Assignment 1
COMP5115

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1 Results vs. GeomProc

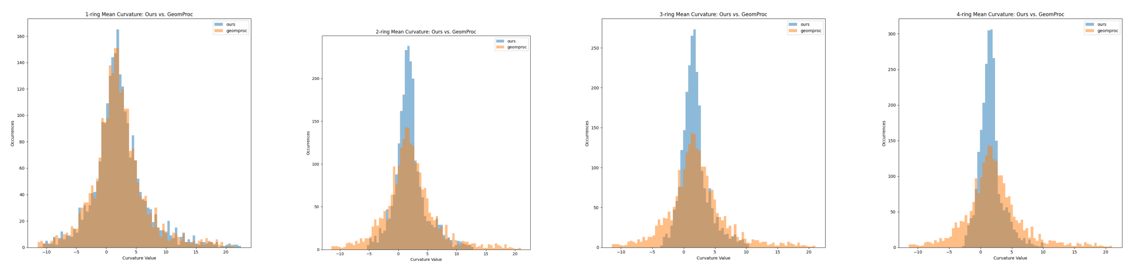
All histograms display values filtered to the 99^{th} percentile to remove outliers that would make visual analysis of the data difficult.

1.1 Mean Curvature

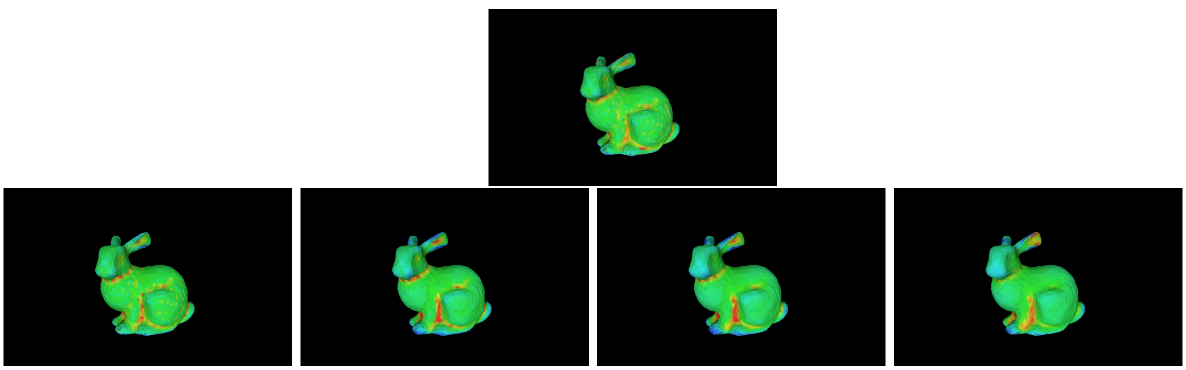
MSE: Distance from our mean curvature method to GeomProc

1-ring	2-ring	3-ring	4-ring
102.328	110.396	116.401	119.725

Curvature Value Distributions:



Visual Comparison: 1 to 4-ring from left to right



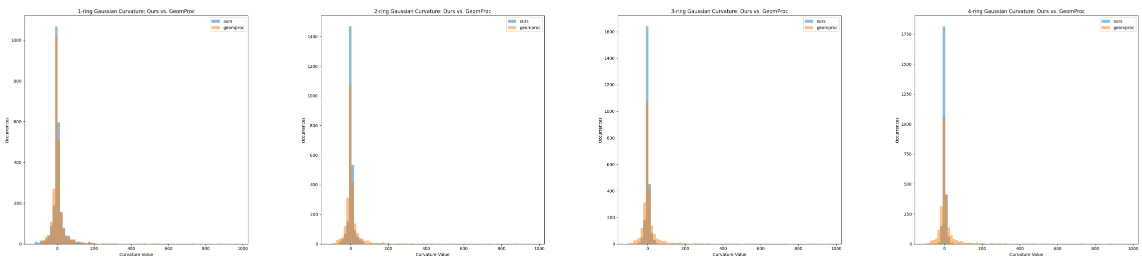
The mean curvature values computed with polynomial curve fitting match the results produced by GeomProc quite closely. In particular, the 1-ring neighbourhood variant has the smallest MSE. As the neighbourhood distance increases we see the curvature values concentrate around zero due to the smoothing effect of averaging curvature over a larger surface. The 2-ring approach of the polynomial surface method seems to most accurately depict the topology of the mesh while still preserving detail in small regions. When compared with the GeomProc baseline, this approach (especially the 2-ring) does a better job at identifying areas of convex curvature such as on the ears and feet while avoiding the splotchy artifacts that arise from relying on only the immediate vertex neighbours for curvature.

