Base Mesh Construction using Global Parameterization

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Motivation

Base mesh construction from a dense-polygon mesh is often used to reduce the complexity of geometry processing problems.

In order to construct a base mesh, existing methods rely on local information to perform simplifications. Local estrategy leads to greedy algorithms wich are non-optimal.

We believe that throught the use of global parameterization, we can develop methods that use global information to create better base meshes.

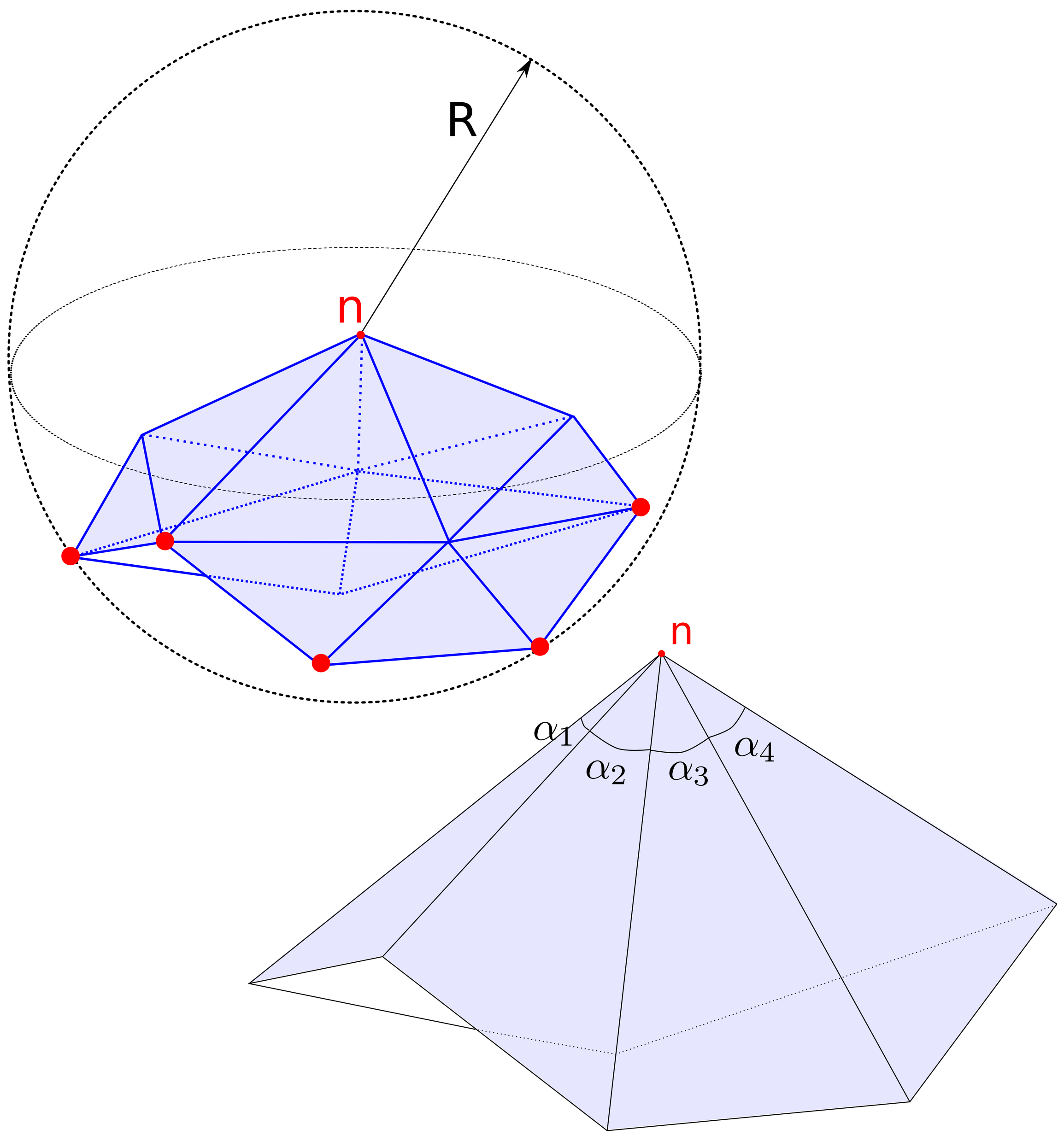
Our Approach

First, we compute a non-optimal global parametrization of the original mesh, allowing distortions and using seams and cone singularities.

