01.110 Computational Fabrication

Lab 1 Report

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3D Scanning

Fidget Cube

At the start, we tried to scan the 30 * 30 * 30mm fidget cube as shown in Figure 1.

Figure 1. Fidget Cube[1]

It turned out to be a non-ideal object for scanning, for reasons listed below:

- **Small**: Due to its small size, it is difficult for Kinect camera to detect the object under the default settings. We fixed this issue by increasing the resolution and decrease the detection distance.
- **Too much details**: The cube has many small buttons and small details that makes the surface not smooth. As a result, even though Kinect was able to register it as a cubic object, it could not scan the fine details well. The result is a cube with non-smooth surface but without showing the buttons correctly. It is difficult to resolve this problem as we are already scanning at the highest resolution.

[1] Image source: https://www.thefidgetcube.co/

Soft Toy

Figure 2. Soft Toy (Pink Bean)

Due to the challenges faced in scanning the fidget cube, we then scanned the 5.0 * 8.0 * 3.0 cm soft toy, as shown in Figure 2.

Although the soft toy is larger, it is still not an ideal target for scanning due to the following:

- **Furry texture and uneven surface**: The texture and the fine details on the surface was hard to capture and caused unevenness in the captured mesh.
- **Lack of definitive shape**: With its shape consisting of only spheroid with two small cones, coupled with the lack of textures captured, the resulting mesh generated from Kinect was too plain and looked too generic to be identified uniquely as this soft toy.

Lab Table

Figure 3. Lab Table

While scanning the fidget cube and soft toy placed on the lab table, we realised the Kinect was able to detect the table better than the objects. Thus, we decided to scan the lab table. It has a dimension of 2.0 * 1.0 * 0.5 m, as shown in Figure 3.

It was a better choice of object for scanning due to:

- **Large**: Due to its large size, we were able to calibrate the Kinect to scan most of it successfully.
- **Simple design**: The table did not have any fancy designs or textures, so Kinect was able to capture the smooth surfaces easily.

However, there were certain limitations to the scanning process:

- **Dark areas**: The table had a layered design underneath the tabletop that was darker, so we struggled to use Kinect to capture those parts cleanly as Kinect had difficulties recognising the exact position of the triangles.

Cap

Figure 4. Razer Cap

We also scanned a cap with a razer logo on it. It has a dimension of 30 * 15 * 20 cm, as shown in Figure 4.

It turned out to be a non-ideal object for scanning, for reasons listed below:

- **Black colour**: Due to its black colour, it is difficult for Kinect camera to detect the object. This was expected as Kinect's performance is known to be unstable with very dark objects.
- **Mesh design**: The cap has many small holes at the back which the Kinect camera failed to detect as a solid object, and mistook it as empty space instead.

Chair

Figure 5. White Chair

It has a dimension of 0.6 * 0.6 * 1.0 m, as shown in Figure 5.
It was a better choice of object for scanning due to:

- **White colour**: Due to its white colour, it is easy for Kinect camera to detect the object surfaces.
- **Distinct shape**: The chair has a distinct shape such that even without any textures, the scanned mesh is easily distinguished as a chair.
- **Distance from background**: We scanned the chair in an open area as compared to the previous scans which were done in the Fab Lab. This minimised the amount of artifacts in the 3D scan.

Round Table

Figure 6. Round White Table

It has a dimension of 1.8 * 1.8m * 1.5 m, as shown in Figure 6.
It was a better choice of object for scanning due to:

- **White colour**: due to its white colour, it is easy for Kinect camera to detect the object surfaces.
- **Distinct shape**: the table has a distinct shape such that even without any textures, the scanned mesh is easily distinguished as a table.
- **Distance from background**: Similar to the chair, we scanned the round table in an open area. This minimised the amount of artifacts in the 3D scan.

Human(s)

In addition to the inanimate objects, we also scanned ourselves, as we wonder how the 3D scans of humans may look like. It is also easier to generate interesting scans when the person poses creative postures.

