Geometric Modeling - Assignment 1

Samuel Austin (4005996) & Tim van Rossum (4246306)

May 2016

1 User manual

1.1 Mesh analysis tools

The mesh analysis tools can be found in the My Workshops menu under the Method menu in the main screen (see figure 1).

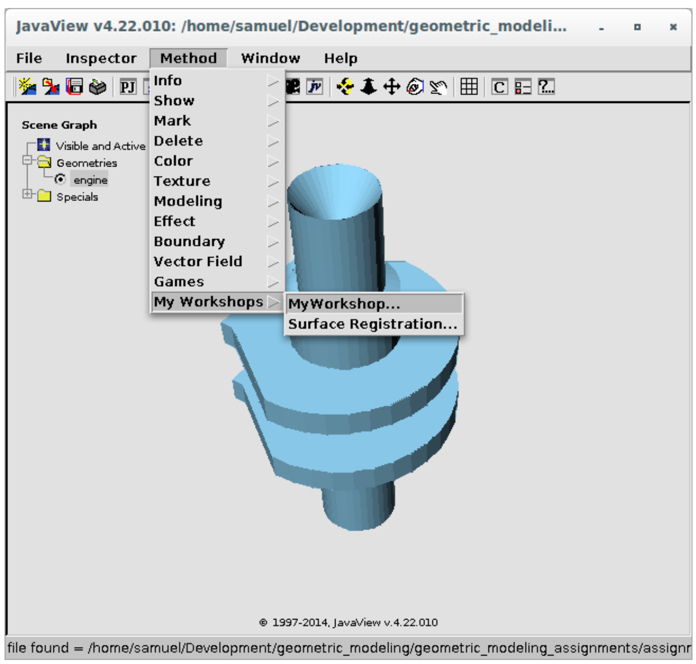

Figure 1: Location of the mesh analysis tools

From here, clicking on MyWorkshop, one can find all the mesh analysis tools. One might have to extend the interface that pops up. Figure 2 displays all the analysis tools. An example of what the mesh analysis tools window looks like after performing the analysis can be seen in figure 3.

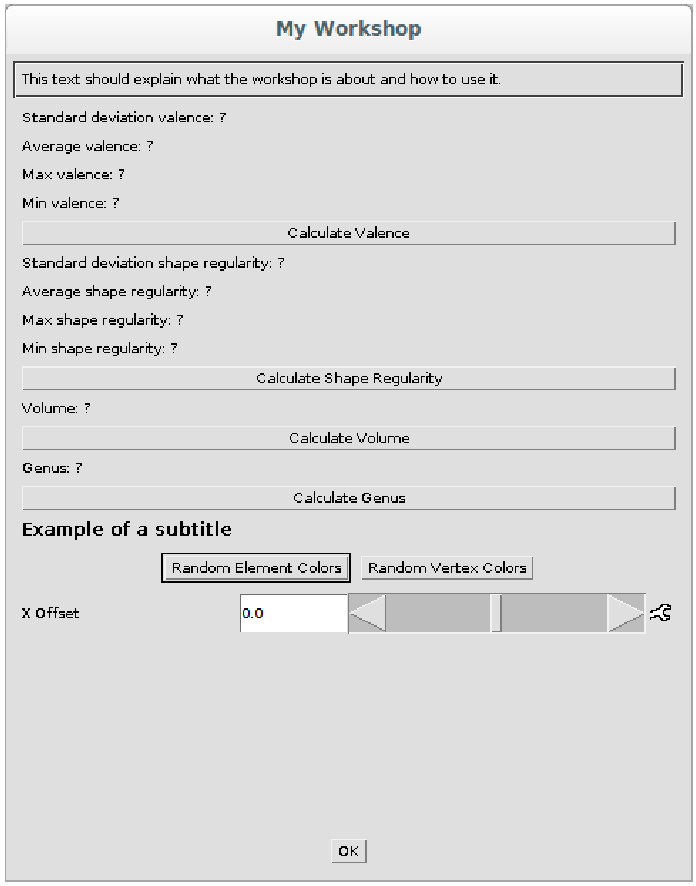

Figure 2: The mesh analysis tools window

1.1.1 Genus calculation

The genus of the mesh can be calculated using the "Calculate Genus" button. The genus will be displayed above the button.

1.1.2 Volume calculation

The volume of the mesh can be calculated using the "Calculate Volume" button. The volume will be displayed above the button.

