Virtualization Gate

Benjamin Petit [*]
INRIA

Jean-Denis Lesage [†]
Grenoble Universities

Edmond Boyer [‡]
Grenoble Universities

Bruno Raffin [§]
INRIA

The virtual reality community developed solutions for immersion based on advanced display technologies, mainly head-mounted displays (HMDs) and immersive multi-projector environments like Caves. Though these environments provide an impressive sense of immersion, users are usually limited in the way they can interact with virtual objects. Their influence on the 3D world, including users appearance, is very limited, impairing the immersion experience. Limitations come from the ability to perceive data from the users. Usually in 3D environments, interactions rely on a 3D tracker providing the position, velocity and identification of a limited set of markers the user is equipped with. Avatars can be used to enforce the sense of presence, but they lack to provide detailed information about the actual user body position or visual appearance.

Multiple cameras can be used to compute, in real-time, a 3D model of the user. It enables to get geometric and photometric data about the user. The challenge is to compute a good quality model at a high refresh rate. Some existing works use octree-based 3D modeling algorithms. The geometrical data can be precise, but the visual appearance is not satisfactory due to the difficulty to accurately texture the octree model using the photometric data provided by the cameras. Other approaches focus on the visual appearance of the user for telepresence. They rely on point cloud 3D modeling algorithms. The visual quality is significantly improved.

Our contribution is to associate multi-camera 3D modeling, physical simulation and tracked HMD for a full-body immersion and presence in virtual worlds. 3D modeling is based on the EPHV algorithm, that provides an exact shape with respect to input data. The geometry enables to compute full-body collisions with virtual objects animated by a physical simulation. Since the algorithm is exact, it allows for a consistent texture mapping hence yielding qualitative models. This full-body representation can thus be rendered on a distant site for telepresence. It can also be rendered into a HMD. The user sees his 3D model superposed with his real body occluded by the HMD. Because the displays are hold in front of the user's eyes, the image projection is not impaired by elements of the real world. With a fixed screen, even in an immersive Cave like configuration, the user would not be able to see a virtual object in his hand palm as his hand would occlude the light emitted by the displays. With our approach the user sees the 3D model of his hand and the virtual object correctly positioned in his palm. It enables a first-person viewing and occlusion-free co-located interactions.

Our set-up[1] is built around several components. The video acquisition, background subtraction, segmentation, texture extraction and 3D modeling steps are distributed on a PC cluster to enable a real-time execution (about 20 times per second). The SOFA[2] framework runs the physical simulation. The 3D model is injected into the simulation that manages it as a solid object not subject to external forces. The user wears a HMD tracked with an infrared positioning system. An off-line calibration process enables to align the cameras, the tracker and the HMD within the real world. The 3D model is textured by mixing the photometric data extracted from the closest cameras to the user's viewpoint. Notice that the 3D modeling system makes no assumption about the scene observed. One or several persons can stand in the acquisition space. It only affects the model quality and the computation time. The application is developed on top of the FlowVR[3] library, a middleware dedicated to high performance interactive applications. It enforces a modular programming though a hierarchical component model that leverages software engineering issues while enabling efficient executions on parallel architectures.

We presented at the 2007 Siggraph Emerging Technologies the Grimage platform for markerless 3D modeling. Images were rendered on a fixed screen positioned behind the acquisition space, providing little immersion and only third-person interactions. The acquisition space was also notably smaller enabling only user's hands modeling.

Acknowledgements We would like to thank the following persons for their fruitful contributions to the project : Laurence Boissieux, INRIA, Thomas Dupeux, INRIA, Nicolas Turro,INRIA, Hervé Mathieu, INRIA, , Franois Faure, Grenoble Universities, Florent Falipou, INRIA, Michaël Adam, INRIA, Clément Ménier, 4DView Solutions, Florian Geffray, 4DView Solutions.

This work was partly funded by Agence Nationale de la Recherche, contract ANR-06-MDCA-003.

[*]e-mail: benjamin.petit@inria.fr
[†]e-mail: jean-denis.lesage@imag.fr
[‡]e-mail: edmond.boyer@inrialpes.fr
[§]e-mail: bruno.raffin@imag.fr

[1]http://grimage.inrialpes.fr
[2]http://www.sofa-framework.org/
[3]http://flowvr.sf.net/

SIGGRAPH 2009, New Orleans, Louisiana, August 3–7, 2009.
ISBN 978-1-60558-726-4/09/0008