PhD Proposal

Location: Bordeaux (France), Inria, team manao (https://www.inria.fr/, http://manao.inria.fr/)
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Real-time Character Skin Deformations with Rich Appearance

General context:

This PhD proposal takes place in the context of the Fold-Dyn ANR research project, which is a collaboration between IRIT (University of Toulouse), Inria Grenoble, Inria Bordeaux and industrial partners such as TemTo and Mercenaries Engineering. This project aims at studying new theoretical approaches for the effective generation of virtual characters deformations, when they are animated. These deformations are two-folds: character skin deformations (skinning) and garment simulations. In this thesis, we will focus on the former ones with an emphasis on real-time performance so that interactive feedback to the artist can be guaranteed when designing the animation of a character for production movies, or to be integrated within interactive games or virtual reality applications. When focusing on controlling the deformations of a skin character in an interactive session, a first solution is produced using linear blending or dual quaternions [1,2,3] and the artist has to produce a long and difficult work for manually adjusting the skin aspect on different character poses [4]. Prior to the Fold-Dyn project, we developed a more advanced solution called "Implicit Skinning" that tries to produce plausible deformations including volume preservation, skin elasticity, and eventually contact at the level of joints [5,6]. This technique is demonstrated in the following videos:

- http://www.youtube.com/watch?v=RHySGIqEgyk
- https://www.youtube.com/watch?v=GyOwwNvHA1w

Goal:

The general objective of this thesis is to investigate some of the limitations of skinning techniques as well as to complement them with a more detailed and plausible appearance. Depending on the candidate skills, motivations and our progress, we will focus on some of the following sub-challenges:

- To efficiently deform a character with skinning techniques, the skin mesh must first be appropriately rigged. Even though implicit skinning reduces the amount of effort required for this preparation, it still relies on the availability of a mesh skeleton. The goal here would thus be to extend the implicit skinning approach to get rid of the need of a rigging pass and thus to enable the direct manipulation of character meshes while preserving plausible deformations.
- Whereas implicit skinning performs well at handling low frequency deformations, details are simply handled as a displacement with respect to a low frequency surface. For large deformations, such details might not be appropriately deformed and we will seek for a better embedding of them, possibly compatible with hardware tessellation to achieve real-time rendering of highly detailed and animated characters [7].

- Finally, when the skin deforms, the dilation/contraction of the meso-geometry (details) and micro-structure (material) might significantly change the reflectance properties, and more generally appearance, of the surface once integrated within realistic illumination models. For instance, skin folds (including wrinkles) might appear or disappear during the deformation, some parts might change from red to white and vice-versa because of the variation of blood concentration, etc. We thus aim at complementing low-scale implicit skinning deformations with such high-frequency details and effects. To this end, we will investigate a combination of procedural approaches with multi-resolution appearance models [7,8].

Thorough the thesis, we will strive to develop techniques that provide interactive feedbacks to the user with parameters that can be intuitively controlled. In general, we are not seeking for physical simulations, but rather for plausible results that are produced quickly, intuitively and with real-time feedbacks. This is a challenging line of research tackling important problems from which artists and the 3D production industry in general have many expectations.

Required Knowledge and background:

Ideally, candidates should have advanced skills in C++ programming, computer graphics, linear algebra and English language.

References:

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