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Interfaces for human-centered production and use of computer graphics assets

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Abstract

Today, computer graphics can be regarded as a core enabling technology, supporting the development of an incredible number of services and applications. As a matter of example, computer graphics can be leveraged as a powerful representation instrument with information visualization, it can enable the creation of non-existent scenarios with virtual reality, and it can even enhance the real world by adding synthetic assets to it with augmented and mixed reality.

Domains that could benefit from this technology are expanding every day, covering traditional areas like video-game and movie production, but also getting ever more commonplace in other scenarios, including manufacturing, education and training, medical practice, cultural heritage and even sports, to name a few.

Despite its positive effects, the growing diffusion of computer graphics is also posing significant challenges to researchers and developers. Challenges concern the whole computer graphics pipeline, from content creation to utilization. The rise of challenges is also due to the fact that the set of users involved in the above processes is getting ever larger, and their skill level is becoming ever more heterogeneous. To make an example, the production of a blockbuster movie could involve hundreds to thousands of actors, designers, programmers, directors, etc., each with his or her own attitudes to technology, in general, and to computer graphics and human-machine interaction, in particular.

Based on the above considerations, the main objective of the research activities carried out during the Ph.D. was to improve the effectiveness of existing methods, tools and paradigms for the production and use of computer graphics contents, by leveraging, among others, recent advances in the fields of multi-modal interaction and intelligent computing.

In the dissertation, the discussion regarding researches performed in the context of graphics assets production and use has been organized as follows.

For what it concerns aspects related to the first dimension, i.e., assets production, activities focused on the computer animation field (Chapter 2 and Chapter 3), since computer-generated animations are massively used in a growing number of application domains ranging from movie and video-game produc-

tion, architecture, industrial design, product advertising, etc. Specific stages constituting the pipeline generally adopted for virtual character animation were considered, by studying the impact that alternative interfaces and technologies can have on the execution of common animation tasks. The broad domain related to the generation of 3D contents was studied in depth (Chapter 4), by considering also the possibility to take advantage of new interactive tools based on Virtual Reality and Augmented Reality technologies as well as of intelligent computing-based approaches for developing such contents.

Proceeding forward on the computer graphics pipeline and focusing on the second dimension of interest, i.e., assets use, the need for new tools capable to make the generated contents accessible through so-called interactive applications was considered (Chapter 5). Lastly, specific use cases for the exploitation of produced contents were analyzed (Chapter 6). More specifically, aspects related to interaction with machines were studied with the aim to find ways to provide users with improved haptic and visual feedback on aspects concerning the operations being performed; contexts considered encompassed virtual environment-based control, sport training and robot teams coordination.