

ENME 489Y – Remote Sensing: Spring 2018
Department of Mechanical Engineering

Due Date	Friday, April 27 th , 2018
Submission Information	<ul style="list-style-type: none">• Compile links to each YouTube video into a single .pdf file and upload the .pdf to Gradescope by 11:59pm

Mesh of lidar point cloud data & (optional) 3D print

General Reminder: continue recording pictures & videos of your project to edit/stitch together in your semester project video (due 5:00pm May 17th) and final project presentation (beginning May 1st)!

Please!...**record videos** with your cell phone, GoPro, etc. **horizontal**. Vertical videos are dangerous!

In Assignment #5 we integrated, aligned, and calibrated our field deployable lidar systems. In Assignment #6 we recorded a preliminary dataset in a controlled environment to ensure our lidar systems were functioning as intended, then headed out on campus to begin mapping our targets. In Assignment #7 we mapped each side of our targets and combined the processed [x, y, z] data into a single 3D point cloud.

In this assignment (...the **last** assignment of the semester!) we create a solid mesh file from the completed 3D point cloud then, as an option for extra credit, 3D print the file.

From the cockpit:

Dr. Mitchell and Will understand that everyone in 489Y is juggling 1×10^6 different activities at this point in the semester. In an attempt to reduce some of the pressure, we have:

1. Modified the schedule for Final Project Presentations. Since Design Day for those students in ENME472 occurs on Tuesday May 8th, **we will hold neither lecture nor presentations on May 8th**. In other words – there is no need to attend 489Y on Tuesday May 8th. Use this time to continue working on your Final Project Video.
2. **Moved the deadline for submission of Final Project Videos** from Tuesday 5/15 back to **Thursday 5/17**. Videos are due via email submission to Dr. Mitchell (mitchels@umd.edu) by 5pm EST on Thursday May 17th. Please cc Will (wbogdan@terpmail.umd.edu) on your submission as well. Include in the email:
 - a. A link to your YouTube video
 - b. An attachment as a single .ppt file (or provide a link for download) which will be the final, polished copy of your Final Project Presentation. Name your .ppt file *lastname_firstname_ENME489Y.ppt*

Question #1 (nothing to submit)

Final Project Presentations will be held in the lecture hall on May 1st, 3rd, and 10th. To be fair and supportive to the entire class, **each student is required to attend each lecture** (even if you are not presenting that day).

To account for the lost day on May 8th (see previous page), Final Project Presentations will **begin promptly at 915am each day**. Please arrive at the lecture hall no later than 910am each day such that we can begin presentations right away.

For details on presentation requirements, order, and submission, refer to ELMS > Modules > Project:

Question #2 (nothing to submit)

Final Project Videos are **due Thursday 5/17** via email submission to Dr. Mitchell (mitchels@umd.edu) by **5pm EST**. Please cc Will (wbogdan@terpmail.umd.edu) on your submission as well.

Include in the email:

- A link to your YouTube video
- An attachment as a single .ppt file (or provide a link for download) which will be the final, polished copy of your Final Project Presentation. Name your .ppt file *lastname_firstname_ENME489Y.ppt*

Note: although homework submissions this semester have been graded primarily for completeness, Final Project Videos will be subject to the full scrutiny detailed in the grading rubric detailed on ELMS > Modules > Project.

The Final Project Video **represents an entire semester's worth of learning and activities** and will be graded as such - so please ensure you present your best work in the submitted YouTube video!



To view exemplary Final Project Videos from previous semesters, scroll through the 489Y YouTube playlist:

<https://www.youtube.com/watch?v=I1i44fPISbw&list=PLekqOMAzgrTRP6Ms7wi37-2IKjU92tqnL>

Question #3 (optional submission)

As discussed by Eugenia de Marco in her lecture, Murphy's Law is ever-present in the field of remote sensing. Here are examples of instances where things did not go as planned, **just *this* semester**:

"Hi Dr. Mitchell,

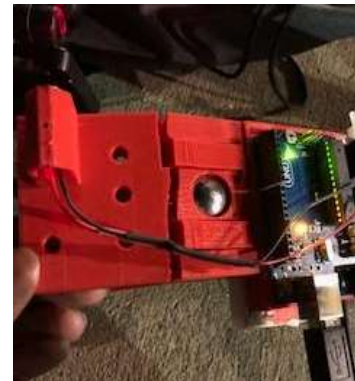
I apologize for emailing you so late, but I wanted to let you know that while I was taking data tonight I accidentally knocked over my mount and broke the ribbon cable connecting my camera to my raspberry Pi."

"Hi Dr. Mitchell,

Everything was working well in my house while I was connected to wifi but the minute I stepped outside, everything stopped working."

"Hey Dr. M,

Got some terrible news. I was collecting data and had to raise the tripod to a greater height to get data. But the wind was really strong and when I wasn't paying attention, it tipped over and broke the 3d printed holder in half. But the even more terrible news is the Rpi camera is not working anymore."



Although frustrating, these types of events do occur...and will occur often in the "real world" after graduation. The key, as Eugenia pointed out, is to budget time (and money) up front such that if something goes wrong you have time to recover and meet the deadline(s). (*customers are demanding!*)

With that in mind, if Assignment #7 did not turn out as well as you would have preferred, consider heading back out on campus to remap your target. **Record a minimum 60 second video clip** of yourself

demonstrating the process of translating .jpg image files into a 3D point cloud, in particular **how you stitched together all of the scans**, recorded via your laptop. Be sure to highlight any interesting qualities of the 3D point cloud. Upload the video to your YouTube account, then insert the link in a .pdf file to be uploaded to Gradescope.

Dr. Mitchell will review your updated videos and offer feedback as desired, such that the final point cloud presented in your Final Project Video is polished and ready for display.

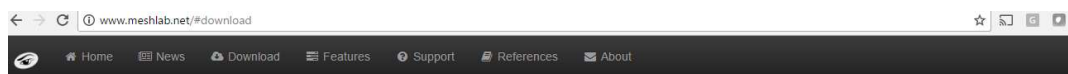
Question #4 (20 points)

As Dr. Resop discussed in his lecture, there exists a variety of software packages that can convert a 3D point cloud into surface and solid model files. Meshlab is one such open-source platform, which we utilize here in 489Y.

