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Evaluation of an Appearance-Preserving Mesh Simplification Scheme for Configura AB

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Contents

1 Introduction

In recent years the field of *computer graphics* has become an important part in many industries, but especially in the entertainment industry (for instance video games and motion pictures). These industries generate a lot of money, and are quickly growing in size. A recent survey by *Kroon and Nilsson* [6] from *Dataspelsbranschen* have shown that the video games industry in Sweden generated €1325 M in revenue in 2016, a steep increase from the €392 M in 2012. Also, most movies nowadays use to some extent 3-D computer graphics in scenes where the cost would be to large to reproduce in reality, be too risky for actors, or simply be impossible.

The *rendering* of *meshes* (a collection of *polygons* that describe a *surface*) is one of the main activities in computer graphics (usually, a *collection of meshes*, a so called *scene* to be rendered). In many cases, these meshes are very detailed, and require a large amount of polygons to fully describe its surface. This is problematic, since the *rendering time* of a scene is mostly dependent on the number of polygons in has. Therefore, it's important to reduce the *polygon count* of a mesh as much as possible. This is especially true in video games, where the scene needs to be rendered in *real-time*. However, if we reduce the amount of polygons too much, we'll reduce the *visual quality* of the mesh, giving a flatter surface than intended, and also remove small visible details. This will destroy the intended *geometrical appearance* of the mesh.

1.1 Motivation

While the geometrical appearance of a mesh is important, it's not the only factor which give the *final appearance* of a mesh when rendering. According to *Cohen et al.* [3], both the *surface curvature* and *surface color* are equally as important contributors. We'll use *textured appearance* as the common name for these, since surface properties are usually specified in a *texture map*.

In computer graphics, the process to reduce the number of polygons in a mesh based on some metric is called a *mesh simplification algorithm*, as seen in *Talton's survey* [9] on the subject. Historically, these have been mostly concerned with minimizing the geometrical deviation of a mesh when applying it. Somewhat recently, methods for minimizing the texture deviation when simplifying a mesh have also appeared. They attempt to reduce *texture deviation* and *texture stretching* caused when removing polygons from a mesh, as described in *Hoppe et al.* [5].

By simultaneously taking into account the geometrical and texture deviation of a mesh, one can *preserve the appearance* of a mesh when applying mesh simplification. If polygons can be removed without affecting appearance significantly, we can reduce render times for "free".

1.2 Aim

We plan to approach this problem by first surveying the field for state-of-the-art mesh simplification algorithms that preserve the visual appearance of a mesh, and then attempt integrate these algorithms into Configura's graphics pipeline. Thereafter, we evaluate each of these by measuring the algorithm's performance and its ability to preserve the meshes original appearance. Our goal is to find a mesh simplification algorithm which suits Configura's requirements.

1.3 Research Questions

1. How can *mesh simplification* be done without affecting the *visual appearance* significantly?
2. What are the alternatives to achieve *mesh simplification* with *appearance preservation*?
3. Which alternative gives the best effect considering *performance* and *appearance preservation*?
    a) When measuring the algorithm's *computation time* while targeting an *appearance threshold*?
    b) When measuring the algorithm's *memory usage* while targeting an *appearance threshold*?
    c) When measuring the *rendering time* of the simplified mesh?
4. Which alternative gives the best *appearance preservation* when targeting a certain *polygon count threshold*?

1.4 Delimitations

Since there are many mesh simplification algorithms in previous work, a proper literature review would have to be done to find possible candidates for implementation. However, since this thesis is mostly concerned with implementing and measuring the performance, we've decided to base our choices on existing surveys and literature reviews to skip doing a literature review ourselves.

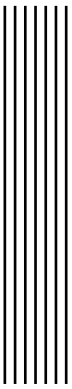
Also, since implementing and doing measurements on all algorithms would take too long, we've decided to only pick a interesting subset of the algorithms presented in the surveys.

1.5 Background

This thesis was requested by *Configura AB*, a company in Linköping which provides space planning software. Their main product, CET Designer, among other things, let's companies create and render 3-D scenes. These scenes have a large amount of polygons, and can be visualized in real-time to customers.

To allow larger scenes to be rendered with higher framerates, for example for exploring environments in Virtual Reality (VR), it would be beneficial to reduce the amount of polygons as much as possible. The models in the scene are usually textured to some degree, and it's important to keep their visual quality high.

While Configura already has a mesh simplification in their pipeline, it only accounts for surface simplifications, and doesn't take into account the texture appearance that might be degraded when applying it. Therefore, the task is to integrate a new mesh simplification method that takes texture quality into account when simplfying the mesh.



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