Masterstudium:
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Digitale Bildverarbeitung

Diplomarbeitspräsentation

Weighted Mesh Simplification of 3D Triangular Surfaces

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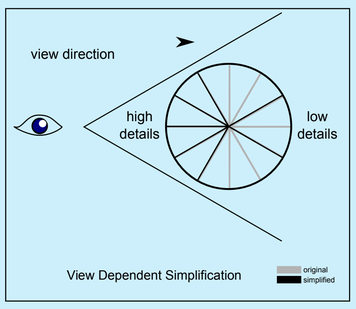
In this thesis, the iterative **simplification of complex three-dimensional triangular meshes** is shown:

- The underlying theory is based on a mesh simplification algorithm using quadric error metrics.
- The Mesh is analyzed and weighted in order to find suitable collapse candidates, so that the overall shape is preserved while small details are removed.

The base algorithm is designed, implemented and enhanced for the usage in the Aardvark Rendering Framework.

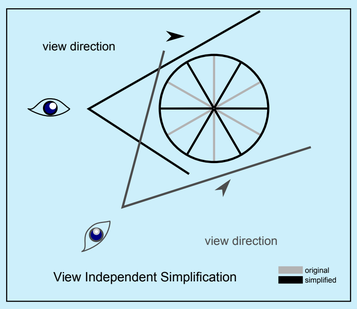
1

The common simplification techniques are either **view-independent** or **view-dependent.**



View-dependent simplification is commonly known as level-of-detail. Objects or regions closer to the camera are displayed with more details than objects farther away. Such steps of simplification can be computed in a preprocessing step. They can be applied in RT applications afterwards.

The concept of **view-independent** simplification is that an application uses a three-dimensional object as input and iteratively reduces the number of triangles along the surface without losing the representativeness of the object. The presented algorithm can not be run in real-time but produces very high quality results.



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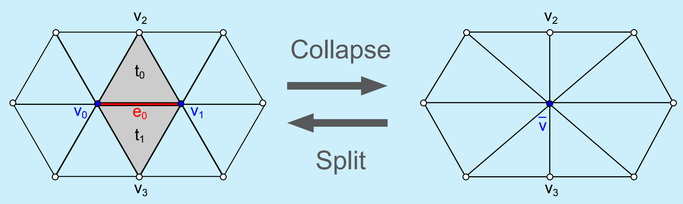
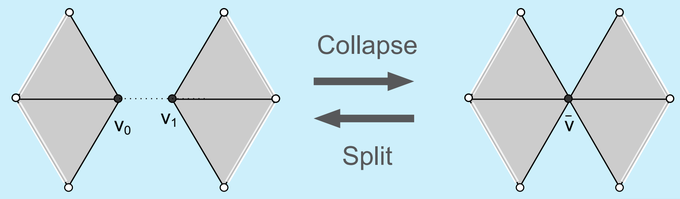


Edge contraction collapses the edge e_0 that has been identified as a suitable candidate for simplfication. The vertex v_0 and v_1 will be merged and the degenerated triangles t_0 and t_1 will be removed. All incident edges to v_1 are being reconnected.

In contrast to edge collapsing, **pair contraction** is a more generalized approach. The algorithm is able to merge unconnected regions. There is a possibility to alter the mesh topology during the simplification processes.



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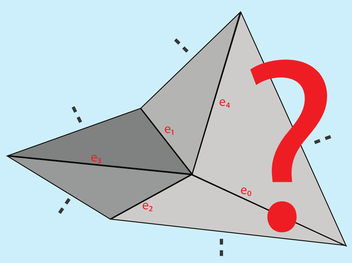
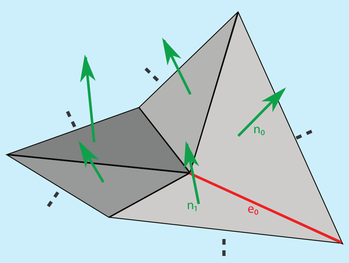
There are different contraction metrics available. They differ both in speed and quality.
The different quality criterion for edge selection used in this work are:
Random Edge Selection, Edge Length Metrics and the *Quadric Error Metrics.*



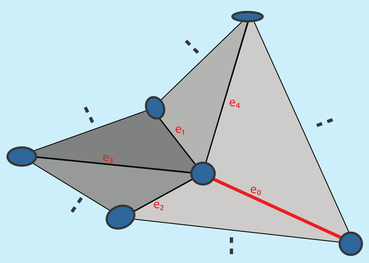
Random Edge Selection

This technique is quite fast but rather destructive for the whole surface. The edges are being selected randomly. The lack of a qualified strategy leads to a model with irregularities and jagged surfaces.



Edge Length Metrics

In contrast to the random approach, the edge length metrics offer a simple quality metric by taking the edge, its length and the angle between the normals of the adjacent faces into account.



