Project Proposal

KinectFusion

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1 Abstract

Real-time reconstruction of dense surfaces of complex 3-dimensional indoor scenes is a classical and challenging field in 3D Scanning. This is a complex task since it also includes subtasks like tracking. The Microsoft kinect RGB-D camera is a low-cost solution for getting depth maps and it was also used by the famous paper by Newcombe et al. [1] that we aim to reproduce in our project, while also following their workflow like described in the technical details.

Using the data obtained by a Kinect sensor, the goal is to create a surface model of the observed scene in real-time.

2 Technical Details

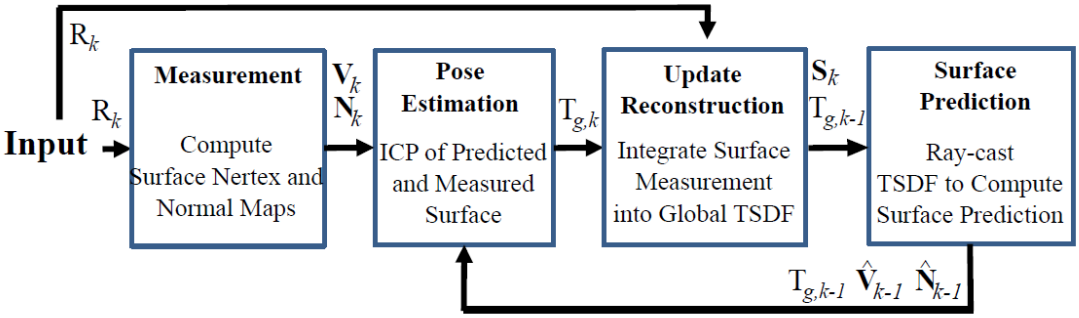

Figure 1: Method overview [sic] [1]

- **Measurement**
  This is a pre-processing stage, where KinectFusion generates a dense vertex map and normal map pyramid which are generated from the raw depth measurements obtained from the Kinect sensor.
- **Pose estimation**
  The sensor pose is obtained by tracking the live depth frame relative to the global model using a coarse-to-fine iterative closest point (ICP) algorithm, which uses all of the observed depth data available. The ICP alignment between the predicted surface and current sensor measurement.

- **Update Reconstruction**
  It is a global scene fusion process,where given the pose, the surface measurement is integrated into the scene model based on a volumetric truncated signed distance function (TSDF) representation.

- **Surface Prediction**
  KinectFusion closes the loop between mapping and re-localisation by tracking the live frame against the globally fused model. This is achieved by Raycasting the TSDF (Truncated Signed Distance Function) into the estimated frame to provide a dense surface prediction against which the live depth map is aligned. Each consecutive depth frame, with an associated live camera pose estimate is fused into one single 3D reconstruction.

The implementation will be done in C++. But since a major property is the real-time capability we can also use CUDA for utilizing the high degree of parallelism described in the paper [1].

3 Weekly milestones

Week 24: Official project start
Week 25: Preprocessing done - generate vertex map and normal map pyramid from 3D depth image
Week 26: Pose estimation done - running ICP between predicted and measured surface
Week 27: Update reconstruction into Global TSDF done
Week 28: Surface prediction by Raycasting done
Week 29: Buffer week for testing and report
Week 30: Create poster

4 Requirements

- Kinect Sensor

References

[1] Richard A. Newcombe, Shahram Izadi, Otmar Hilliges, David Molyneaux, David Kim, Andrew J. Davison, Pushmeet Kohli, Jamie Shotton, Steve Hodges, and Andrew Fitzgibbon. KinectFusion: Real-time dense surface mapping and tracking. *Proceedings of the 2011 10th IEEE International Symposium on Mixed and Augmented Reality*, pages 127–136, 2011.