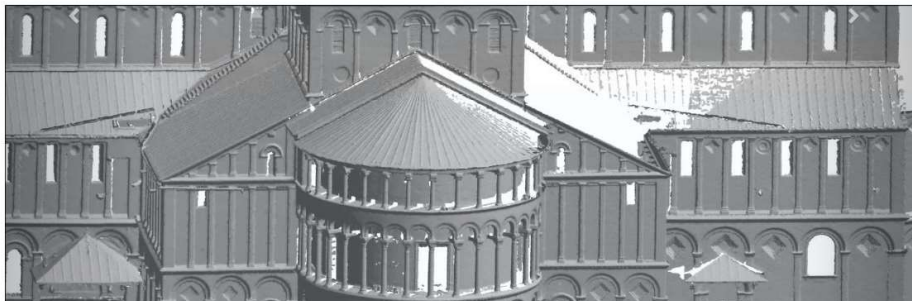
To complete Question #4, you will need all of your point cloud data in a single .txt file. If you opened/combined multiple .txt files in MATLAB to plot your cloud in Assignment #7, save those as a single .txt file listing all [x, y, z] coordinates for this exercise. One approach to creating such a .txt file is to use the **fprintf()** command in MATLAB:

```
fileID =  
fopen('\\\\client\C$\Users\Steve\Desktop\Path_to_file_here\NAMEOFFILE.txt', 'w')  
;  
fprintf(fileID, '%f %f %f\r\n', B);  
fclose(fileID);
```

Head to <http://www.meshlab.net/> and download the latest version of MeshLab onto your laptop.



MeshLab the open source system for processing and editing 3D triangular meshes. It provides a set of tools for editing, cleaning, healing, inspecting, rendering, texturing and converting meshes. It offers features for processing raw data produced by 3D digitization tools/devices and for preparing models for 3D printing.



Input the .txt file containing all of the [x, y, z] coordinates that define the complete 3D point cloud into MeshLab.

For additional details on the use of MeshLab, please refer to the Appendix of this assignment (credit: Katie Jahn & Will Bogdan, UMD '18).

Record a minimum 120 second video clip of yourself demonstrating the process of translating a 3D point cloud .txt file into a mesh file in Meshlab. Be sure to highlight any interesting qualities of the surface mesh as compared to the 3D point cloud. Upload the video to your YouTube account, then insert the link in a .pdf file to be uploaded to Gradescope.

Question #5 (optional submission)

As detailed in the Project Requirements, students may 3D print a solid model of their target, to be delivered to Dr. Mitchell for a maximum of 5 pts extra credit. A brief writeup on how to import Meshlab files into CREO has been provided by Jason Musick (UMD '17) and is available on ELMS:



Jason also discusses the point cloud to mesh file to solid model file processing here (7:00 minute mark):

https://www.youtube.com/watch?v=UDsq_CgguYQ&index=2&list=PLekqOMAzgrTRP6Ms7wI37-2IKjU92tqnL

Record a minimum 60 second video clip of yourself demonstrating the process of translating a mesh file into a solid model file in CREO, SolidWorks, etc. Upload the video to your YouTube account, then insert the link in a .pdf file to be uploaded to Gradescope.

Once completed, 3D prints can be **delivered at your convenience** to the **ME front office** anytime **prior to 5pm EST on Thursday, May 17th**. Simply ask the staff to place the print in my mailbox.

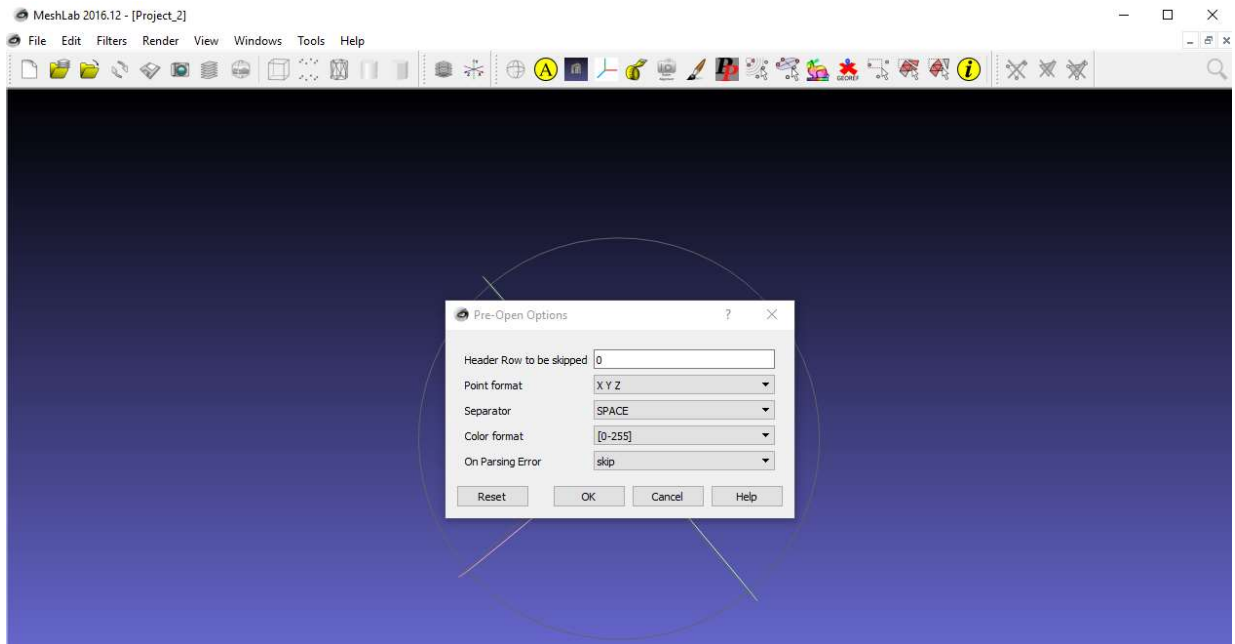
Finally, to complete Assignment #8:

Upload a **single page .pdf** to Gradescope with the links to each YouTube video recorded within this assignment. Label each link such that Dr. Mitchell understands which videos correspond to which questions.