Due to the size of human body, it is relatively easier to be scanned than small objects. However, there are still some factors that restrict the scanning:

- **Elongated Shape:** As a human’s height is generally much longer than his or her width, the human body does not fit into a square scanning region perfectly. This makes it difficult to scan the entire human body. As a result, we decided to only scan the top half of the body.
- **Small details:** The finger tips, hair texture, as well as facial details were hard to capture by Kinect.

Scanned Meshes

SUTD Statue of Liberty Scan

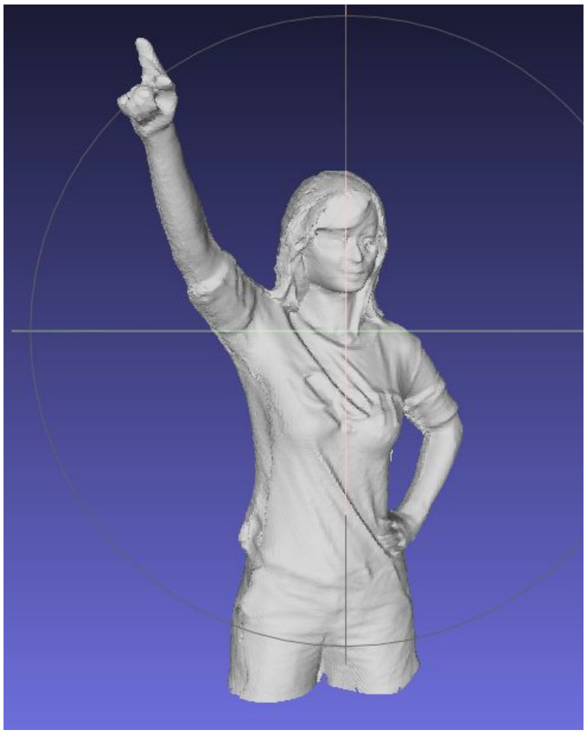


Figure 7. Pre-cleaned mesh

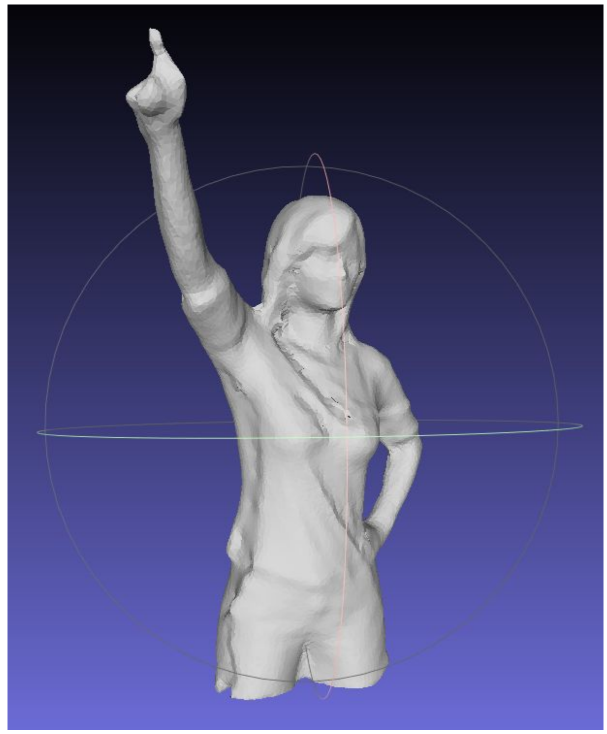


Figure 8. Mesh cleaned using point cloud (Poisson disk sampling with 15000 samples) followed by computing normals and then using Surface Reconstruction: Ball Pivoting on MeshLab. Holes were closed using Meshmixer’s automatic inspector and the model was smoothened using Microsoft 3D Builder

