3D Characters for Virtual Reality

(Half day tutorial)

keywords: character animation, facial animation, motion capture, virtual reality, animation pipeline, look-a-like avatar

Presenter(s) details:

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Overview

Creating a 3D avatar that looks like a specific person is time-consuming, requires expert artists, expensive equipment and a complex pipeline. In this tutorial we explain the different stages of a traditional character animation pipeline: modeling, rigging and animation. But, most important we describe how each of this stages bind together and which are the challenges developers face today at each stage. Our ultimate goal is to explain step-by-step the creation of a unified facial animation pipeline. We build the tutorial over our experience on what worked, what didn't work, why we did what we did and how we are planning to improve in the future. Given the popularity of Virtual Reality since the launching of Oculus Rift, we also describe how a traditional animation pipeline can be applied in Virtual Reality, it's challenges, limitations and potential. Throughout the tutorial we introduce the theoretical background for character animation and present the current state of the art in this field. Last, we aim to trigger a discussion to analyse different lines of research that emerge by bringing together traditional character animation and Virtual Reality.

Main take away for the audience

Learn the process of character animation and how to build your own animation pipeline using different softwares, plug-ins, engines, algorithms and more.

Potential target audience

(Level: beginner)
Researchers and developers on the field of computer graphics, computer vision and human computer interaction are the main target audience. This tutorial is an introduction to character animation applied to virtual reality. Math and programming knowledge are beneficial, but not mandatory. Starting PhD students will found this tutorial extremely useful as it will help them set the basis and have a full overview to create 3D characters.

Dissemination of Materials
We will set up a tutorial web page with the material presented at the conference. The web page will be available after the conference.

Outline

1. Introduction and history of character animation
2. Artistic and technical challenges
3. Traditional animation pipeline: modeling, rigging and animation
4. The design of a new and experimental animation pipeline
5. The look-a-like avatar pipeline description
6. 3D characters for virtual reality.
7. How we build the application “the Virtual Mirror“
8. Discussion and conclusion: an industry perspective

Sections 1 through 4 are based on the vast experience of Veronica Orvalho and John P. Lewis. We will based the tutorial on current state of the art reference, but in particular in the articles published by Verónica Orvalho and John P. Lewis.

http://www.portointeractivecenter.org/site/?page_id=519
http://www.scribblethink.org/

As an example see the STAR articles:
A Facial Rigging Survey
Veronica Orvalho, Pedro Bastos, Bruno Oliveira and Xenxo Alvarez
Proceedings of the *33rd Annual Conference of the European Association for Computer Graphics* – ***EUROGRAPHICS 2012***, Vol. 32, Pp. 10 – 32 | Cagliari, Italy | May 2012

Practice and Theory of Blendshape Facial Model
Lewis, J. P.; Anjyo, Ken; Rhee, Taehyun; Zhang, Mengjie; Pighin, Fred;

Deng, Zhigang
Proceedings of the *33rd Annual Conference of the European Association for Computer Graphics* – ***EUROGRAPHICS* 2014**

For **section 5,** see a sample of the content in the PDF presentation sent through wetransfer to the chairs of the tutorials

Section 6. 3D characters for virtual reality.

In this section, we describe a framework for VR facial MoCap and animation. We start by presenting the current literature regarding VR facial MoCap tracking and explain the paradigms raised by the occlusions created in faces by VR headsets. Then, we propose new methods to solve the aforementioned challenges.

State of the art (just a glimps)

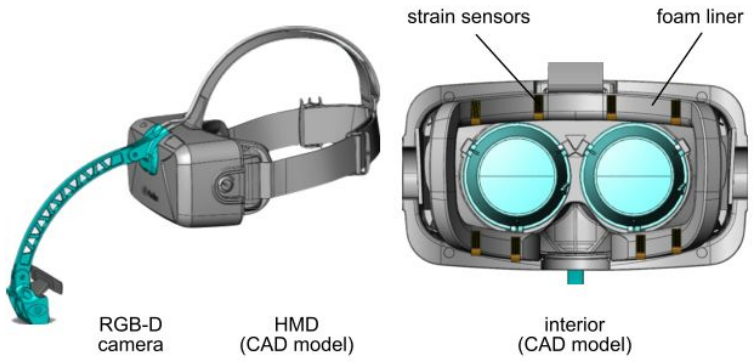

Figure 1 - VR hardware-based setup proposed by Li et al [LTO15] to overcome partial occlusions issue.

There are already several solutions for markerless real-time automatic facial tracking. Although, with the arise of VR commercial approaches of consumer-level HMD's (Oculus VR 2014), a new issue was raised: the real-time automatic tracking of faces partially occluded by hardware (i.e. persistent partial occlusions of face) [Sla14]. Current MoCap approaches do not support persistent partial occlusions presenting error accumulation [CHZ14].Therefore, due to the absence of VR devices in mass-market, the occlusion issue remained unsolved. Only in 2015, Hao Li et al. [LTO15] highlighted this problem and proposed a hardware based tracking solution. Li et al [LTO15] uses an RGB-D camera combined with eight ultra-thin strain gauges (flexible metal foil sensors) placed on the foam liner for surface strain measurements to track upper face

movements, occluded by the HMD (Figure 1). Besides the complexity of usage and complex calibration with FACS [EF78]., Li et al's [LTO15] work pinpointed drifts and accuracy decrease due to variations in pressure distribution from HMD placement and head orientation. As a consequence, the HMD head positioning influences eyebrows' movement detection.

Example of the content that will be presented at the tutorial.

