

# Visual Effects

submitted by

Ieva Kazlauskaite, Garoe Dorta-Perez, Richard  
Shaw

unit

Unit Leader: Dr Darren Cosker

University of Bath

Department of Computer Sciences

EngD in Digital Entertainment

May 2015

Signature of Author .....

Ieva Kazlauskaite, Garoe Dorta-Perez, Richard Shaw

# Chapter 1

## Introduction

*“Birds are the most accomplished aeronauts the world has ever seen. They fly high and low, at great speed, and very slowly. And always with extraordinary precision and control.” [?]*

## Chapter 2

# Previous Work

### 2.1 Data Capture

### 2.2 Sparse Reconstruction

### 2.3 Blendshape Optimisation

### 2.4 Skin Rendering

Rendering realistic skin is a challenging task. As social beings we interact with other individuals on a daily basis, which has made human perception quite sensitive to skin appearance, even more so with human faces. Skin is composed of several layers with different properties, to accurately simulate skin the light transport between these layers has to be simulated. The full effect of light scattering between two points on the surface can be modelled using a Bidirectional Surface-Scattering Distribution Function (BSSRDF).

Weyrich et al [WMP\*06] proposed a two-layer model for skin rendering, the outer layer simulates the air-oil interface and the inner layer models the subsurface scattering in the skin. The authors considered the scattering to be homogeneous, with this assumption they measured the skin BRDF of several subjects in a light dome, while the scattering was sampled at three points in the face with a custom made sensor. The BRDF data was fitted to a Blinn-Phong and a Torrance-Sparrow isotropic models, and the scattering was fitted with a single transport coefficient. Donner et al [DWd\*08] also proposed a two-layer model, however the authors

allow for the layers to be heterogeneous. With this addition they are able to introduce the effects of haemoglobin, veins and tattoos. Emotional induced haemoglobin variations have also been explored [JSB\*10]. The authors measured the haemoglobin distributions of several subjects in different poses, then a linear combination of the captured data would determine the final haemoglobin distribution for a new sequence. Recently, Iglesias et al [IGAJG15] introduced a five-layer model to handle skin ageing. Haemoglobin, collagen and fat changes with age are modelled using the different layers.

Normal maps are used to alter the normals of the scene objects during rendering. This technique is used to add geometric detail to an object at rendering time without actually changing the geometry. Normal maps for skin rendering are usually captured using expensive light domes with a number of synchronized cameras [GTB\*13, WMP\*06].

Another technique to increase the quality of a face render is to scale the resolution of the textures being used. Ashikhmin et al [Ash01] presented a method to generate new textures using a goal image by greedily extending existing patches whenever possible. Hertzmann et al [HJO\*01] extended Ashikhmin et al [Ash01] method by adding a second example image and using more complex distance metric to choose the next synthesized pixel. Graham et al [GTB\*13] applied Hertzmann et al [HJO\*01] example-based filter to generate bump maps with increased quality for skin rendering. An alternative approach using a dictionary of samples was presented by Jianchao et al [YWHM10]. This method is restricted to generating super-resolution images, however, the previous methods support a wide variety of filter effects. For an in depth analysis of super-resolution techniques, we refer the readers to Tian et al [TM11] survey.

## Chapter 3

# Methodology

### 3.1 Data Capture

### 3.2 Sparse Reconstruction

### 3.3 Blendshape Optimisation

### 3.4 Skin Rendering

Our objective in skin rendering is to generate a face that would be indistinguishable from a real one. To be more specific, we have taken a 3D scan of a subject and our aim is to improve the realism of it. For this task we will mainly look at the techniques presented by Hertzmann et al [HJO\*01] and Graham et al [GTB\*13].

Before we begin, let's explain the Image Analogies framework [HJO\*01] in more detail. Given three images  $A$ ,  $A'$  and  $B$ , where  $A$  is an unfiltered example,  $A'$  is a filtered example, and  $B$  is an input image, the algorithm will generate an output image  $B'$  such that  $B'$  relates in the same way to  $B$  as  $A'$  does to  $A$ , as shown in Figure 3-1. A k-d tree for an Approximate Neighbour Search is built using a feature vector from a neighbour pixel  $p$  in  $A$  and  $A'$ . The closest match for a neighbourhood in pixel  $q$  in  $B$  and  $B'$  is located in the tree. Following Ashikhmin et al [Ash01] method, a match that is coherent to what has been already synthesized is computed as well. These two candidates are weighted and the best one is chosen. The whole process is carried in a multiresolution pyramid, as shown in Figure 3-1, where  $l$  indicates the

current level, in essence what this means is that the neighbourhoods also include the previous level in the search.