Female Half Body Scan

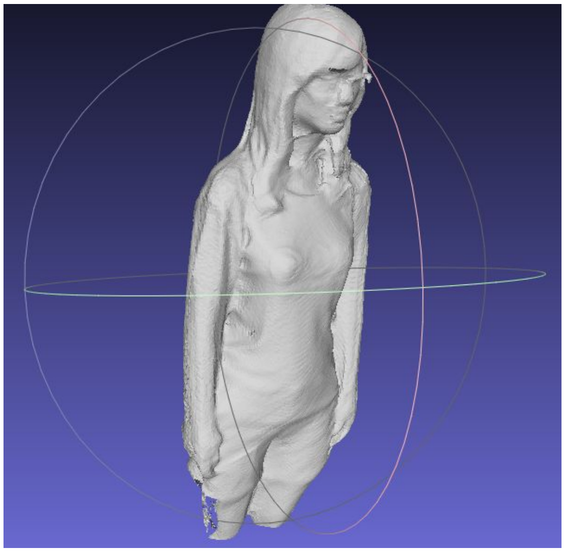


Figure 9. Pre-cleaned mesh

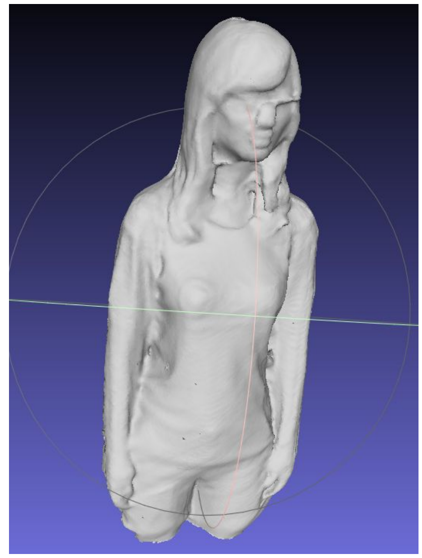


Figure 10. Mesh cleaned using using poisson surface reconstruction on MeshLab followed by Meshmixer's automatic inspector tool