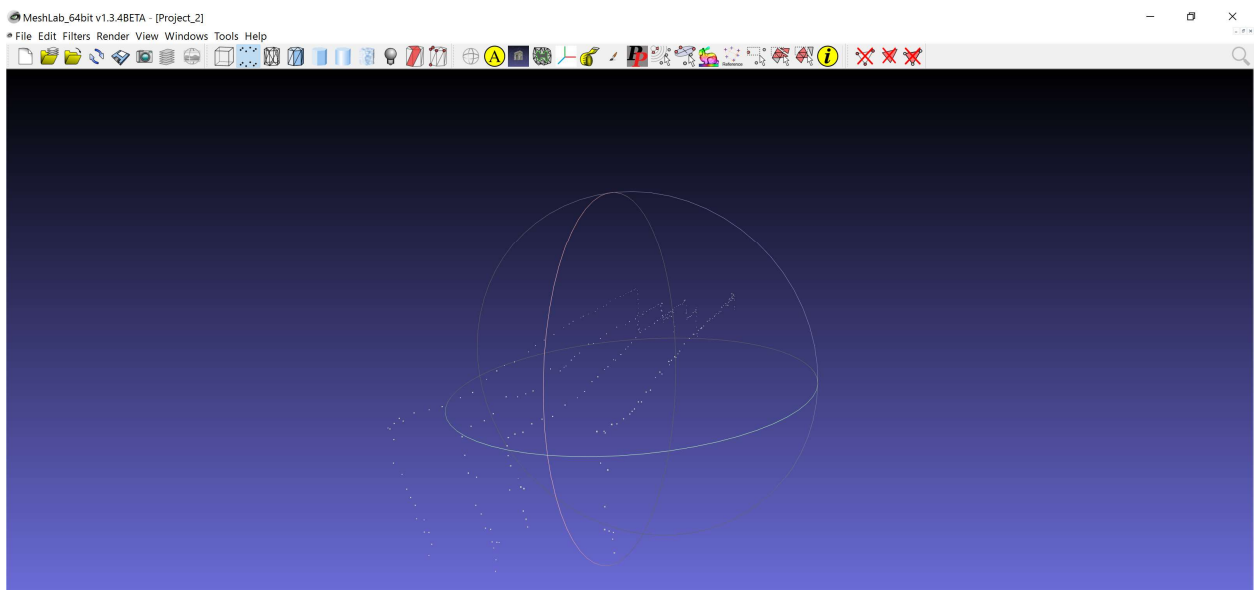
Creating a Mesh in MeshLab

Import points:

1. Start new project
2. Press open folder icon (*Import Mesh*)
3. Select text file containing points
4. Select separator used between data points in text file (*SPACE*)



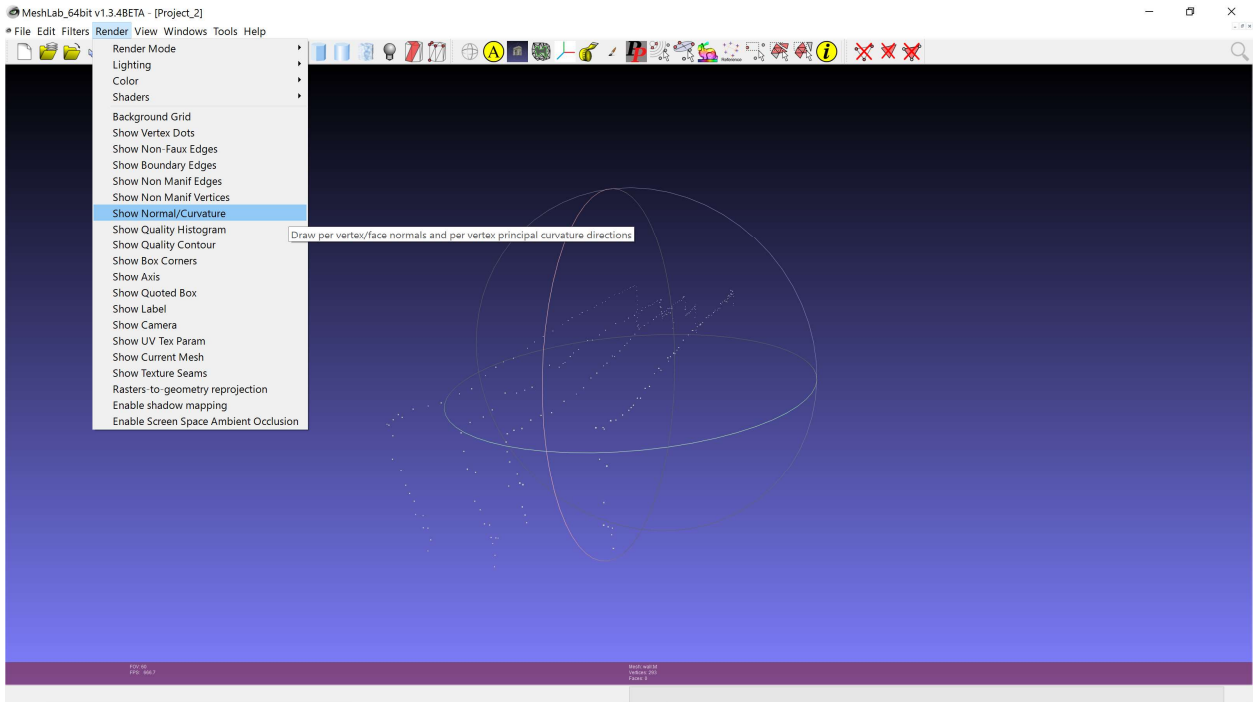
5. Hit ok



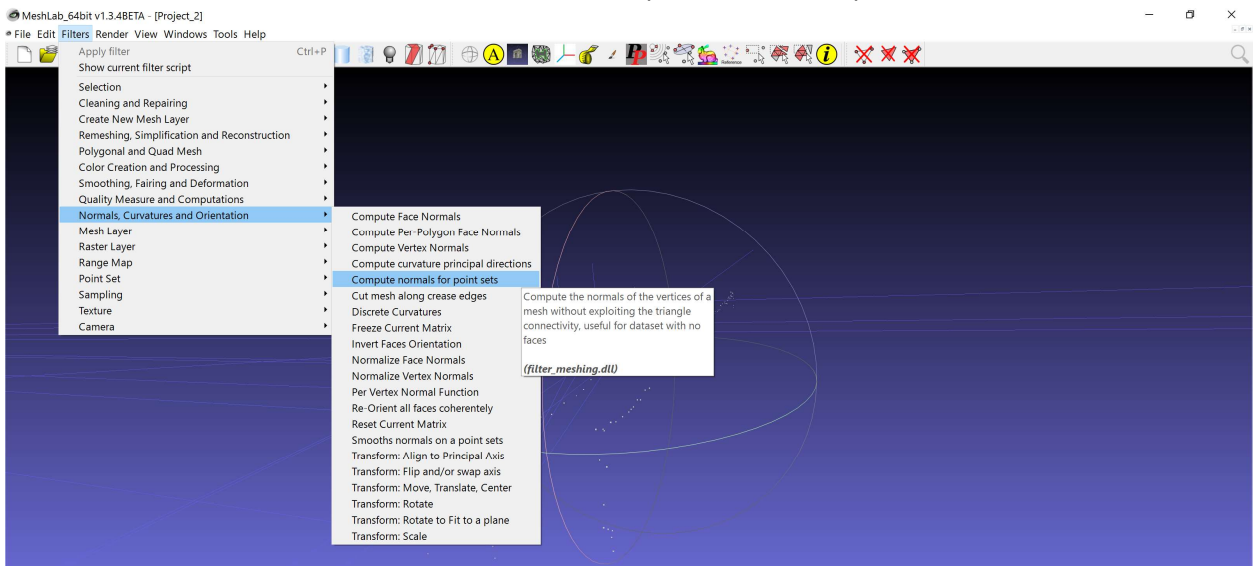
6. Adjust the Point Size trackbar (lower righthand side of screen) to increase/decrease diameters of points.
7. At this point, the point cloud in MeshLab should look like the point cloud in MATLAB.

