ENSTA Paris - Ecole polytechnique

Computer Animation

Hair Simulation

Authors :

Désiré Ouedraogo
Rania Ben Kmicha

Supervisor

Damien Rohmer

Academic year: 2022/2023

Contents

List of Figures

Introduction

Computer animation has been an important part of many huge industries pipeline such as cinema and video games industries. Research teams are trying to improve this field to be as real as possible using recent mathematical methods.Recently,they start to use machine learning knowledge to improve some real behaviors and expressions. Therefore, this project takes part as an application of Computer animation course' theoretical knowledge as we implemented a hair simulation.We used Computer Graphics Programming Library -CGP- and Blender for environment preparation.Then,we tried to implement the real hair simulation on head shape taking into account applied forces and handling collisions.

Chapter 1

Project idea and Environment Preparation

1.1 Project idea

Coming to our animation project idea, we decided to do a hair simulation using some pre-implemented TPs' code as a start.This idea was done before by some students,however in this project, we simulate hair while being attached to a head shape in order to have a realistic scene [1].

Figure 1.1: Windy Hair simulation

---

[1]github.com/Nebnoma9/Hair-Simulation.git

1.2   Tools

For the purpose of making hair simulation, we used the cgp library that we used to work on during the lab sessions. On top of that, we had to use the Blender app to prepare the assets for the project. The assets are two main files : an OBJ format file 'head.obj' 1.2 and an image of hair 'hair.png' 1.4. We browsed the web to find a free human head shape. Then we created on Blender a group of vertices of the scalp 1.3 in order to access only these vertices for the hair generation.
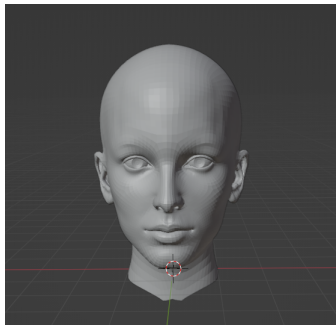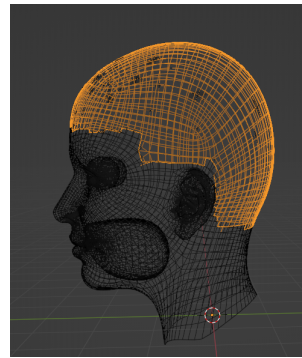

Figure 1.2: Head shape

Figure 1.3: Wideframe representing the vertices of the scalp in orange

Figure 1.4: Hair texture

Two labs were very important in making this project. The first one is the blend_shape lab where we used the code to prepare the environment of the project in setting the frame and the head shape.
The second useful lab for this project has been the cloth simulation lab. It helped us to model the hair shape and simulate its response to many forces.

Chapter 2

Hair simulation

2.0.1 Hair structure

In order to start our project, we need to select a structure to represent the hair as an elastic model. So we chose a mass spring representation for a strand of hair as we must simulate physics-based scene and take into account some forces applied on hair and collision avoidance [1].
As mentioned before, we have built the scalp for our head,then we have obtained the list of scalp's vertices and then fixed the hair on it as fixed constraints. Also, we used a real hair texture to enhance the simulation quality.

2.0.2 Force simulation

In this part, we are going to underline the forces applied on the hair since we are implementing a physics-based project.Therefore,every strand of hair will be affected by a set of forces such as :

- Wind force

- Gravity force

- Spring force

- Dumping force

2.0.3 Constraints

At first, when we have tried to simulate the hair, we have encountered some problems like the collision between the strands of hair and the head object.It was ugly and far from being real as we wanted.In order to fix this issue, we found a solution tested successfully. It is about creating virtual spheres placed in the center

of the head with convenient radius; they let us avoid any contact between hair and the scalp which make this simulation more realistic.

Conclusion

 This project was a real challenge since it is a direct application of our recent computer graphics knowledge. It was an opportunity to deal with a new library and use new few tools like Blender. We have encountered many problems like hair surface or collision that we found solutions for. The simulation's result is good and real and can be enhanced by some future ideas that can be applied. As a an example, we can implement a tool that can cut the hair as we want.

Bibliography and references

[1] ROHMER, D. Elastic models. `https://imagecomputing.net/damien.rohmer/teaching/inf585/lecture/17_cloth/17_cloth.pdf`. Accessed: 2023-03-23.