Then, we map the boundaries of the parametrization pairwise, excluding the cone points and possible boundaries of the original surface. Finally, we place a few vertices on top of the global parametrization and compute a 2D Delaunay triangulation, yielding our base mesh.

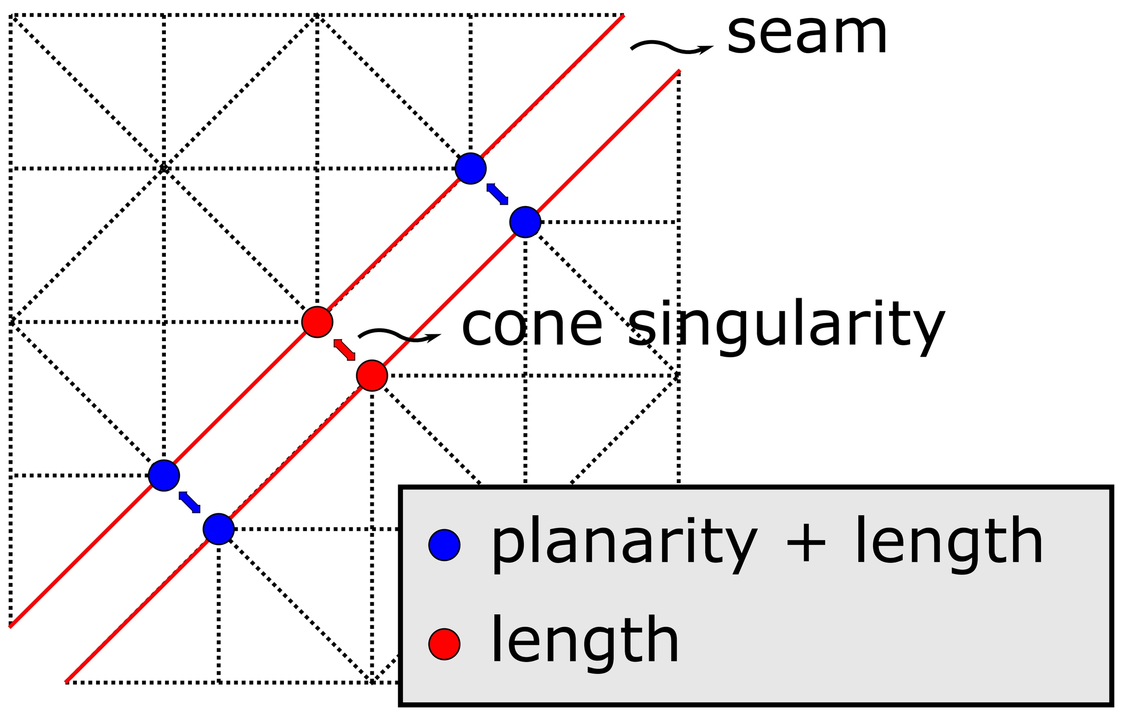
The analysis of where to place the base mesh vertices is done once, without iterations, and with global knowledge of the surface.

Cone singularities are selected by analyzing the local curvature of each vertex in the input mesh. The curvature is estimated by measuring the local distortion for various regions sizes.