Compute Normal for Points:

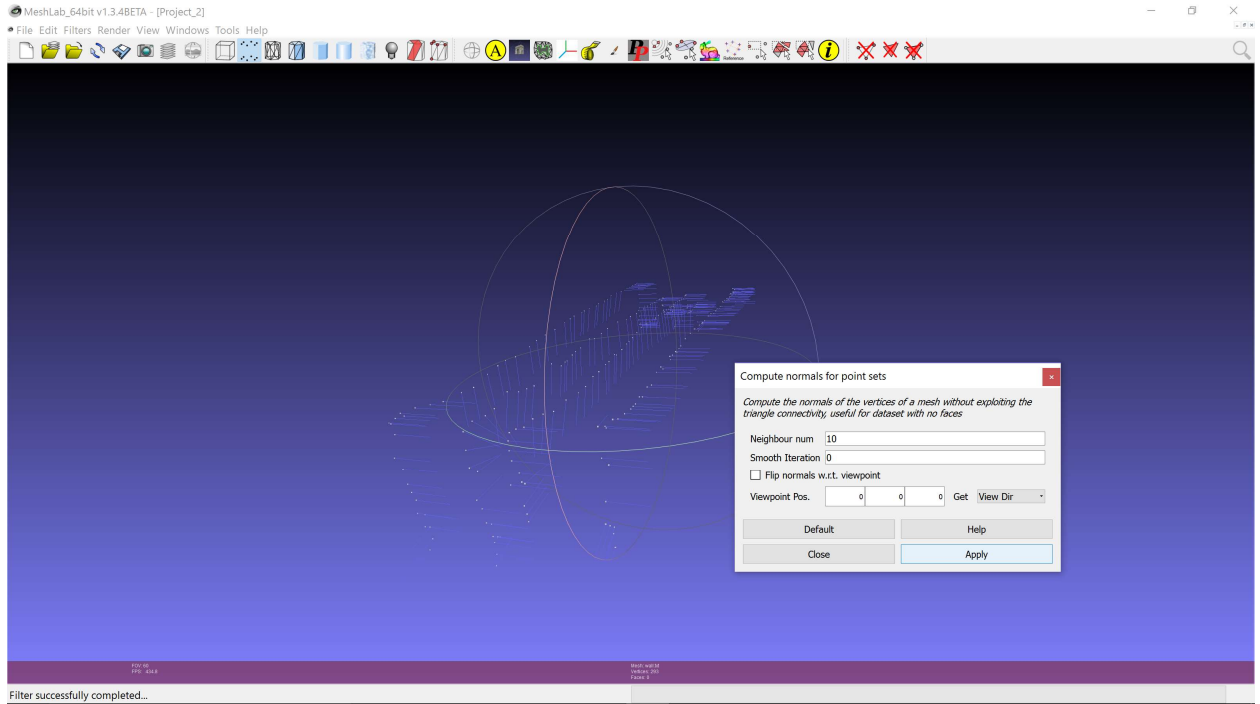
1. Render -> Show Normal



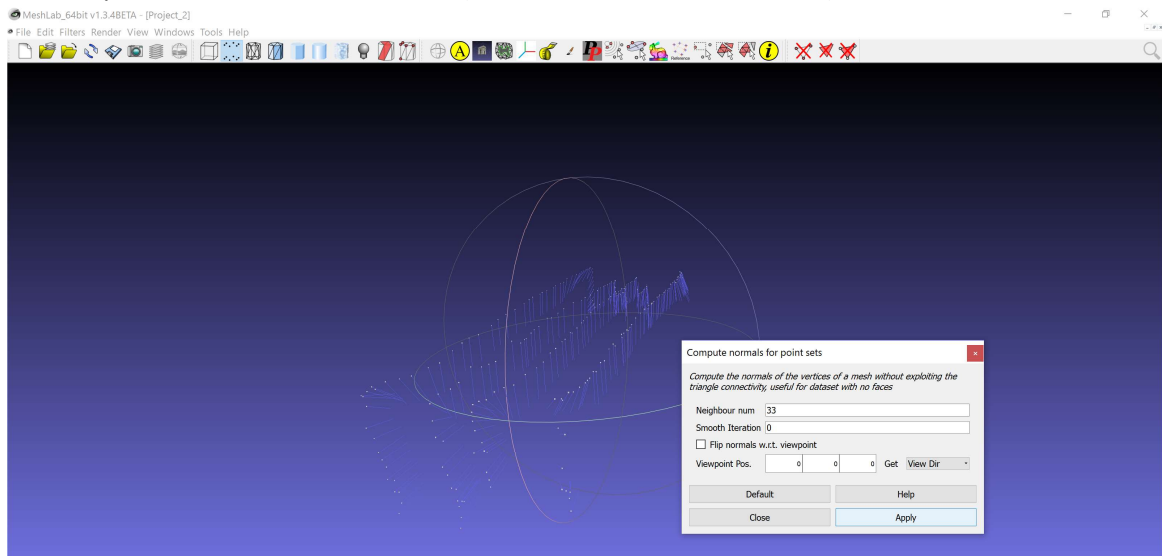
2. Filters -> Normals, Curvatures and Orientation -> Compute normals for point sets