1.1.3 Shape regularity calculation

The shape regularity of the mesh can be calculated using the "Calculate Shape Regularity" button. The average, minimum, maximum and the standard deviation of the shape regularity will be displayed above the button. Additionally the

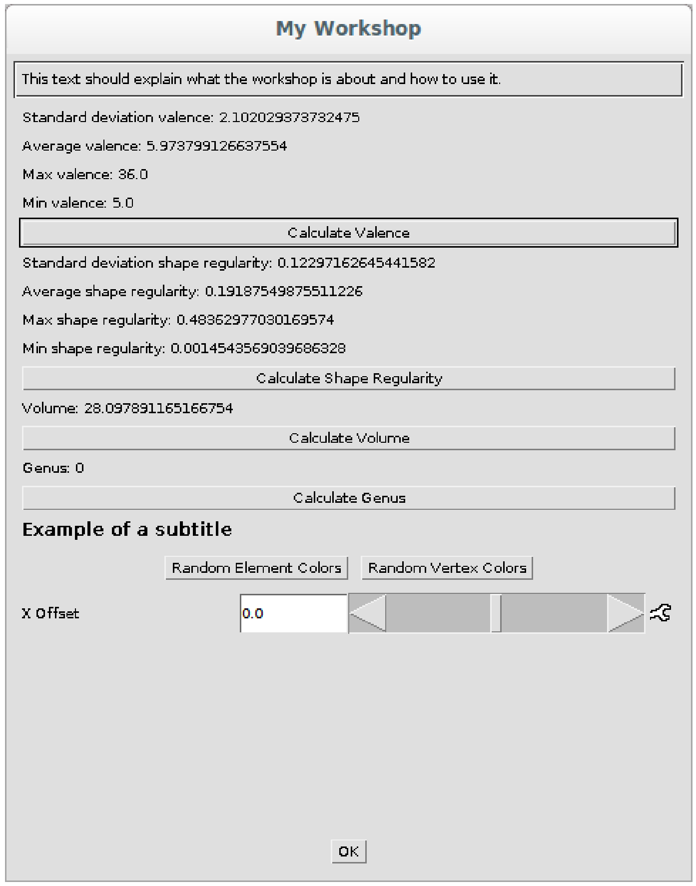

Figure 3: The mesh analysis tools window after applying the analysis

mesh will be coloured based on the shape regularity of the individual triangles. If a triangle has a darker shade of red, then the shape regularity is lower.

1.1.4 Valence calculation

The valence of the mesh can be calculated using the ”Calculate Valence” button. The average, minimum, maximum and the standard deviation of the valence will be displayed above the button.

1.2 Surface Registration

The surface registration tools can be found under the Surface Registration menu item in My Workshops. Selecting it gives the menu as displayed in 5. This tool requires there to be at least two meshes loaded in javaview. The first step is to choose two surfaces in the surface selection boxes and press the ”Set selected

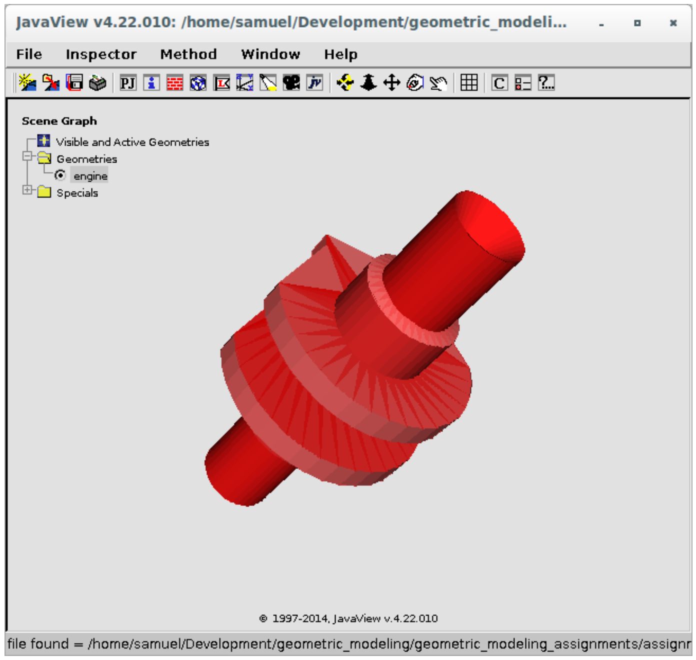

Figure 4: The colouring of the mesh after the shape regularity calculation

surfaces" button. After this, a choice can be made between point to point and point to plane distance calculation using the radio buttons. Once the desired settings are chosen the "Iterative closest point" button can be used to perform a single iteration of the algorithm.