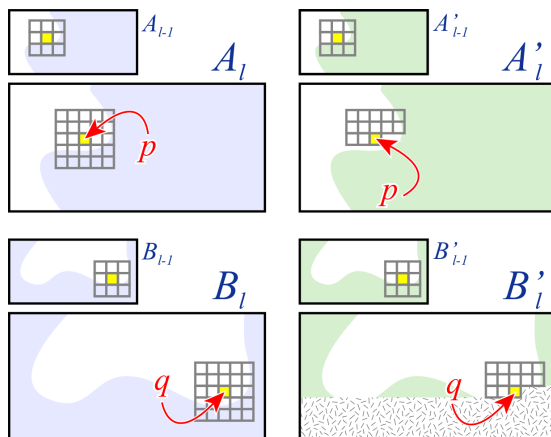


Figure 3-1: Neighbourhood matching for the Image Analogies framework, image taken from [Ash01].

A first approach we tried to use the Image Analogies filter to create increase quality textures. We found three implementations available [ImAa, ImAb, ImAc].

## **Chapter 4**

## **Results**

## **Chapter 5**

## **Conclusions**



# Bibliography

- [Ash01] ASHIKHMINSKY M.: Synthesizing natural textures. In *Proceedings of the 2001 Symposium on Interactive 3D Graphics* (New York, NY, USA, 2001), I3D '01, ACM, pp. 217–226.
- [DWd\*08] DONNER C., WEYRICH T., D'EON E., RAMAMOORTHY R., RUSINKIEWICZ S.: A layered, heterogeneous reflectance model for acquiring and rendering human skin. *ACM Trans. Graph.* 27, 5 (Dec. 2008), 140:1–140:12.
- [GTB\*13] GRAHAM P., TUNWATTANAPONG B., BUSCH J., YU X., JONES A., DEBEVEC P., GHOSH A.: Measurement-based synthesis of facial microgeometry. *Computer Graphics Forum* 32, 2pt3 (2013), 335–344.
- [HJO\*01] HERTZMANN A., JACOBS C. E., OLIVER N., CURLESS B., SALESIN D. H.: Image analogies. In *Proceedings of the 28th Annual Conference on Computer Graphics and Interactive Techniques* (New York, NY, USA, 2001), SIGGRAPH '01, ACM, pp. 327–340.
- [IGAJG15] IGLESIAS-GUITIAN J. A., ALIAGA C., JARABO A., GUTIERREZ D.: A biophysically-based model of the optical properties of skin aging. *Computer Graphics Forum (EUROGRAPHICS 2015) To Appear* (2015).
- [ImAa] Image analogies: C++ single threaded code. <http://vis.berkeley.edu/courses/cs294-69-fall1/wiki/index.php/FP-JeffDonahue>. Accessed: 2015-05-19.
- [ImAb] Image analogies: Cuda code. <https://sites.google.com/a/college.harvard.edu/yaoyu-imageanalogies/parallel>. Accessed: 2015-05-19.
- [ImAc] Image analogies: Hertzmann's code. <http://www.mrl.nyu.edu/projects/image-analogies/>. Accessed: 2015-05-19.

- [JSB\*10] JIMENEZ J., SCULLY T., BARBOSA N., DONNER C., ALVAREZ X., VIEIRA T., MATTS P., ORVALHO V., GUTIERREZ D., WEYRICH T.: A practical appearance model for dynamic facial color. In *ACM SIGGRAPH Asia 2010 Papers* (New York, NY, USA, 2010), SIGGRAPH ASIA '10, ACM, pp. 141:1–141:10.
- [TM11] TIAN J., MA K.-K.: A survey on super-resolution imaging. *Signal, Image and Video Processing* 5, 3 (2011), 329–342.
- [WMP\*06] WEYRICH T., MATUSIK W., PFISTER H., BICKEL B., DONNER C., TU C., McANDLESS J., LEE J., NGAN A., JENSEN H. W., GROSS M.: Analysis of human faces using a measurement-based skin reflectance model. In *ACM SIGGRAPH 2006 Papers* (New York, NY, USA, 2006), SIGGRAPH '06, ACM, pp. 1013–1024.
- [YWHM10] YANG J., WRIGHT J., HUANG T., MA Y.: Image super-resolution via sparse representation. *Image Processing, IEEE Transactions on* 19, 11 (Nov 2010), 2861–2873.