3. Hit apply

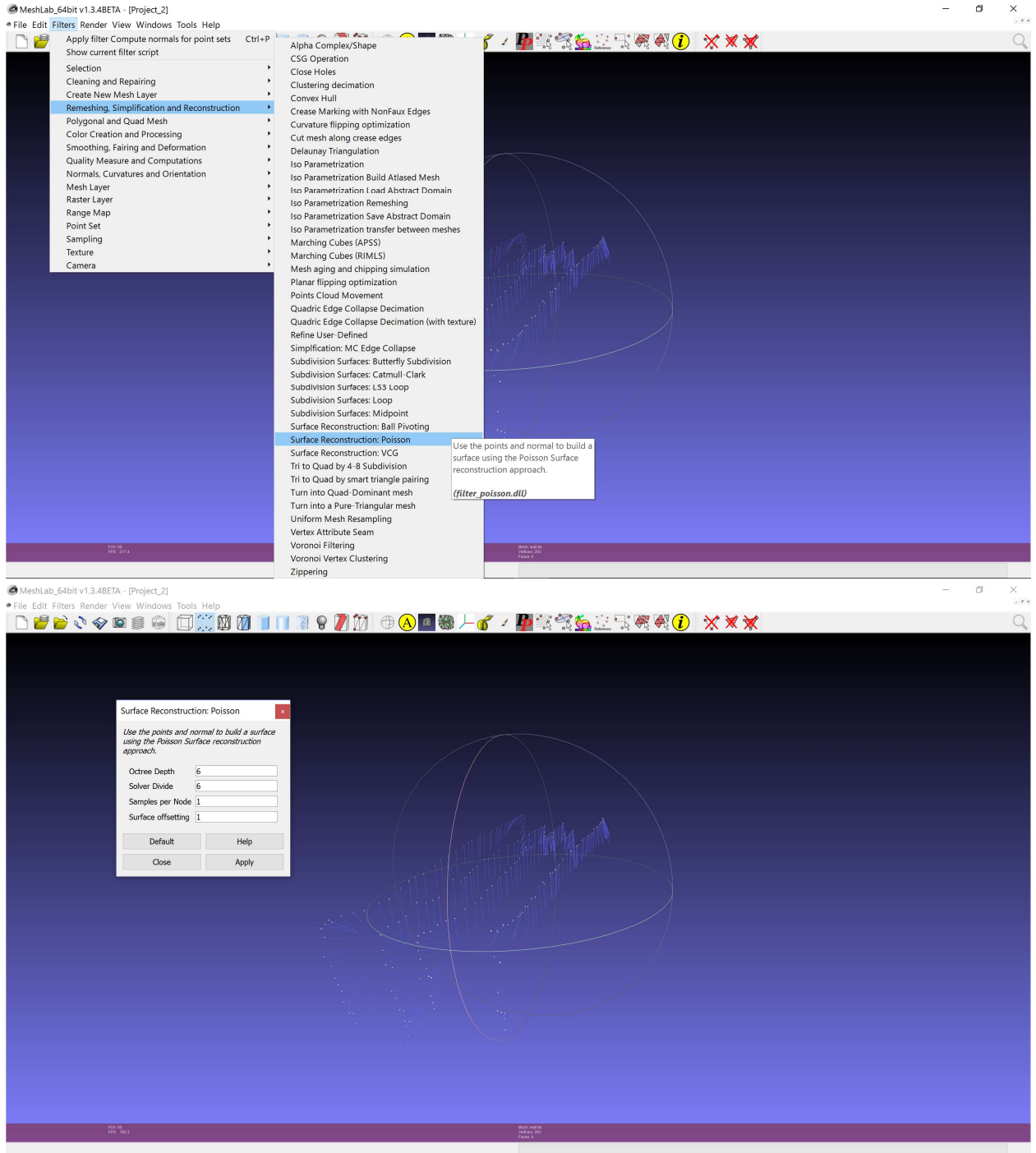


4. The default value will most likely not work, since the goal is to get all the arrows facing the same direction
 - a. Try not to smoothen (keep the second box as 0)
 - b. Higher neighbor num usually yields better results, try not to get too high (stay just above where the arrows are pointed towards the same direction)
 - c. If you know where the lidar was in relation to the points, you can input that into the viewpoint position which may help
 - d. Keep hitting apply and changing numbers until you get the desired result: all arrows pointed in the same direction (it will overwrite the last result)



Apply Mesh:

1. Go to Filters -> Remeshing, Simplification and Reconstruction -> Screened Poisson Surface Reconstruction



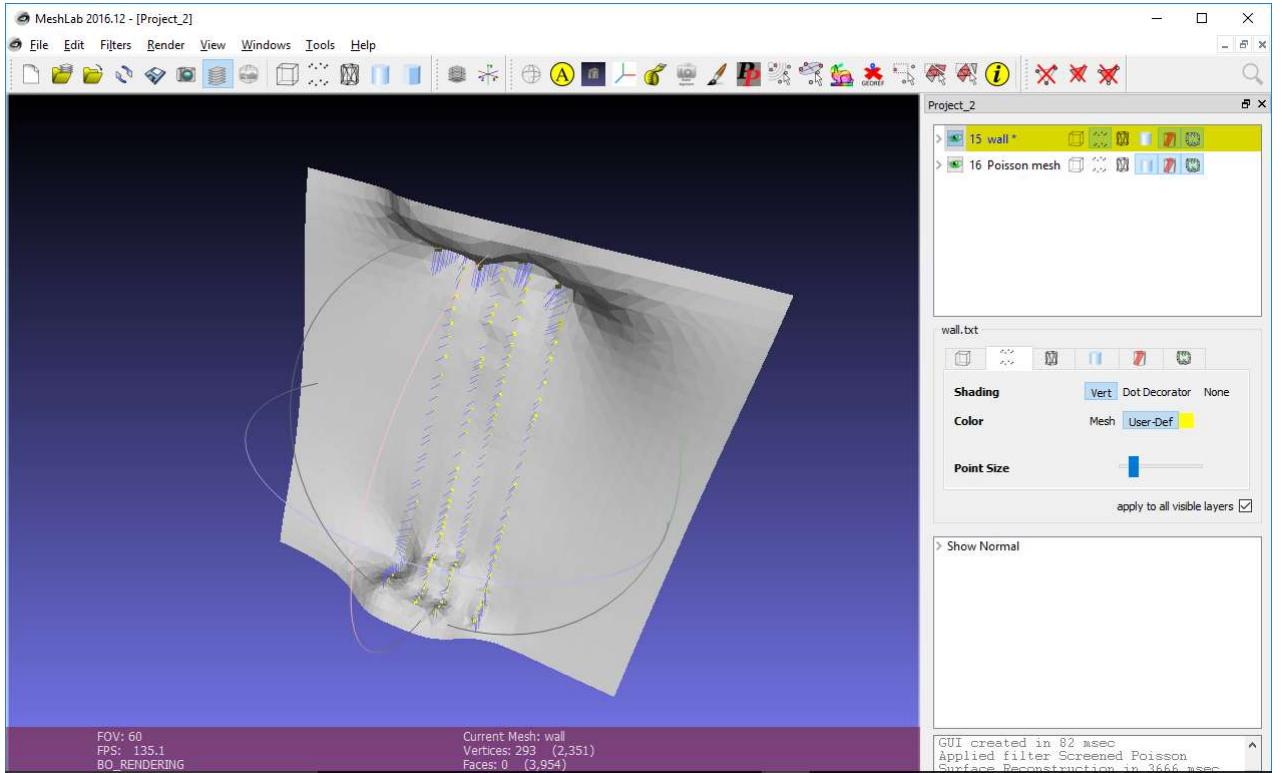
2. Default may work, try this first by hitting Apply. If not then trial and error again
 - a. Keep surface offset at 1