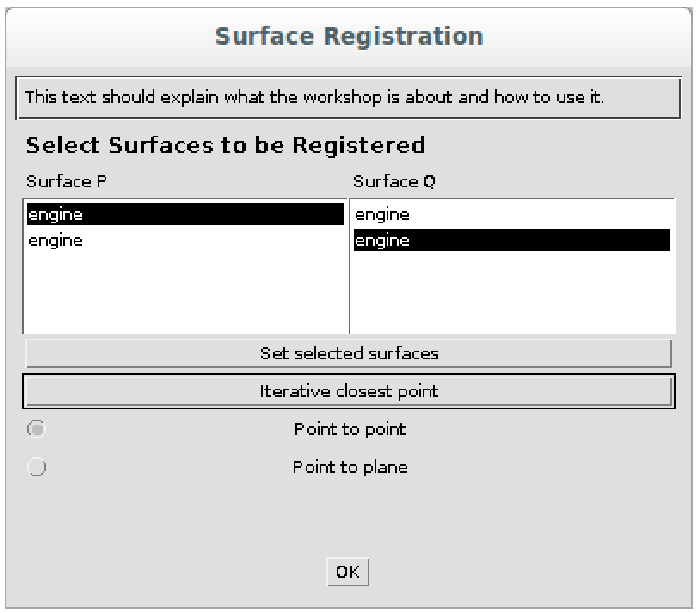

Figure 5: The surface registration window

2 Experiences

2.1 Mesh analysis tools

Our experience with developing the mesh analysis tools were painless and easy experiences. The tools basically worked right after implementing them, except for the shape regularity colouring tool, which did not work as intended the first time around (it could give triangles that had pretty much the same shape regularity completely different shades of red). Eventually, we discovered that this was caused by how Java implements HSB colors. After fixing this, the tool worked as intended. Also, we had some unexpected results for the genus calculation of several meshes (some meshes had a negative genus). We believe this is caused by some inconsistency in the meshes themselves as for the more simple meshes the genus calculation works as expected.

2.2 Iterative closest point

The experiences with the surface registration tools (both point-to-point and point-to-plane) were different for each of the tools. In theory, iterative closest point registration using point-to-plane distances should be better for some cases, but we have not found any meshes for which it performed better.

The main issue we ran into is that once iterative closest point had a bad iteration which caused the meshes to be rotated 90 degrees relative to each other it would almost never recover (see figure 6). This was usually cause by the point to plane method.

2.3 Number of used points for iterative closest point

We played around with the amount of vertices selected and the maximum deviation allowed from the mean distance, but nothing really changed in executing the algorithm. A very low number of vertices would cause an almost random behaviour but the difference between a medium number of points and all the points was not noticeable. Right now, the amount of vertices used is either 2000 of either mesh or all the vertices of either mesh, depending on which one is lower.

2.4 Values of k for point to plane

For lower values of k (the amount of times a distance can be higher than the mean distance before being disregarded as a useless point) point to plane iterative closest point seemed to behave more erratic. Therefore, we have set that number to 5. This lowers the erratic behaviour of point to plane iterations, but still does not really give desired results, especially regarding convergence.

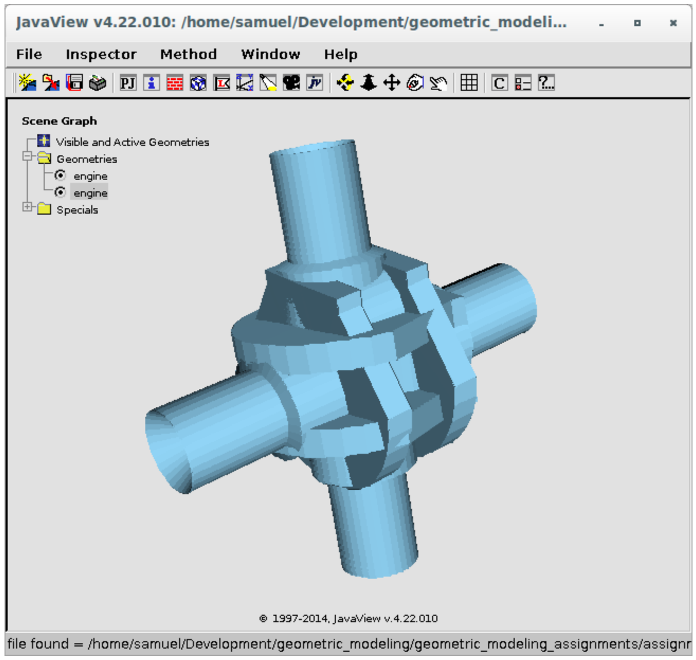

Figure 6: Meshes in wrong position after iterative closest point, using point-to-plane distance

2.5 Point to point vs Point to plane

Point to plane iterative closest point did not seem to converge to a single position. The mesh would infinitely jump around sometimes getting close to a correct match but then suddenly jumping back to a completely incorrect position. Point to plane was good for making big jumps in a single iteration. Point to point on the other hand seemed to do very small adjustments of the mesh per iteration but did converge to a single position.

An effective way of matching two meshes seemed to be to use the point to plane method until the two meshes were almost in the correct positions and then using the point to point method to converge to the matching positions of the surfaces. Also, point to plane is effective for getting a mesh that has converged and been put in the wrong position out of the wrong position in order to try again. Point to point is less effective for this task, as it only executes small steps and converges easier.