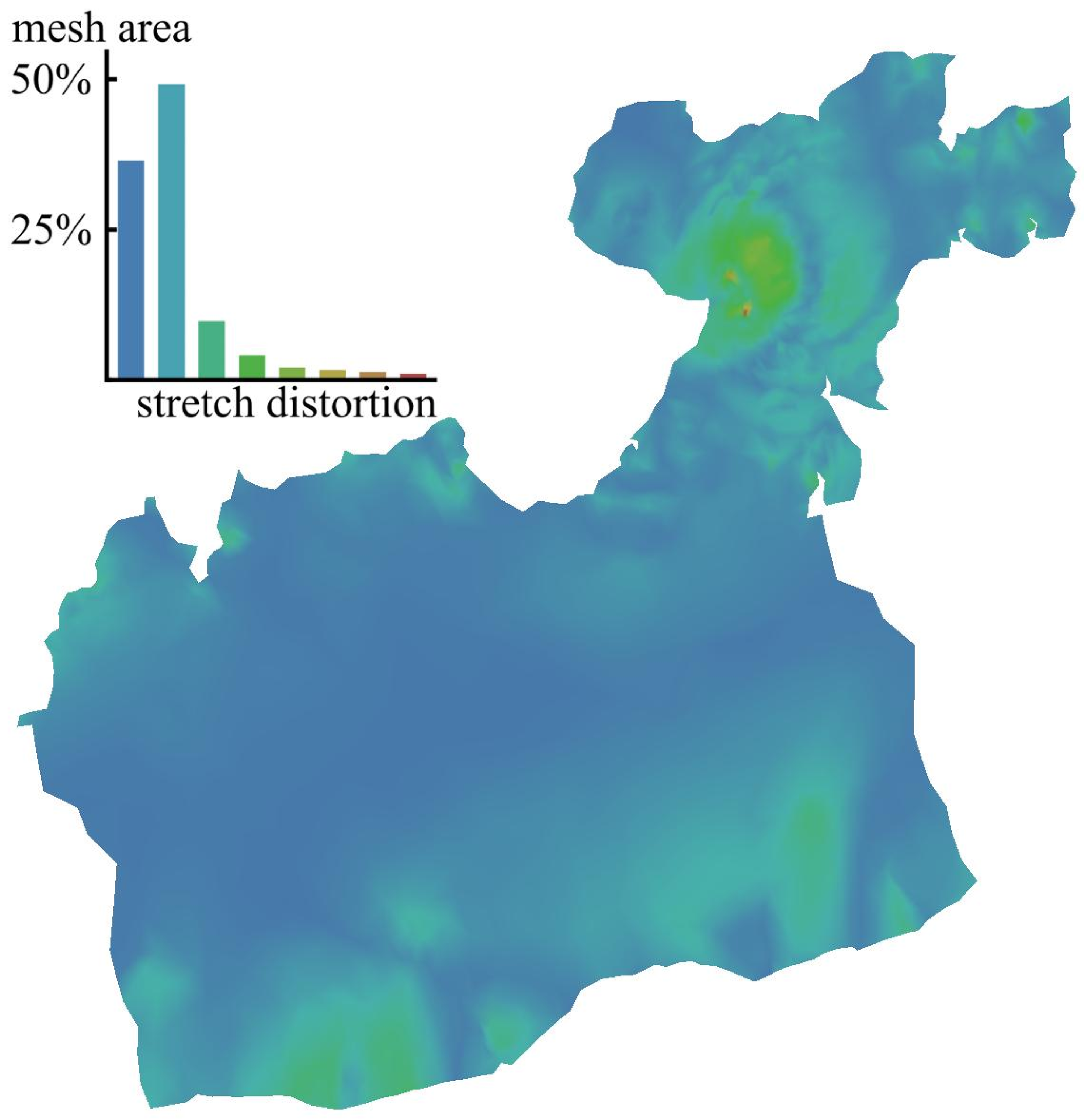


To minimize the **area distortion** on the global parameterization we cut the mesh along **seams** that connect the cone singularities.