(We expect to expand in detail each module of the framework and provide written material to the attendeds)

As explained in the previous section, the partial occlusion of the user's face during the usage of VR headsets difficult the MoCap tracking through literature approaches. The persistent partial occlusion raises two problems: (i) the tracking of features in the bottom part of the face and (ii) estimation of facial movements in the upper part.

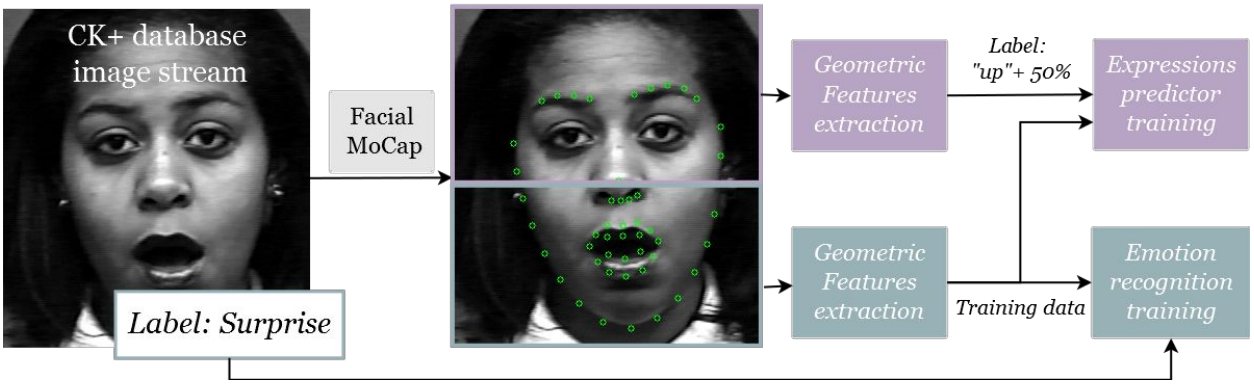

Figure 2 - Machine learning methods to predict facial movements occluded by VR headsets.

We start by proposing a capture setup and, then, a method to solve (i). The occlusions' solution will explain how we can make generic MoCap systems compatible with persistent partial occlusions. Then, by applying the occlusion method, we are able to track properly the bottom face's features and use them to generate machine learning methods that predict upper face facial movements and solve (ii) (see Figure 2). Both solutions introduced in this tutorial point out a hardware-free direction in the VR MoCap tracker's research that remains unexplored.

VR MoCap references

[CHZ14] Chen Cao, Qiming Hou, and Kun Zhou. Displaced dynamic expression regression for real-time facial tracking and animation. ACM Transactions on Graphics (TOG), 33(4):43, 2014.

[EF78] P. Ekman and W. Friesen. Facial Action Coding System: A Technique for the Measurement of Facial Movement. Consulting Psychologists Press, Palo Alto, 1978.
[LTO15] Hao Li, Laura Trutoiu, Kyle Olszewski, Lingyu Wei, Tristan Trutna,Pei-Lun Hsieh, Aaron Nicholls, and Chongyang Ma. Facial performance sensing head-mounted display. ACM Transactions on Graphics (Proceedings SIGGRAPH 2015), 34(4), July 2015.
[Sla14] Mel Slater. Grand challenges in virtual environments. Frontiers in Robotics and AI, 1:3, 2014.

Section 7. How we build the application "the Virtual Mirror"

The image bellow shows the virtual mirror application we have developed. During this

tutorial we will explain step by step how we created the application, including the algorithms that we have implemented and software and plug-ins that we have used and developed.

Verónica Orvalho

Verónica Costa Orvalho holds a Ph. D in Software Development (Computer Graphics) from Universitat Politécnica de Catalunya (2007), where her research centred on "Facial Animation for CG Films and Videogames". She has been working in IT companies for the past 15 years, such as IBM and Ericsson, and Film companies, including Patagonik Film Argentina. She has given many workshops and has international publications related to game design and character animation in conferences such as SIGGRAPH. She has received international awards for several projects: "Photorealistic facial animation and recognition", "Face Puppet" and "Face In Motion". She has received the 2010 IBM Scientific Award for her work of facial rig retargeting. Now, she is a full time professor of Porto University. In 2010 she founded Porto Interactive Center (www.portointeractivecenter.org) at Porto University, which is the host of several International and national projects as project coordinator or participant. She works close with film and game companies and participated in several productions like Fable 2, The Simpsons Ride. She has current and past close collaboration with film and game companies such as: Blur Studios, Electronic Arts and Microsoft. Her main research interests are in developing new methods related to motion capture, geometric modeling and deformation, facial emotion synthesis and analysis, real time animation for virtual environments and the study of intelligent avatars.

Catarina Runa Miranda

Catarina Runa Miranda is a Computer Sciences' PhD candidate at PIC – FCUP and IT Porto. Holding a Master degree in Biomedical engineering since 2011, she focuses her studies in the research and deployment of real-time motion capture facial animation methodologies. In the past, she worked in companies like Siemens S.A. and Microsoft and was consultant of technology transfer at University of Porto Innovation. Currently, her pursuit is to deploy on-the-fly motion capture tracking systems and facial expressions recognition using machine learning algorithms for Virtual Reality.

John P. Lewis

John's research area is mathematical algorithms for computer graphics. In the past he has worked in academic and industrial research labs, as well as in the film industry at Industrial Light and Magic, Disney, and elsewhere. He has published in journals and conferences including SIGGRAPH, Transactions on Graphics, and others, and has credits on a couple films including *Avatar*, *The Matrix* sequels, and *Forrest Gump*. Several of his algorithms have been adopted in the film and games industries and incorporated in commercial graphics software packages. John's current research interests include computer vision and statistical learning applied to graphics, and design

and composition from a computational point of view. John is part-time and also works as a research contractor at Weta Digital.