Conversion of RGBD Images to Textured Triangle Meshes with GPU

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I. Background

Previous work has demonstrated the diverse capabilities of RGBD cameras, from generating highly accurate 3D surface models [2] to reliable 3D pose estimation [1, 3]. However, many algorithms attempt to store the generated environment as a RGB 3D point cloud, which is not easily adaptable to dynamic environments, requires very large quantities of memory to store large environments, and provides no intuition to higher perception processes about distinct objects beyond a volumetric approximation. Other approaches have been able to store and merge the surface data more efficiently, but still regard the environement as a unified whole rather than discrete objects. By extracting meaningful geometry from the RGB-D in the form of triangle meshes instead, a large number of advantages can be realized.

1) High storage efficiency
2) Natural low level object segmentation
3) Easy to manipulate, modify, and render in real time
4) Efficient and easy to process intuition of geometry that higher cognitive functions can use for object recognition and manipulation tasks.
5) Straightforward tradeoff between simplicity and accuracy with mesh resolution

II. Project Scope

For this project, a segment of the pipeline will be implemented utilizing CUDA/OpenGL powered GPU acceleration (Figure 1). Each segment of the pipeline has elements which may benefit from GPU acceleration. Blue segments are trivial functions that are easy to implement in CUDA/OpenGL. The red block represets the actual mesh generatation; this is the most complicated part of the pipeline and the main focus of the project. Green blocks represent stretch goals for the project.

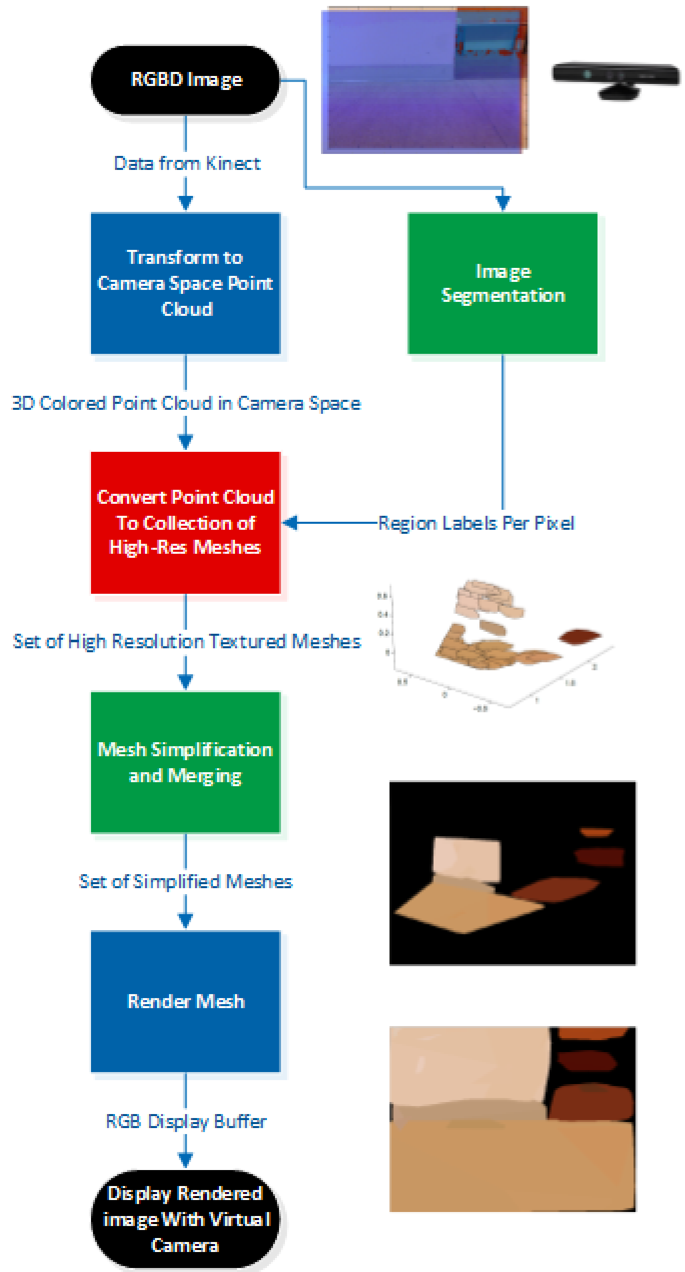

Fig. 1. Pipeline Overview

References

[1] Felix Endres et al. "An Evaluation of the RGB-D SLAM System". In: *Robotics and Automation (ICRA), 2012 IEEE International Conference on.* (2012).

[2] Richard A. Newcombe et al. “KinectFusion: Real-time dense surface mapping and tracking.” In: http://redwood.berkeley.edu/bruno/3DFM/kinect-fusion-IEEE.pdf, 2011.

[3] Yuichi Taguchi et al. *Point-Plane SLAM for Hand-Held 3D Sensors*. Tech. rep. http://www.cc.gatech.edu/ yjian6/publication/taguchi2013icra.pdf: Georgia Institute of Technology, University of Michigan.