1.2 Gaussian Curvature

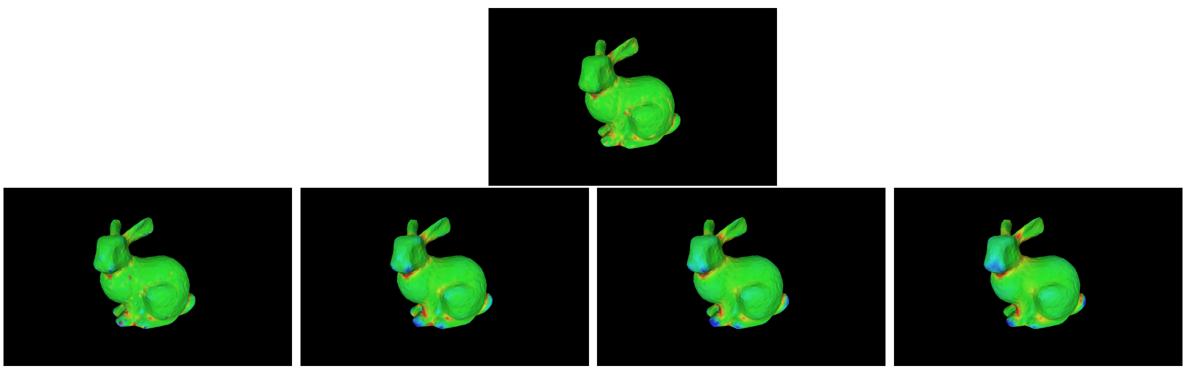
MSE: Distance from our gaussian curvature method to GeomProc

1-ring	2-ring	3-ring	4-ring
257379.800	244928.308	246108.370	246522.981

Curvature Value Distributions:



Visual Comparison: 1 to 4-ring from left to right



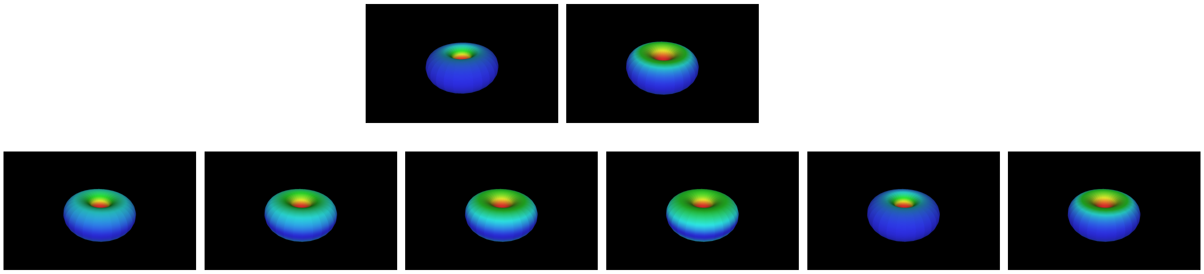
The polynomial surface gaussian curvature estimation outlined in the specification resulted in a large MSE to the GeomProc baseline. From examing the histogram results and visualizations, the GeomProc method has a long tail of positive curvature values and is missing many of the negative curvature regions identified by the polynomial method. This can be most notably seen in the 2-ring visualization, the convex areas of the bunny are highlighted such as the nose, tail, and feet where it is near zero on the GeomProc model. It seems there are almost no blue regions on the baseline model. The 1-ring gaussian curvature model seems to perform much worse than the GeomProc method as it contains more noise and doesn't identify areas of high curvature that are highlighted in the control.

2 Results vs. Analytic

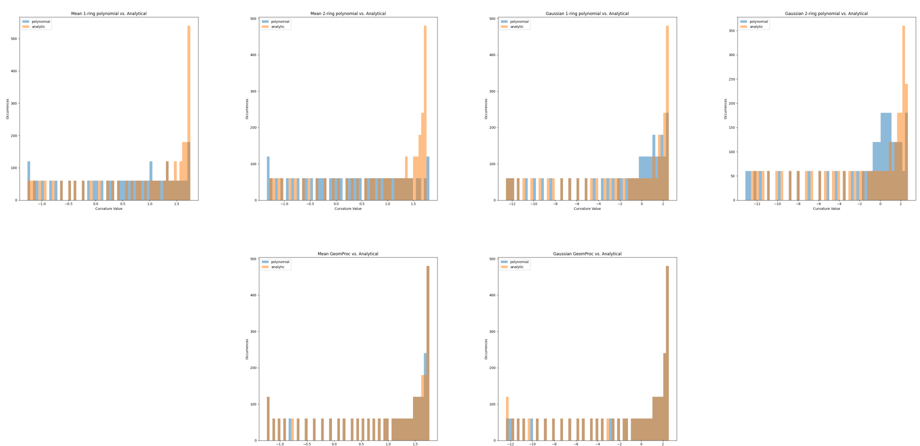
MSE to analaytic torus curvature

1-ring Mean	2-ring Mean	1-ring Gaussian	2-ring Gaussian	GeomProc Mean	GeomProc Gaussian
0.1186	0.3000	0.2475	0.8243	0.00004115	0.0005890

Visuals: Analytic mean & gaussian vs. discrete (bottom same order as table)



Curvature value distribution comparisons:



In terms of replicating analytical curvature values with the least possible error, the GeomProc Voronoi curvature estimation far exceeds the polynomial surface fitting method. This can be seen by examining both the error values in the table as well as how closely the GeomProc method fits the analytic distribution of curvature. Visually, the Voronoi method also looks identical to the analytic solution where the polynomial method has considerable differences in color region and gradient. In conclusion, for the real-world models the polynomial method seemed to produce more intuitive results, however, when trying to minimize tiny error on an analytic surface, the GeomProc approach is the better choice.