01.110: Computational Fabrication Summer 2017

Lab 1: 3D Scanning with Kinect

May 23th 11:30pm-1:30pm Fab Lab Ground Floor.

Report Due June 4th at 11:55pm.

1 Overview

In this lab, you will scan a real-life object with Kinect^{TM}. You will then clean up the scanned mesh to make it ready for 3D-printing.

2 Software Requirement

This lab requires the Kinect for Windows SDK 2.0. The software is available only on Windows. It can be downloaded from `http://www.microsoft.com/en-us/download/details.aspx?id=44561`. You will need:

1. Kinect for Windows SDK that includes the driver for Kinect.
2. Kinect for Windows Developer Toolkit that has a Kinect Fusion application.
   It is what we are going to use for scanning.

After downloading and installing the Kinect SDK, launch the Kinect Fusion application.

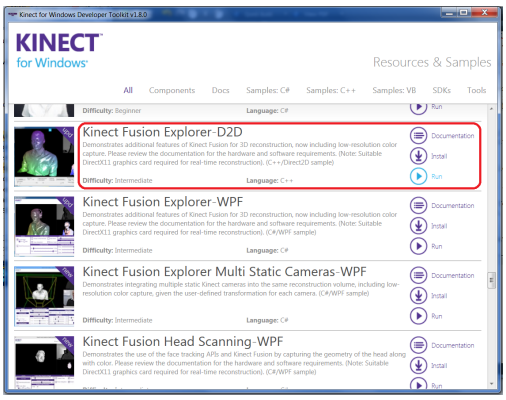

Figure 1: Launch Kinect Fusion Explorer-D2D from the Kinect for Windows Developer Toolkit Browser.

To launch the Kinect Fusion application, open the Kinect for Windows Developer Toolkit Browser that can be found from the start menu. The toolkit browser looks like Figure 1. Find the Kinect Fusion Explorer-D2D and click "Run". After that, you can plug in your Kinect.

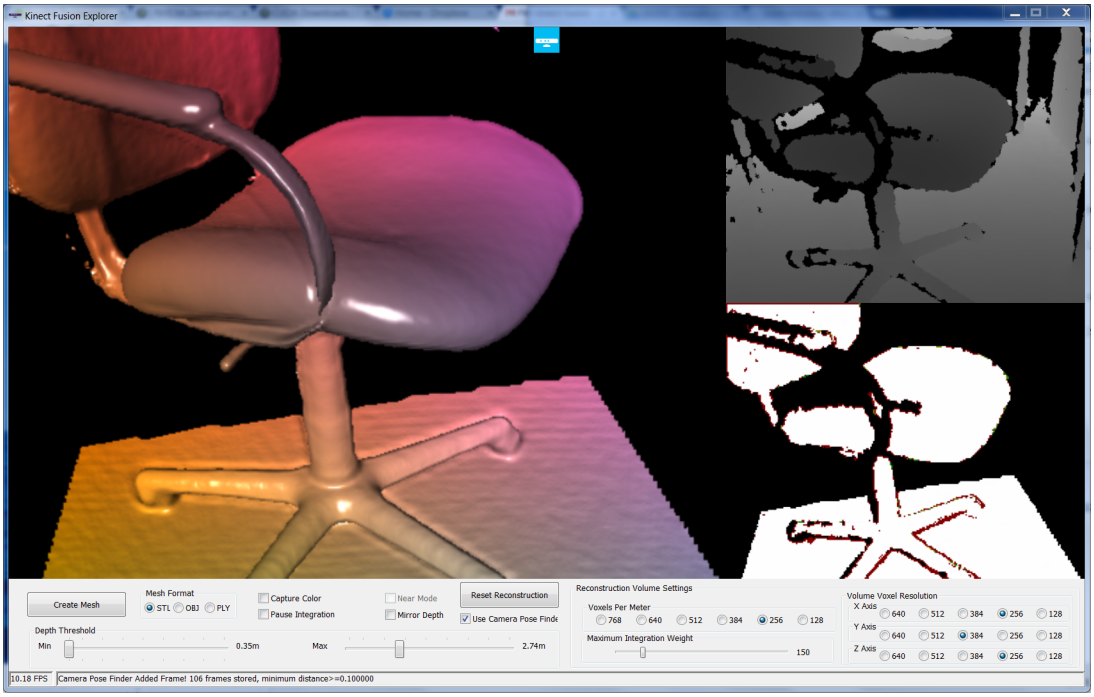

Figure 2: Kinect Fusion Explorer. The main view displays the 3D reconstruction on the left. The two small views on the right display depth data in current view and reconstructed depth. In the bottom of the window, some useful options are displayed.

