Facet Extraction and Classification for the Reassembly of Fractured 3D Objects

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Problem statement:
The reassembly of fractured 3D objects is a critical problem in computational archaeology. An essential part of this problem is to identify which facets of a fragment are fractured. A general strategy to solve this region classification problem is to first divide the geometry into regions and then classify each one as intact or fractured, based on statistical properties.

Contributions:
1. Comparative evaluation of some well-known segmentation strategies in the context of reassembly, in terms of performance and quality of segmentation.
2. A novel method for the classification of the segmented regions into intact and fractured ones, based on their statistical properties.

1. Segmentation - Distance Metrics
   
   Global: The angle between the average normals of two segments.
   
   Local: The angle between average normals of two segments computed on the local neighbourhood at their common border.
   
   Comments: The global metric performs well on planar surfaces, but it results in over-segmentation on curved ones. This can be alleviated using the local metric.

2. Post-Processing
   
   The greedy nature of the merging algorithms can lead to severe over-segmentation. This is fixed by a custom post-processing step that first decomposes small regions into single elements, which are subsequently merged to the nearest neighbouring segments.

3. Classification
   
   In order to discriminate regions to fractured and intact ones, we estimate the surface roughness using the Sphere Volume Integral Invariant. A semi-automatic machine learning approach is used to classify segments as fractured or intact.

Conclusions

Our results indicate that the choice of a distance metric has a far greater impact on the segmentation quality than choosing an optimal order of operations. A robust post-processing is essential for making region growing practical, since omitting this step leads to a large number of segments.

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http://presious.eu/resources/3d-data-sets

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