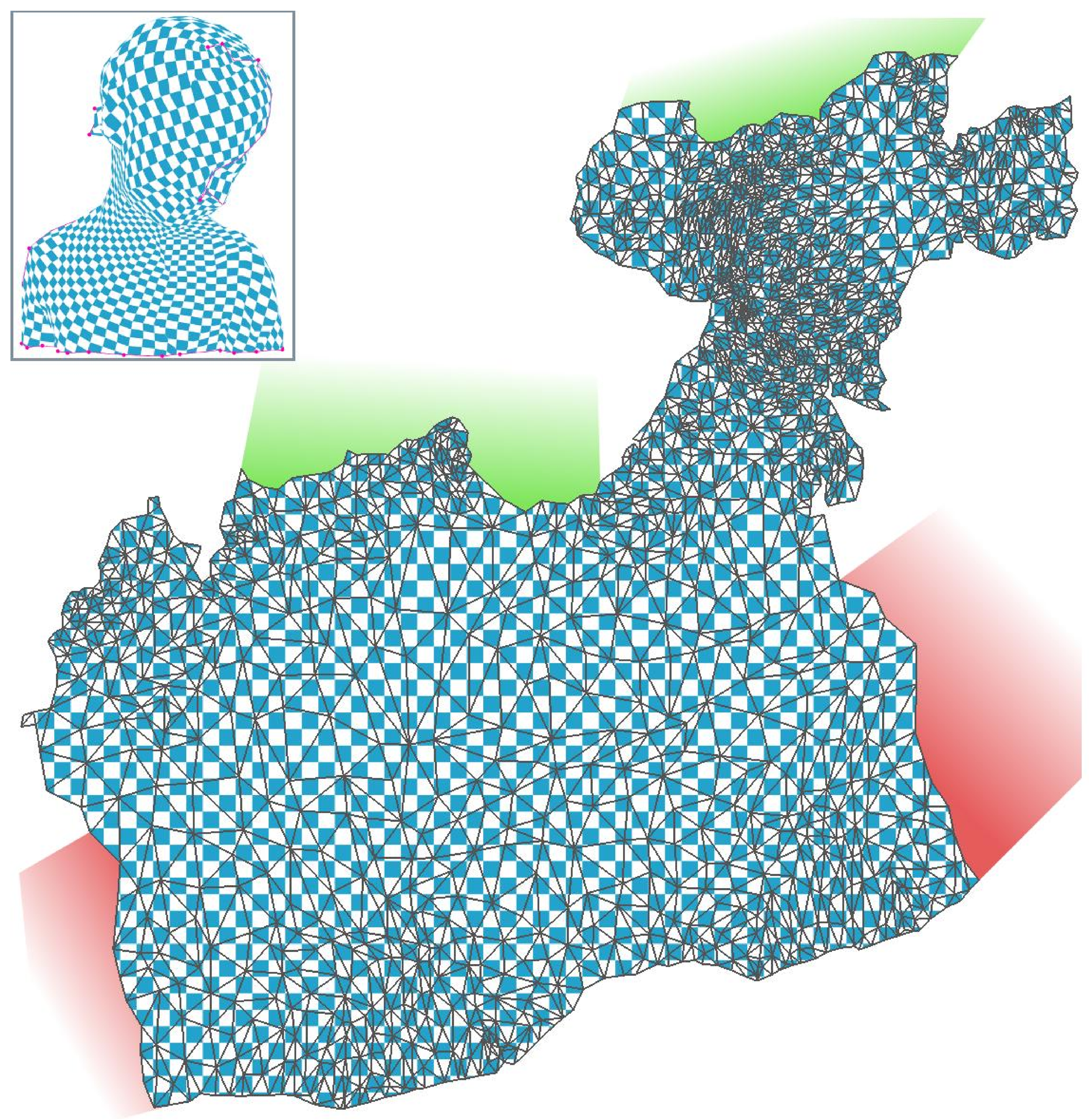
Next, we use a **modified angle-based flattening** algorithm with boundary restrictions, where mesh vertices lying on boundary seams are treated as internal vertices except for the few vertices marked as cone singularities.

