Mesh Segmentation

Mesh segmentation is the process of breaking a mesh into smaller submeshes that represent meaningful features. In [1], Shapira et al. present an algorithm based on a volume based shape function called the shape diameter function (SDF) to partition closed and intersection free meshes in a largely pose oblivious manner. The algorithm works as follows:

1. Compute the SDF for each face of the mesh. This is done by shooting several rays within a cone centered around the inward normal direction of each face to the other side of the mesh. The SDF is the weighted average of all rays lengths which fall within one standard deviation from the median of all lengths. Weights used are the inverse of the angle between the ray to the center of the cone to reduce the effect of more frequent rays with larger angles. Additionally, the SDF can be normalized to enhance the importance of delicate parts:

   $$nsdf(f) = \log\left((sdf(f) - \min(sdf)) * \alpha / (\max(sdf) - \min(sdf) + 1) \right) / \log(\alpha + 1)$$

   where α is a normalization parameter set to 4 in [1]. The default value for the cone angle is 120 degrees while the number of rays sent out per face is 30.

2. Apply soft clustering on the faces of the mesh to k clusters based on their SDF values. This can be achieved by either using the Expectation-Maximization algorithm or a soft variant of k-means such as fuzzy c-means. As a final (optional) step, use the alpha expansion graph cut algorithm to minimize an energy functional based on the probability vector from the soft clustering and the quality of boundaries (smoothness and concavity) in order to arrive at the final partitioning [1].

It is worth noting that each SDF cluster might contain multiple mesh parts. As the clustering works based on close SDF values rather than face connectivity, there is no direct relationship between the number of clusters and the final number of segments.

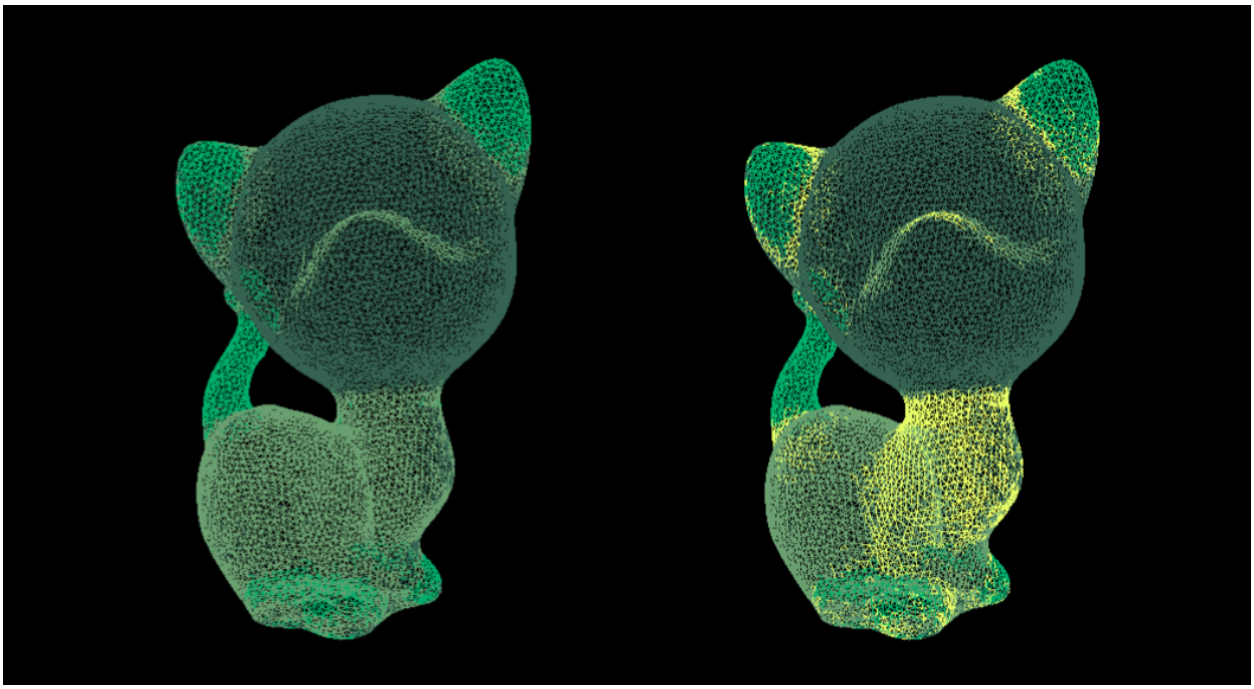

Figure 1: Mesh segmentation with 3 clusters on the left and 4 on the right

[1] Shapira et al. Consistent Mesh Partitioning and Skeletonization using the Shape Diameter Function