Female Half Body Scan 2

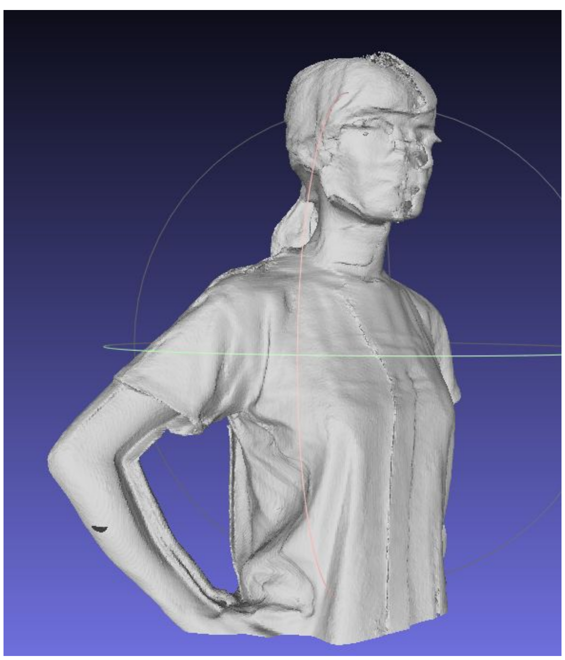


Figure 11. Pre-cleaned mesh

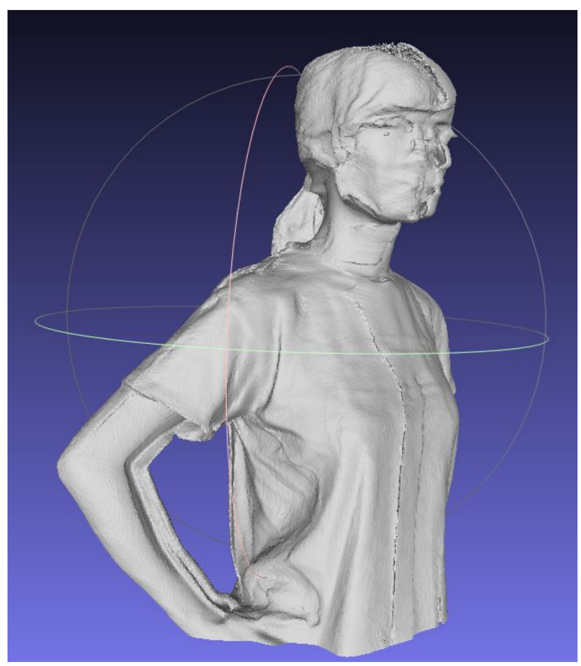


Figure 12. Mesh cleaned using using poisson surface reconstruction on MeshLab

Shocked Face Half Body Scan

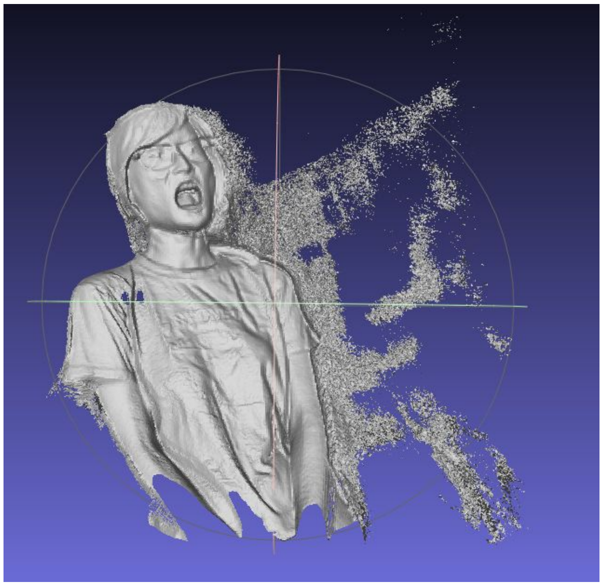


Figure 13. Pre-cleaned mesh

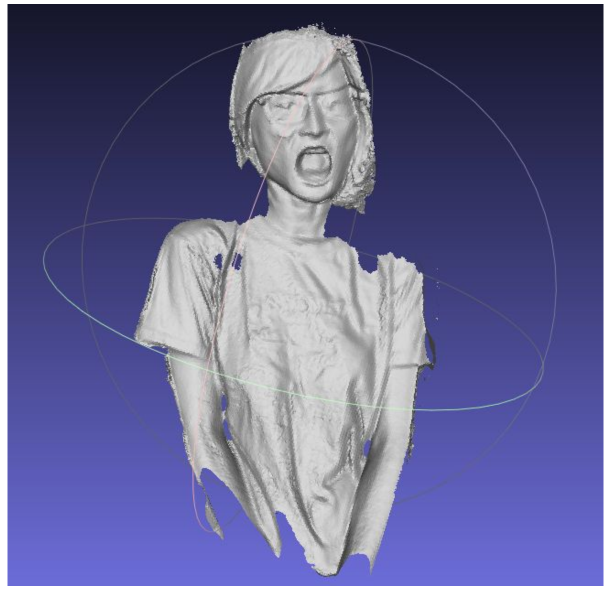


Figure 14. Mesh cleaned using using poisson surface reconstruction on MeshLab

Round Table Scan

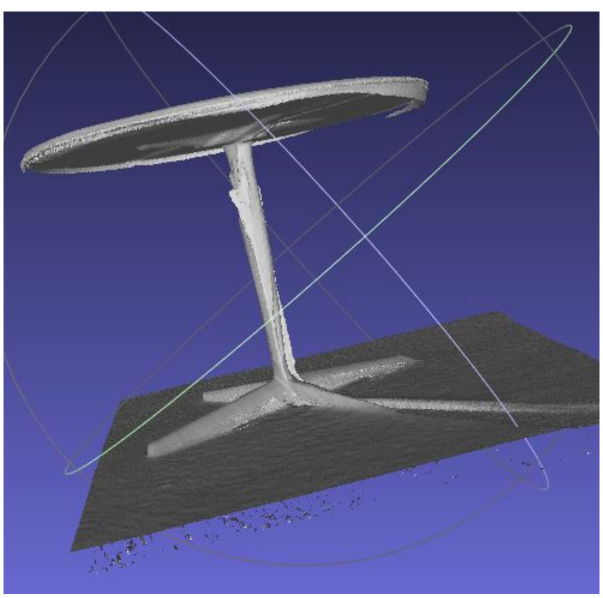


Figure 15. Pre-cleaned mesh

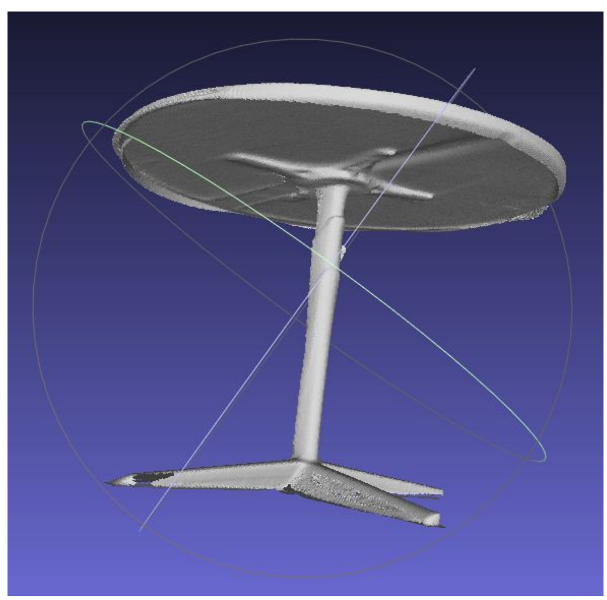


Figure 16. Mesh cleaned using using poisson surface reconstruction on meshlab followed by MeshMixer's inspector tool