3 Scanning

The Kinect Fusion Explorer window is shown in Figure 2. Once you launch the Kinect Fusion Explorer, it will automatically start scanning. To restart the scanning, click "Reset Reconstruction". A complete scan of a chair is shown in Figure 3. There are few options that you can change:

1. You can change the near and far distance of the scanner to clip away more background.
2. You can also change the voxel resolution to reduce the final mesh size. The "Voxels Per Meter" parameter specifies the number of voxels in one meter and the "Volume Voxel Resolution" parameter specifies the total number of voxels.

You can compute the size of your scanning volume in meters by

$$\text{Scanning Volume Size} = \frac{\text{Voxel Resolution}}{\text{Voxels Per Meter}}.$$

For the chair example, we set depth threshhold between 0.35m and 2m, and volume voxel resolution at $256 \times 384 \times 256$. If you want to scan a complete object, make sure you can go around the object without obstruction and without moving the object. A sample scanning process is shown in this video `http://www.youtube.com/watch?v=quGhaggn3cQ`. Once you are happy with the scan, click "Create Mesh" to save.

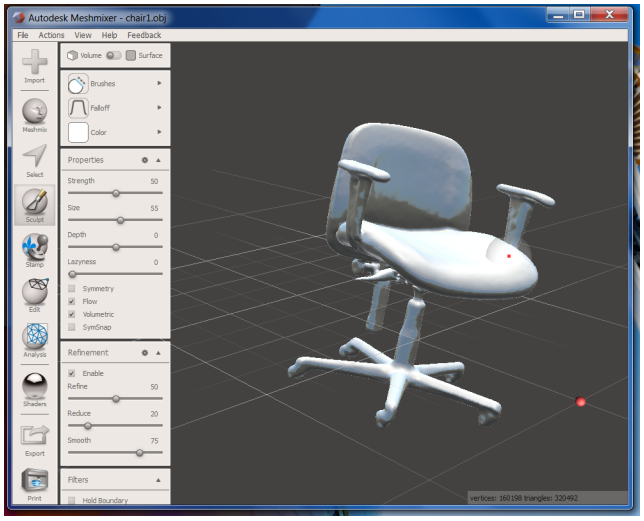

Figure 3: A fully scanned chair.

4 Mesh Clean-up

The mesh probably contains a lot of background. In order to remove the background, you can use mesh processing software such as Meshlab, Meshmixer and Blender. Here, we use Meshlab to create a closed mesh. Below is a list of a few useful operations in Meshlab.

- Merge duplicated vertices to reduce mesh size. In the menu, go to Filters→Cleaning and Repairing→Merge Close Vertices. Set "perc on" to 0.1.
- Select and remove vertices. Click Select Vertices button, drag a box to select vertices and then click Delete button. The buttons are shown in Figure 4.
- Compute vertex normals to prepare for Poisson Surface Reconstruction:
  1) Filters→Normals, Curvatures and Orientation→Recompute Face Normals.
  2) Filters→Normals, Curvatures and Orientation→Recompute Vertex Normals. Click "Apply".
- Poisson Surface Reconstruction to create a closed surface:
  Filters→Point Set→Surface Reconstruction: Poisson. In the chair example, we set Octree Depth to 10 and Solve Divide to 8. For the new Meshlab version, you can find the it under Filters→Remeshing, Simplification and Reconstruction→Screened Poisson Surface Reconstruction. Set the Reconstruction Depth parameter to 10.

5 Hints

1. Object. Kinect's sensor does not work with highly reflective or transparent objects. For very dark objects, Kinect's performance is also not stable. In the chair example, the bottom of the chair is not scanned very well because the surface is black. Choose your object wisely.
2. Range. Kinect has certain workable range. It does not work well if the object is too close and too far.
3. Resolution. Sometimes the process might work better if you reduce the voxel resolution.

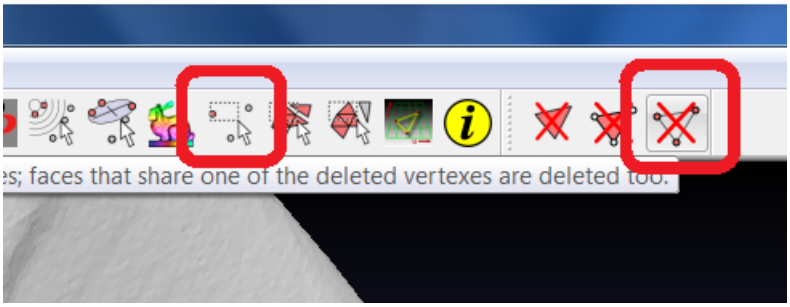

Figure 4: Buttons for selecting and deleting vertices.

6 Submission

Submit your assignment on e-dimension by **May 31st by 11:55pm**. Please submit a single archive (`.zip` or `.tar.gz`) containing:

- A write up for your group in either a text file or a pdf file. Describe difficulties in scanning. What surfaces are difficult to scan? Discuss what methods you use to fix the meshes.
- Screen shots of all the meshes you scanned. Please include both raw scanned meshes and cleaned meshes.
- The `.obj` files of the scanned meshes.
- Write down the **names** of your group members.