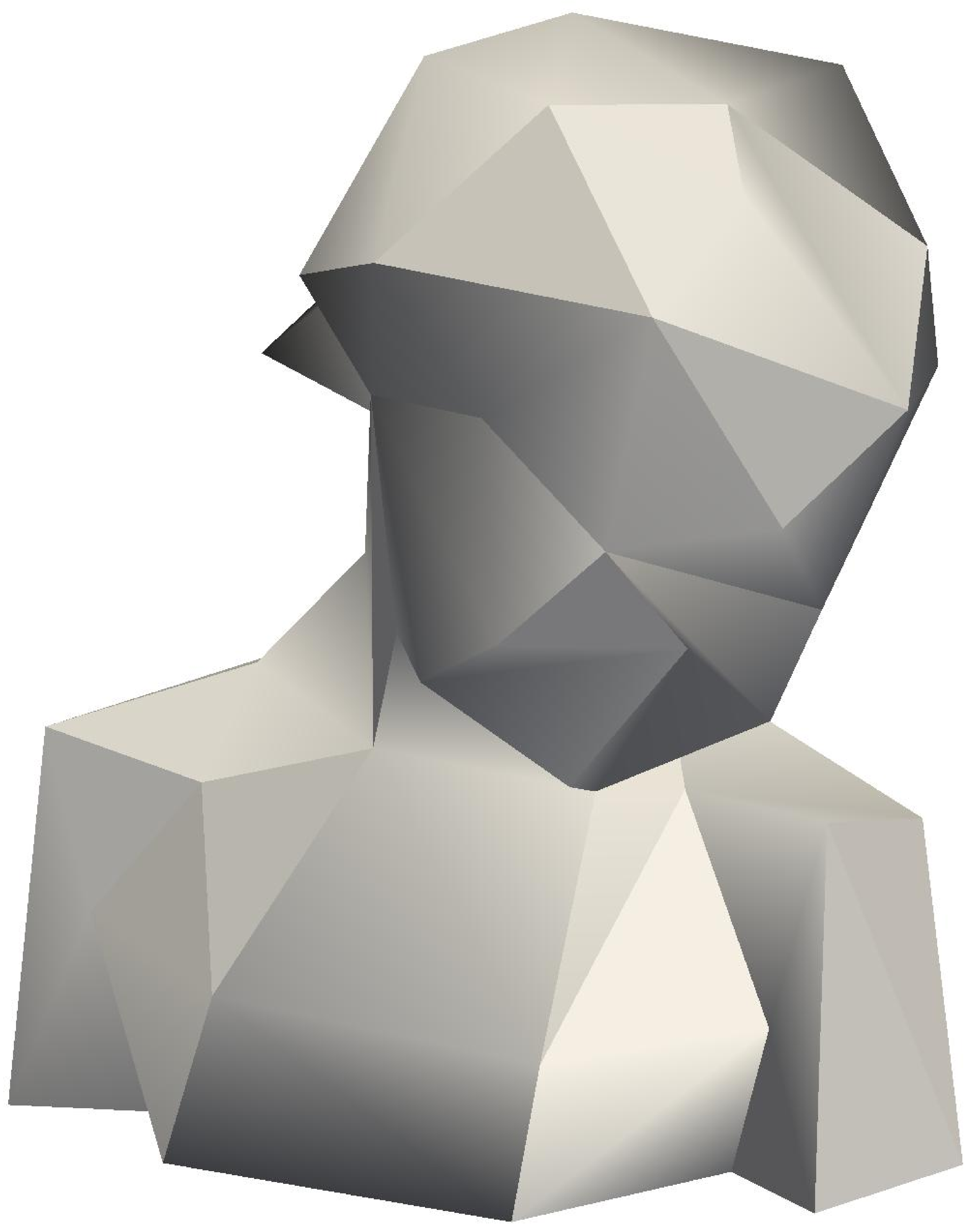


As a consequence, the total curvature of the surface is distributed at the cone points. And the new parameterization has a **consistent metric** across the border create in the process.



The last step of our algorithm is to create and place a small number of **base vertices** over the global parametrization and triangulate them to construct a new coarser mesh. We compute the length distortion ratio for all edges and place the vertices on the least stretched areas. The angular distortion is used to avoid placing base vertices on top of (or near to) cone singularities. The triangulation is a **Delaunay triangulation** on the 2D parameter domain and uses the correspondence across boundaries stored on edges. The final base mesh is obtained by getting the base vertices from the parametrization back to 3D maintaining the triangulation.





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Future Directions

Our approach creates only base meshes, but it has the potential to create meshes at any resolution. An interesting future direction is to investigate how these meshes interact and define a set of production rules to describe multiresolution meshes.

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