Soft Toy Scan

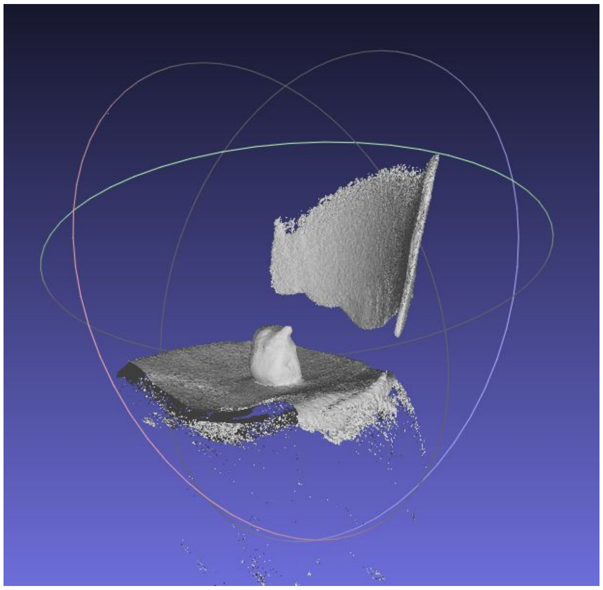


Figure 17. Pre-cleaned mesh

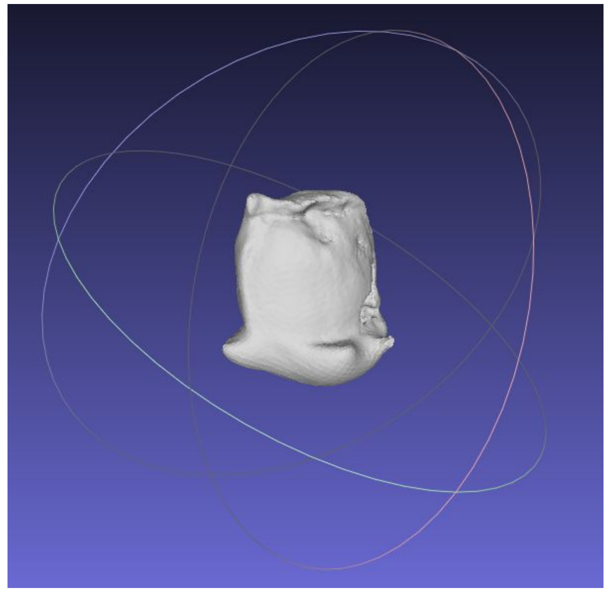


Figure 18. Mesh cleaned using using poisson surface reconstruction on Meshlab

Chair Scan