Surface Reconstruction: Poisson ✕

Use the points and normal to build a surface using the Poisson Surface reconstruction approach.

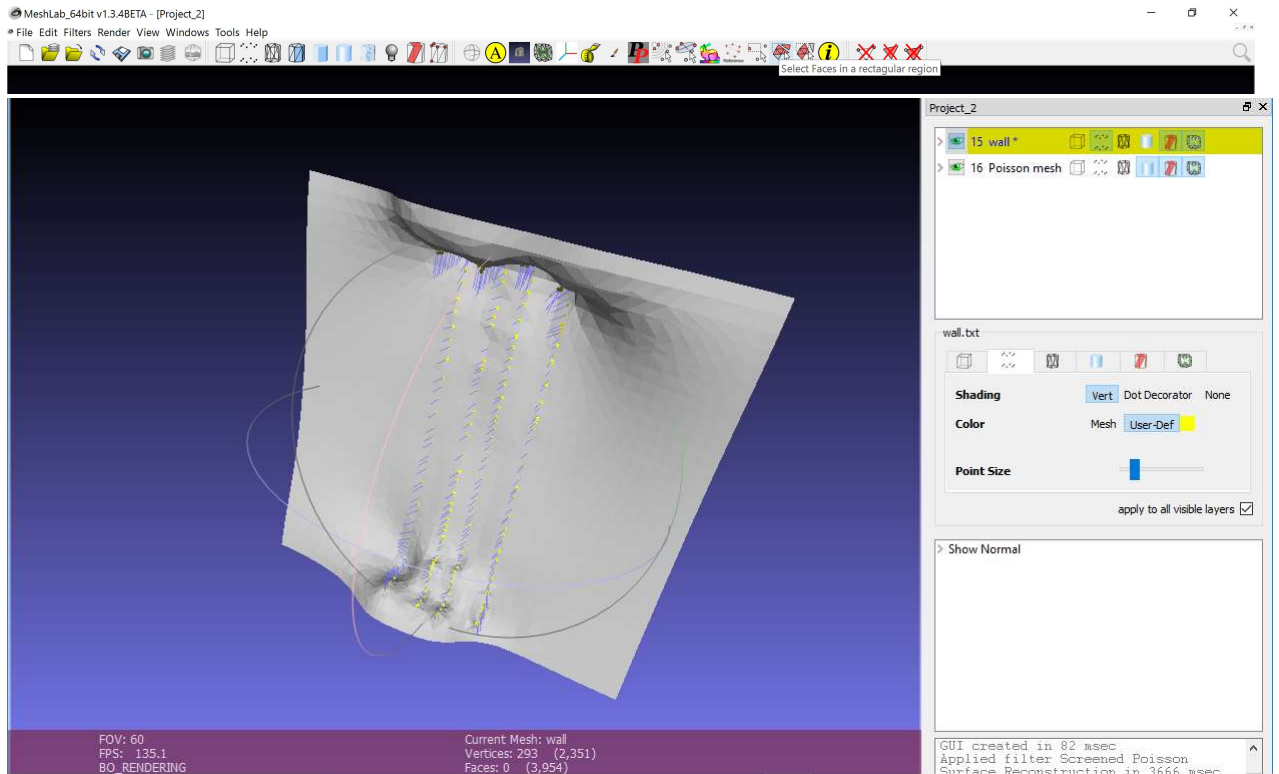
Octree Depth	<input type="text" value="6"/>	Set the depth of the Octree used for extracting the final surface. Suggested range 5..10. Higher numbers mean higher precision in the reconstruction but also higher processing times. Be patient.
Solver Divide	<input type="text" value="6"/>	This integer argument specifies the depth at which a block Gauss-Seidel solver is used to solve the Laplacian equation. Using this parameter helps reduce the memory overhead at the cost of a small increase in reconstruction time. In practice, the authors have found that for reconstructions of depth 9 or higher a subdivide depth of 7 or 8 can reduce the memory usage. The default value is 8.
Samples per Node	<input type="text" value="1"/>	This floating point value specifies the minimum number of sample points that should fall within an octree node as the octree construction is adapted to sampling density. For noise-free samples, small values in the range [1.0 - 5.0] can be used. For more noisy samples, larger values in the range [15.0 - 20.0] may be needed to provide a smoother, noise-reduced, reconstruction. The default value is 1.0.
Surface offsetting	<input type="text" value="1"/>	This floating point value specifies a correction value for the isosurface threshold that is chosen. Values 1 external offsetting. Good values are in the range 0.5 .. 2. The default value is 1.0 (no offsetting).

