Dynamic volume deformation using surfels

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A dissertation submitted in partial fulfilment of the requirement for the award of the degree of MSc in Computer Game Technology

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October 2010

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**Abstract**

**Acknowledgements**

Thanks to:

My beautiful wife, Hrafnhildur and our son, Mikael Máni. For their love and support throughout my studies.

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# 1. Introduction

Computer game realism has improved tremendously since the days of Doom and Wolfenstein 3D. Bill Gates said in a promotional video for Windows ’95 where he was superimposed into Doom 2: “These games are getting really realistic” (Matthewandrewtaylor 2006). Fifteen years later this statement is still true, games are getting really realistic. But what is video game realism? Is it the visual quality of the game world, or is it the behaviour of the world as the player expects it to be? Video game realism is a combination of the two, it needs to look well and behave properly. There is no reason creating the most real looking video game when there is no logic to the world behaviour.

The game world behaviour has many layers, from physics to night and day cycles. The behaviour that will be covered in this project is the volumetric deformation of walls. This feature is more often than not excluded from modern big budget games. Fallout 3 (Bethesda Game Studios 2008) is a perfect example of this discrepancy. In this game the player is given a rocket launcher that fires mini nuclear weapons. While this weapon works wonders on killing mutants and any other computer generated villain, it does no damage to structures. In a computer generated world that is so rich of interesting characters and beautiful graphics, this omission does make the game world feel like it lacks something. The behaviour of the game world therefore plays an important role in maintaining the user immersion.

Figure - Fallout 3 nuclear weapon launcher [Sigger 2008]

A few reasons exist why this is not incorporated into every 3D realistic game. The first one is because static environments simplify the game development by a large margin. In a game world where structures are static, a single wall’s vertices can be pre-calculated and placed into a vertex buffer. This vertex buffer is in turn used when the wall needs to be drawn. If the wall is dynamic and destructible there are many systems that need to be updated. First of all there needs to be an internal mechanism that controls how the wall deforms, which needs to be updated every time a collision occurs. In addition to the interior, the exterior needs updating as does the system that handles the collision detection. In addition to these steps, the deformation needs to be realistic, which is something which can be hard to do.

This project will aim to find a realistic and yet efficient method of deforming 3D volumes dynamically in video games. The methods used in this project will be a combination of surface and physical elements (surfels and phyxels respectively). Where the surfels are used to simulate the exterior of the model, but the phyxels simulate the interior.

# 2. Literature Review

This chapter is dedicated to the immense research and knowledge that exists in the field of volumetric deformation. Each method will be summarized and discussed with special focus on this project.

## 2.1 Mesh-based methods

This sub-chapter will cover the different types of mesh-based interior and exterior methods.

### 2.1.1 Voxels

Volumetric pixels (voxels) were first introduced by Lorenssen and Cline in 1987 in their seminal paper. They used voxels in their marching cube algorithm

## 2.2 Mesh-free methods

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