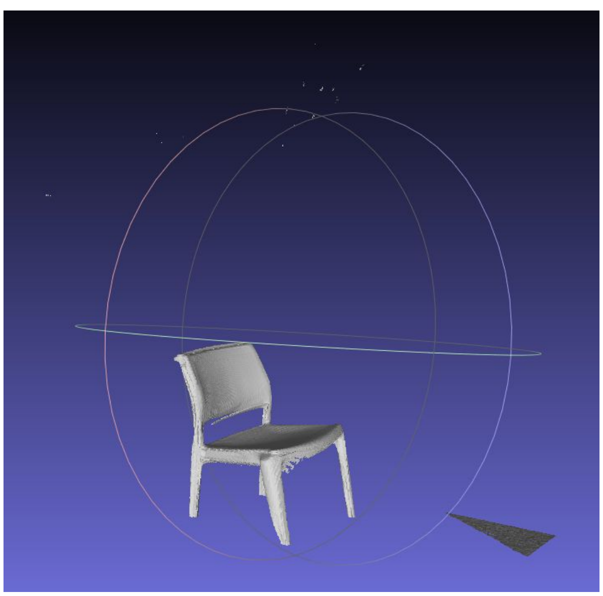
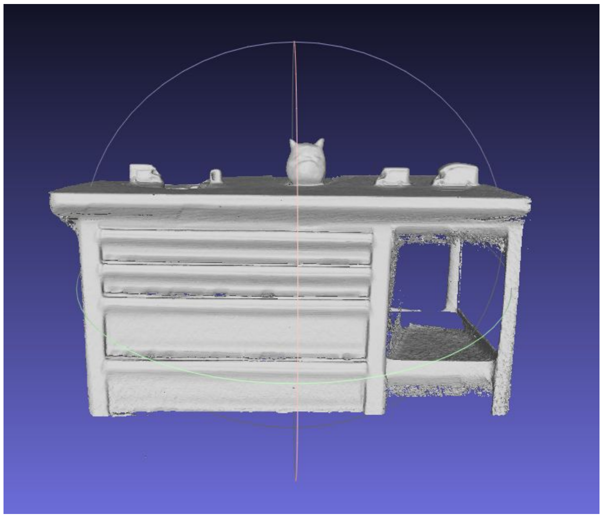
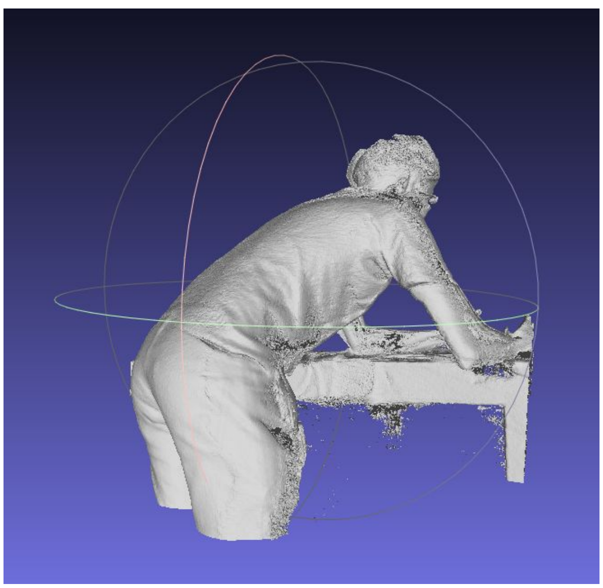


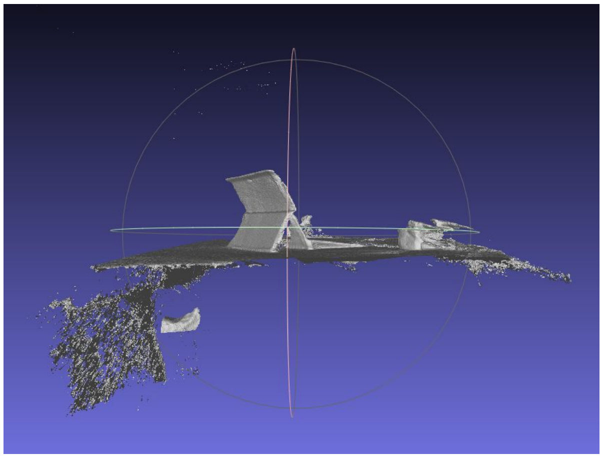
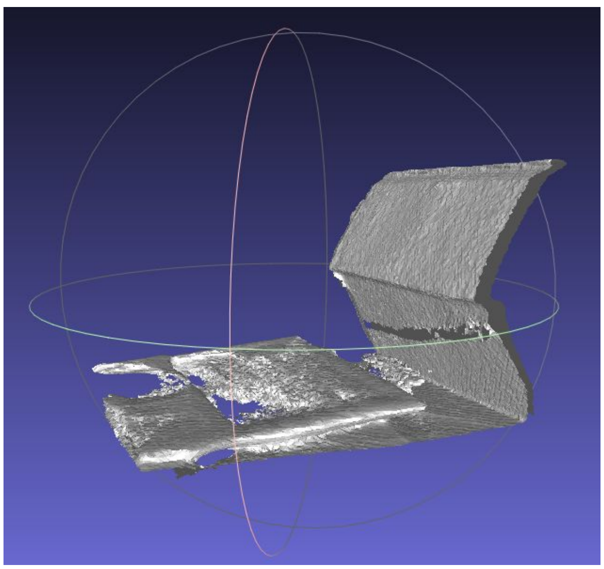
Figure 19. Pre-cleaned mesh