Quadric Error Metrics

The quadric error metrics are the best trade-off between quality and speed. Per vertex, the metrics of the surrounding faces are taken into account. The flatter a region, the earlier it will be contracted.

4

The figures below show the differences between random edge selection, edge length metrics, and quadric error metrics with a face count of 25% compared to the original mesh. The visual comparison is shown by overlaying the original mesh (red) and the reduced one (grey) simultaneously.

1.) The rather jagged and huge grey patches indicate a significant loss of quality.

2.) Using the edge length metrics leads to smaller grey patches and a smoother composition between the original and the reduced size model.

3.) The figure shows an almost equal distribution between grey and red patches which is an evidence that only tiny details were removed.

1.) Random Edge Selection

2.) Edge Length Metrics

3.) Quadric Error Metrics

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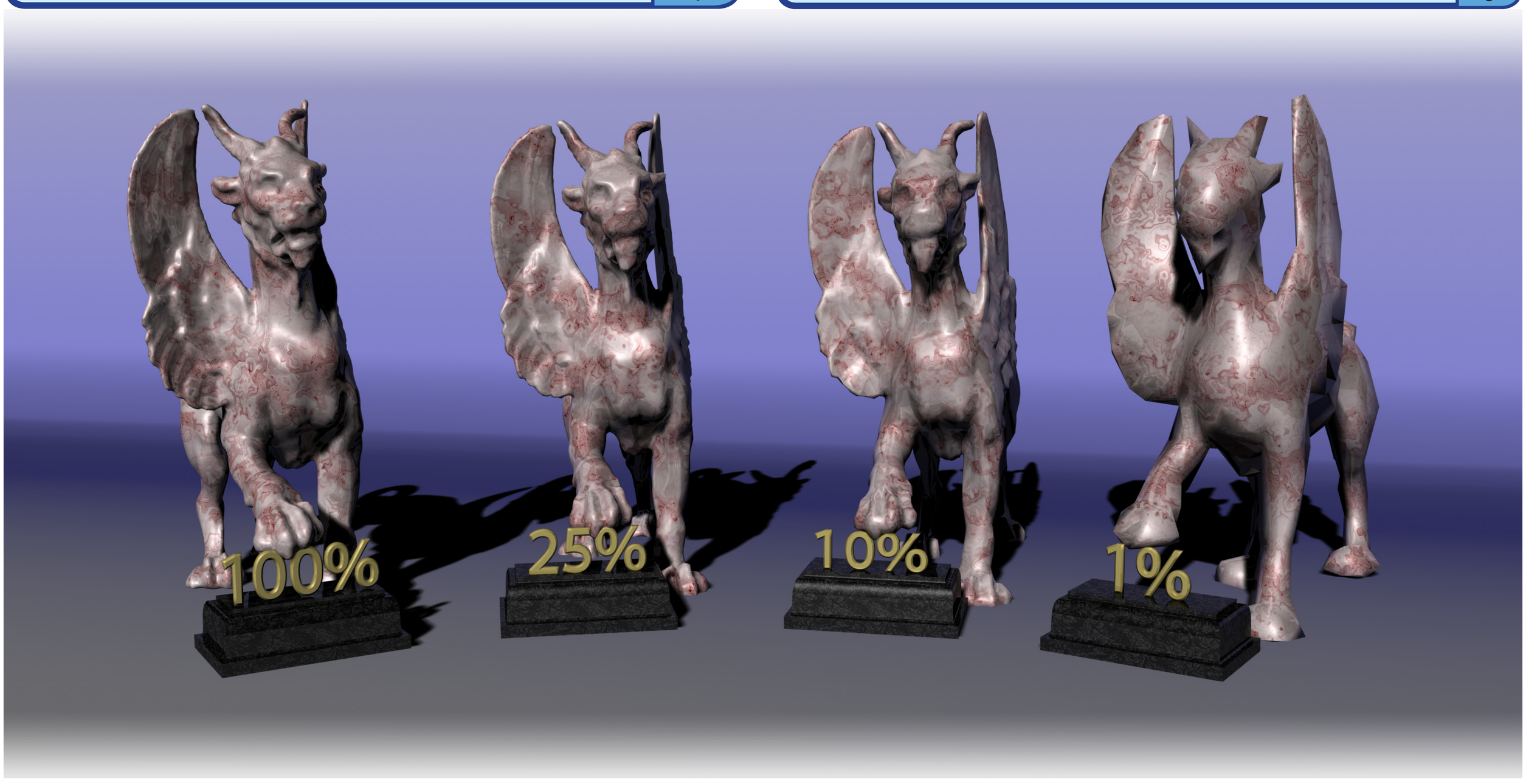

The leftmost version shows the original model consisting of approximately 100,000 triangles. The model on the outer right consists of only one percent (~1,000 faces) of the original model: only small details are missing, while the basic shape has been preserved. The output models of the simplification application have been rendered using Maya & MentalRay

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