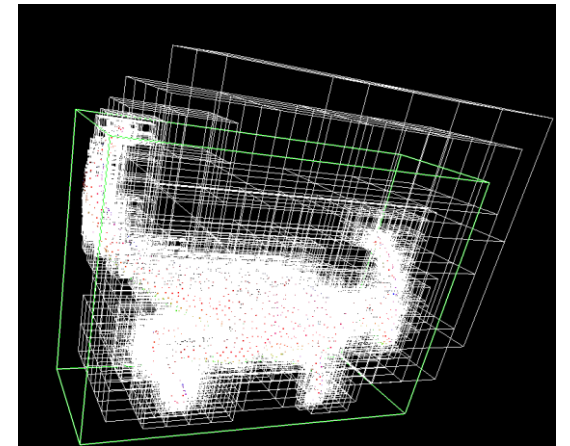
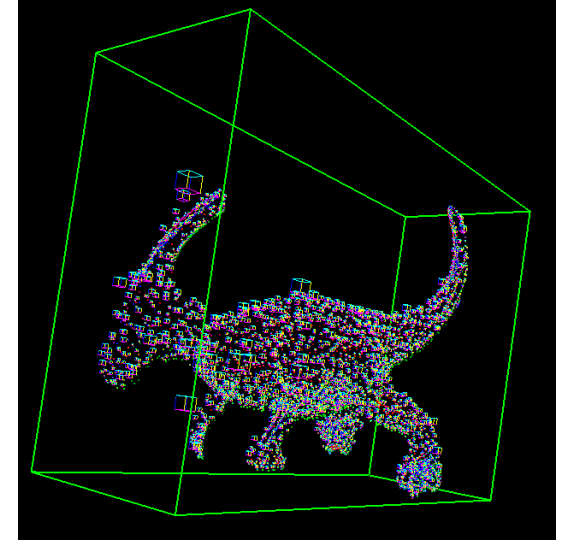
Finest Level

# 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.
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- [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 making this an ingenious experience.