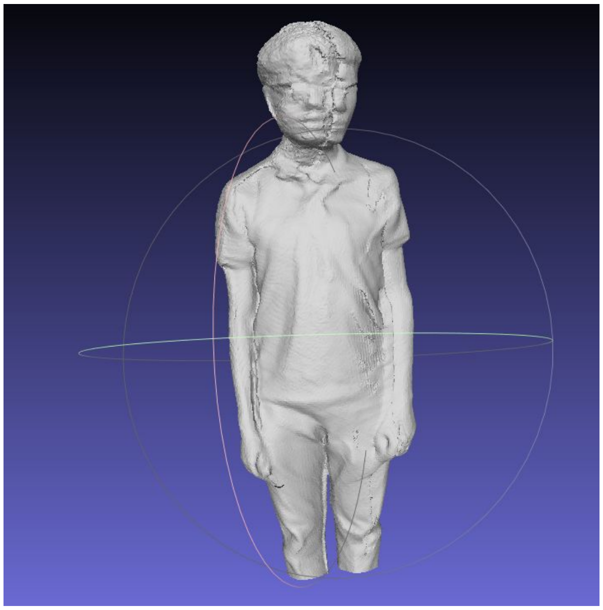
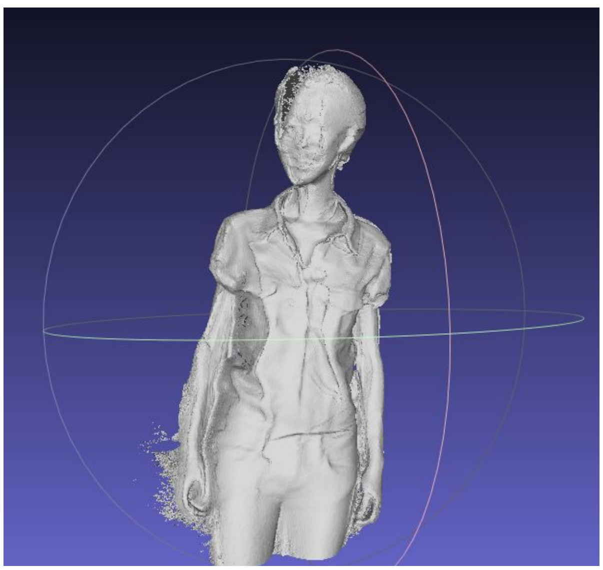
Figure 20. Mesh cleaned using using poisson surface reconstruction on Meshlab

Uncleaned Meshes

There are several 3D scans that we decide not to clean or used for printing for various reasons:

3D Scan	Reason for not cleaning
 Figure 21. Objects on lab table	Too many uneven edges and holes.
 Figure 22. Person bending over a table	Too many uneven edges, holes and noise, especially at the face, the front torso, and the table feet.

 Figure 23. Laptop on table	Too many incomplete vertices and noise.
 Figure 24. Cleaning attempt	Attempt at cleaning up laptop mesh but scan was too noisy

 Figure 25. Nigel	Too many incomplete vertices and noise.
 Figure 26. Zhexian	Too many incomplete vertices, holes and noise.