Hair simulation using Position Based Dynamics

5th semester Project Laboratory report

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Figure 1. The achieved visual look

Abstract

A self-assessment of the 5th semester Project Laboratory Project is presented in this article. My goal was to achieve hair simulation of acceptable quality both in terms of look and performance. Multiple approaches were considered before arriving at a Position Based Dynamics based solution. The simulation was implemented in C++ with the Open Graphics Library (OpenGL [1])

CCS Concepts: • **Computing methodologies** → *Physical simulation.*

Keywords: hair simulation, position based dynamics, OpenGL

1 Introduction

In the 5th semester of their undergrad studies, BSc students from Budapest University of Tehchnology and Economics embark on their first journey of scientific research. I was always interested in and fascinated by computer graphics, it came naturally to choose a subject in this area. As I had

[1] http://www.opengl.org

little hands-on experience in this field, a long time had to be dedicated to research and trying out different simulation methods.

The first of this paper reflects this, giving an overview of considered methods, and other possible routes that could have been taken to implement hair simulation.

2 Overview of considered methods

There were mainly three methods considered, two of them being substantially different:

2.1 Mass Spring System

The whole idea of doing hair simulation as my project laboratory came from *TODO reference Pixar article and Khan Academy video*

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\documentclass[STYLE]{acmart}
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2.2 Position Based Dynamics

2.3 Follow the Leader

The Dynamic Follow-The-Leader method outlined in *TODO reference article*

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A Supplementary development

A.1 OBJ Reader

An OBJ reader utility was implemented as part of the project. As the OBJ file format [2] describes a wide range of properties for objects. The present OBJ reader handles only the subset of these describtion options needed for the project. Lines containing other type of object descriptions were ignored, resulting in a successful file read if possible.

Table 1. Supported OBJ Data Types

Type of data	Format
Comment	`# comment`
Geometric vertex data	`v x y z`
Texture coordinates	`vt u v`
Vertex normals	`vn i j k`
Triangular faces	`f v1/vt1/vn1 v2/vt2/vn2 v3/vt3/vn3`

- "`v x y z`" defines a vertex with position (x, y, z).[3]
- "`vt u v`" defines a 2D texture coordinate with position (u, v).[4]
- "`vn i j k`" specifies a normal vector with components i, j and k.
- "`f v1/vt1/vn1 v2/vt2/vn2 v3/vt3/vn3`" Specifies a face with the given indices. For the first vertex, the *v1*th previously defined vertex position is used, the *vt1*th texture coordinate and *vn1*th normal vector is used.[5]

A.2 Recording the simulation on-the-fly

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[2] http://paulbourke.net/dataformats/obj/

[3] The obj file format allows for a w coordinate (also called the weight) for describing rational curves and surfaces. The default value of *w* is 1.0. My implementation handles only the assignment *x*, *y* and *z* values.

[4] The obj file format allows for 3D texture coordinates as well, but this implementation handles only 2D texture coordinates.

[5] The obj file format allows for face definitions far beyond only triangles, although this implementation handles only face definitions of the above format.