Project Proposal: Interactive Geometry Remeshing

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April 28, 2025

For my final project, I would like to implement the remeshing pipeline introduced by Alliez et al. in their paper *Interactive Geometry Remeshing* [1]. More specifically, my goal is to create a system that takes a 3D mesh as its input, and produces a higher-quality remeshed version based on geometric properties or the original mesh (represented by scalar density functions). The pipeline involves the following steps:

1. **Parameterization**: Project the input 3D mesh onto a 2D parameter space – I plan to use a harmonic parameterization as it creates a bijective map from the 3D mesh to the 2D space.

2. **Map Generation**: Compute 2D maps defined over the parameter space that encode geometric information from the original 3D mesh. Although the paper introduces multiple possible maps, I plan to initially focus on computing $\mathcal{M}_A$, a map that encodes the area distortion created by the parametrization.

3. **Sampling Point Generation**: Generate points for the new mesh by sampling a "control map," meaning a mapping that comprises the aforementioned map and an importance map indicating the desired sampling rate. The points will be generated via a halftoning/error-diffusion algorithm. Initially, I plan to use a constant importance map, meaning my function will uniformly sample from the area.

4. **2D Triangulation**: Generate a 2D mesh by applying a Delaunay triangulation to the sampled points.

5. **3D Mesh Reconstruction**: Obtain the higher-quality remeshing by projecting the 2D mesh back into 3D using a mapping from the 2D parameterization space to the original 3D geometry.

I plan to leverage the `libigl` implementations for the initial harmonic parameterization (`igl.harmonic`) and the 2D Delaunay triangulation (`igl.delaunay_triangulation`), and implement my own error diffusion function to perform the point sampling.

Time permitting, I hope to explore using different importance maps (like curvature) for the point sampling, as demonstrated in the paper.

References

[1] Pierre Alliez, Mark Meyer, and Mathieu Desbrun. Interactive geometry remeshing. *ACM Trans. Graph.*, 21(3):347–354, July 2002.