Default	Help
Close	Apply

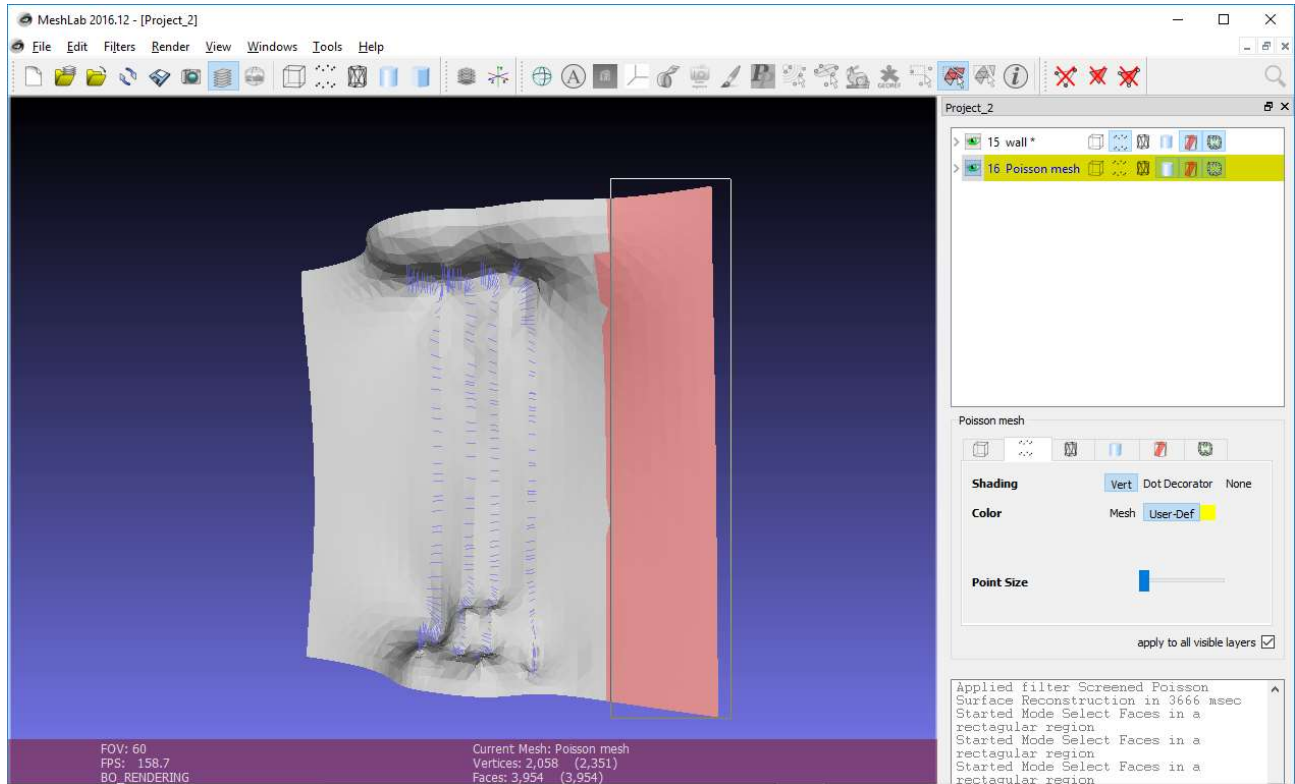


Delete Additional Faces:

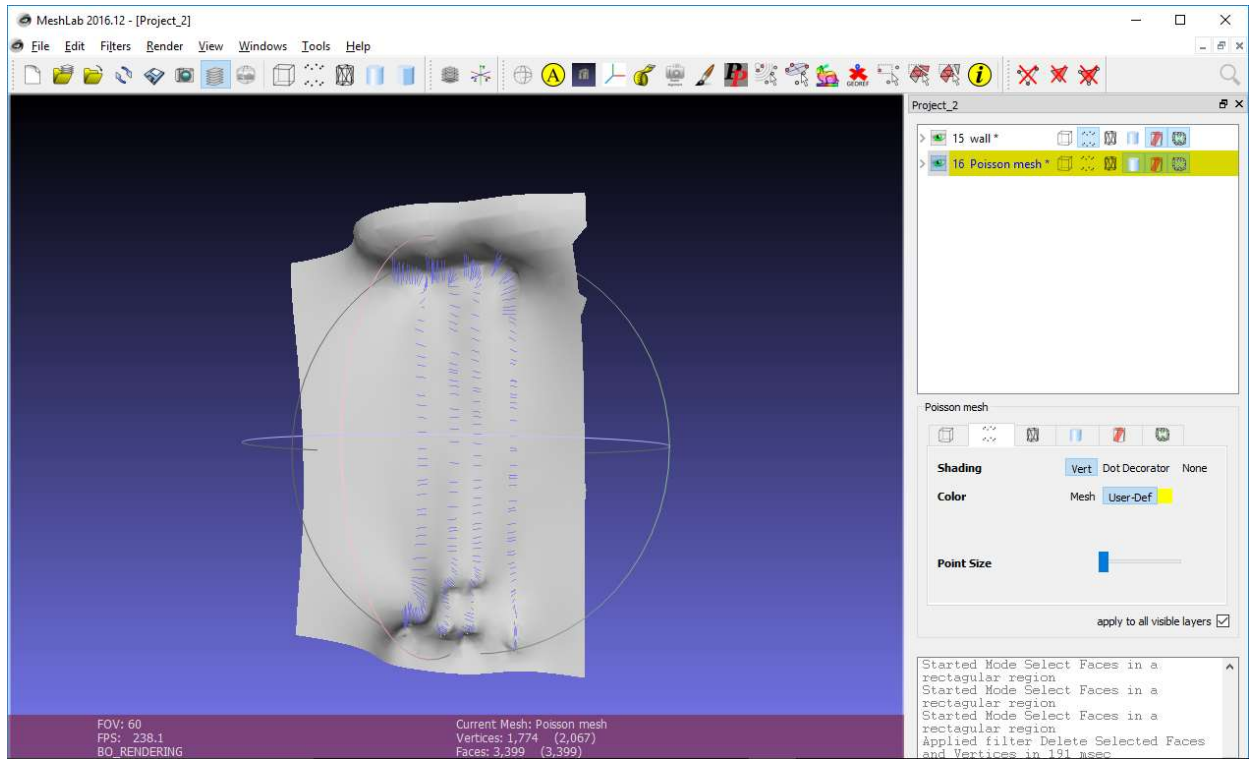
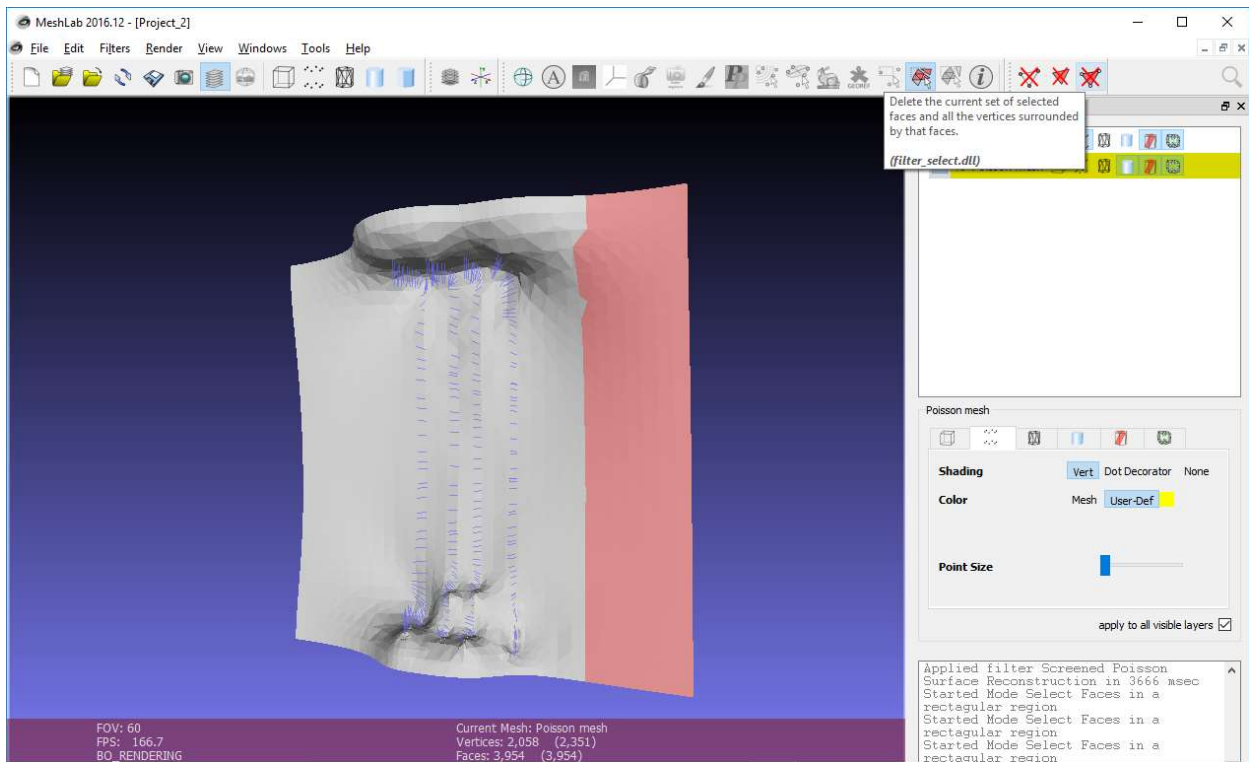
1. As you may notice, the Poisson mesh gives additional faces that you need to remove, so click the select faces in rectangular region on the toolbar (icon with mouse highlighting faces shown below)



