Christian Nitschke

A Framework for Real-time 3D Reconstruction by Space Carving using Graphics Hardware

Diploma Thesis

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A Framework for Real-time 3D Reconstruction by Space Carving using Graphics Hardware

by

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To my Parents

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

Christian Nitschke, Weimar 12/06/2006

ABSTRACT

Reconstruction of real-world scenes from a set of multiple images is a topic in Computer Vision and 3D Computer Graphics with many interesting applications. There exists a powerful algorithm for shape reconstruction from arbitrary viewpoints, called Space Carving. However, it is computationally expensive and hence can not be used with applications in the field of 3D video or CSCW as well as interactive 3D model creation. Attempts have been made to achieve real-time framerates using PC cluster systems. While these provide enough performance they are also expensive and less flexible. Approaches that use GPU hardware acceleration on single workstations achieve interactive framerates for novel-view synthesis, but do not provide an explicit volumetric representation of the whole scene. The proposed approach shows the efforts in developing a GPU hardware-accelerated framework for obtaining the volumetric photo hull of a dynamic 3D scene as seen from multiple calibrated cameras. High performance is achieved by employing a shape from silhouette technique in advance to obtain a tight initial volume for Space Carving. Also several speed-up techniques are presented to increase efficiency. Since the entire processing is done on a single PC the framework can be applied to mobile setups, enabling a wide range of further applications. The approach is explained using programmable vertex and fragment processors with current hardware and compared to highly optimized CPU implementations. It is shown that the new approach can outperform the latter by more than one magnitude.

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”The stone unhewn and cold becomes a living mould,
The more the marble wastes the more the statue grows.”
Michelangelo Buonarroti

CONTENTS

LIST OF FIGURES