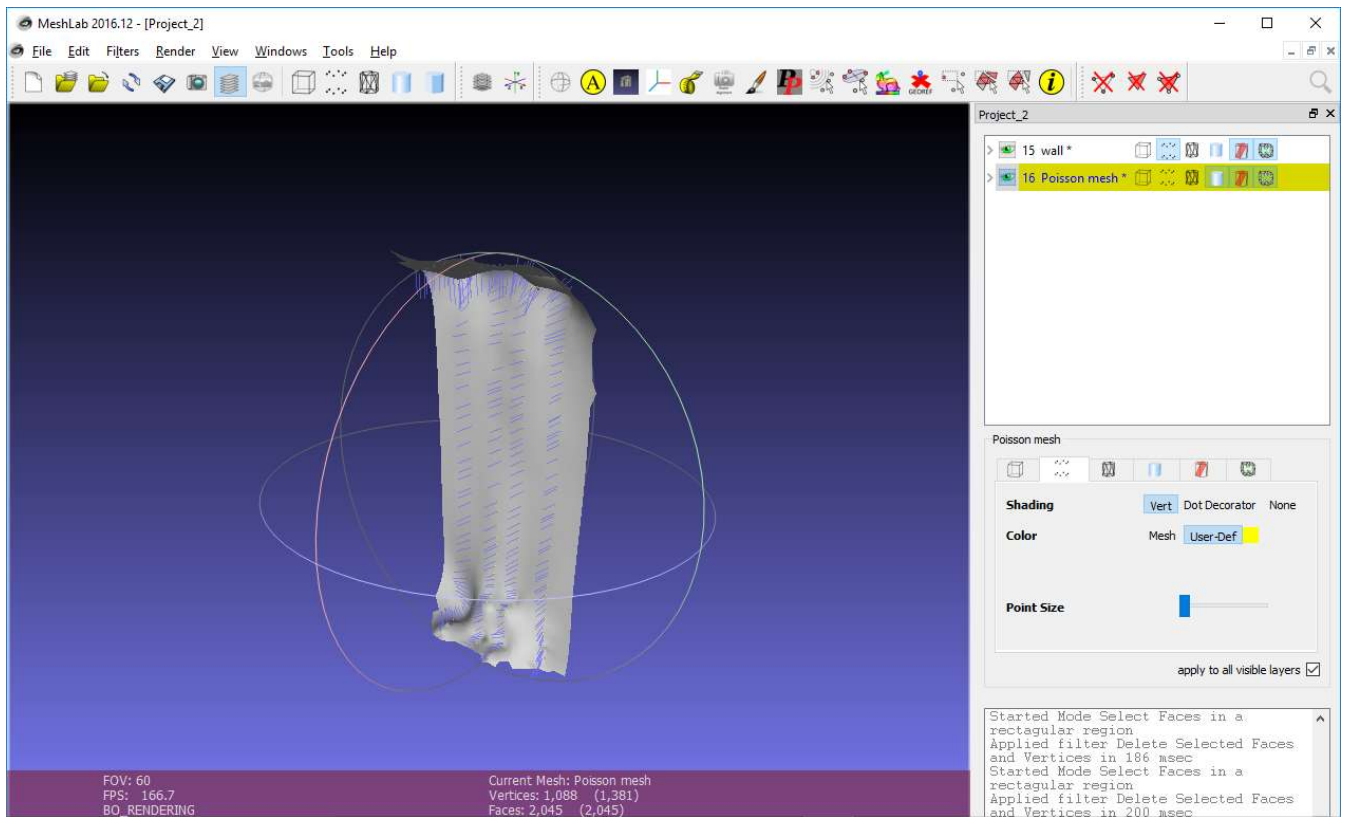
2. Highlight the unwanted faces
 - a. Do not select your points (if this happens, just reselect the faces before proceeding)
 - b. Don't try to get them all at once
 - c. Rotate your object to a good view before clicking the icon



- Click the delete face icon on the toolbar, making sure you click the one with the red x, that includes both the points and the highlighted face



4. Repeat until you only have the mesh you are looking for
 - a. Be careful not to delete your data points



5. Perform additional processing of the mesh as desired.