Interactive Virtual Set Applications for Post Production

Jens Herder*, Wolfgang Vonolfen†, Arnfried Griesert†,
Stefan Heuer*, Ansgar Hoffmann*, and Bernd Höppner‡

*Virtual Sets and Virtual Environments Laboratory, Department of Media
FH Duesseldorf, University of Applied Sciences
Josef-Gockeln-Str. 9, D-40474 Duesseldorf, Germany
voice/fax: [+49](211) 4351-800/803, email: `herder@fh-duesseldorf.de`
www: `vsvr.medien.fh-duesseldorf.de`

†Competence Center ITV, Fraunhofer Institute for Media Communication
Schloss Birlinghoven, D-53754 Sankt Augustin, Germany
voice/fax: [+49](2241) 14-2013/2449, email: `{vonolfen,griesert}@imk.fhg.de`
www: `www.imk.fhg.de`

‡archemedia
Fichtenstrasse 75, D-40233 Duesseldorf, Germany
email: `hoeppner@archemedia.de`

Abstract

Virtual set environments for broadcasting become more sophisticated as well as the visual quality improves. Realtime interaction and production-specific visualization implemented through plugin mechanism enhance the existing systems like the 3DK.

This work presents the integration of the Intersense IS-900 SCT camera tracking and 3D interaction into the 3DK virtual studio environment. The main goal of this work is the design of a virtual studio environment for post productions, which includes video output as well as media streaming formats such as MPEG-4. The systems allows high quality offline rendering during post production and 3D interaction by the moderator during the recording.

Keywords: interaction, tracking, virtual set environments, virtual studios, post production, MPEG-4

1 Introduction

The application of computer graphics is increasingly important in today's TV and video productions. The reason for this development is on one hand due to the rapid development of graphics hardware, and on the other hand it is a result of the implementation of photorealistic rendering techniques for offline use. Highly qualitative 3D graphics can be created on standard PCs with the help of the appropriate software. The application of these techniques offers the producer the possibility to represent any content graphically. One necessary condition for the integration of real and computer-generated images in a video production is the coherence between the optical perspectives of both images. Virtual studios can accomplish this task even with a moving camera and with variable optical settings.

To save expenses when purchasing a virtual studio and to increase the quality of the computer graphics the normal way is to recur to systems which support an offline rendering of the synthetic part of the image after the recording of the real image. Thereby the level of the integration of real and virtual images is raised by letting the actor interact with computer-generated graphical objects during the production. Furthermore the opportunity to interact offers advantages for the preparation of these productions. For the purpose of setting up an interactive virtual studio for productions with post processing, this paper concentrates on the usage of the camera tracking system IS-900 SCT [WR00] from Intersense (see Figure 1) as well as on the virtual studio software 3DK which was developed at the Fraunhofer Institute for Media Communication (IMK).

The concept of interaction makes it possible to ani-

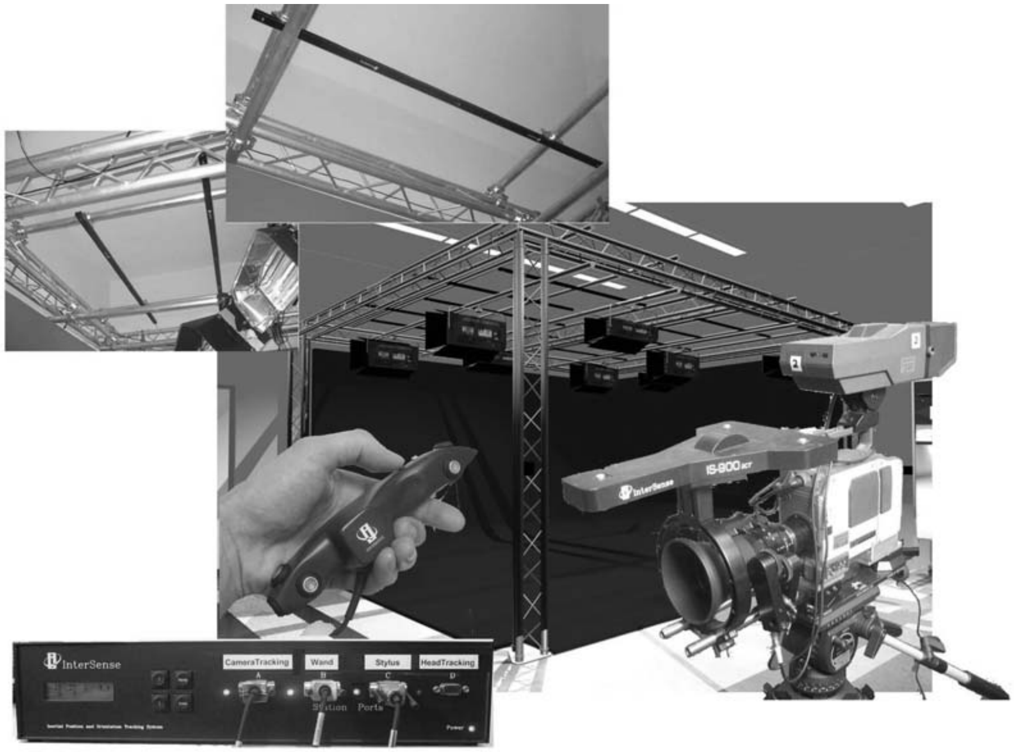

Figure 1: Camera including tracking and 3D interaction device (stylus) in our interactive virtual studio environment.

mate selected virtual objects with a 3D input device of the IS-900 SCT by rotoscoping. Because of the direct coupling of position and orientation of virtual objects to those of the 3D input device a seemingly natural animation is achieved, e.g. when the actor moves his hand. In addition, the possibility to interact offers a help concerning the three-dimensional arrangement of the real and virtual objects during the preparation of the production.

The interaction control as well as multiple interfaces of a virtual set environment have been discussed and classified in [Her01]. An overview about virtual set environments and an introduction to the virtual studio software 3DK, which were used in this project can be found in [GAB$^+$98]. Figure 2 shows the layout of the interactive virtual studio environment for post production.

The broadcasting and production requirements for virtual set environment as well as a brief review of similar projects are given in Section 2. How the interaction of an actor in a studio can be integrated into a production and what additional steps are necessary are presented in Section 3. The same section contains also a workflow for achieving an interactive media product (as MPEG-4 based on interaction during the production process. Interaction and working with the system is described in Section 4. The implementation itself and the system design is outlined in Section 5. Section 6 reports about a trial production. Finally, we discuss our experiences with the system and give future directions in Section 7.

2 Production requirements

The requirements for virtual studios usually differ from those for the post prodution. While post production sets focus mainly on high quality rendering using very complex scenes with many polygones and sophisticated animation scenarios, virtual studios require a constant real-time frame rate of 50 half images per second for the PAL video format (60 for NTSC) and accurate image quality. [Mos00] This is because in virtual studios, the composition of real objects and computer generated graphics is supposed to take place immediately during the production of the real shots thus making post production tasks superflous. As a consequence, virtual studios are mainly used for productions of short term contents and the data format conversion

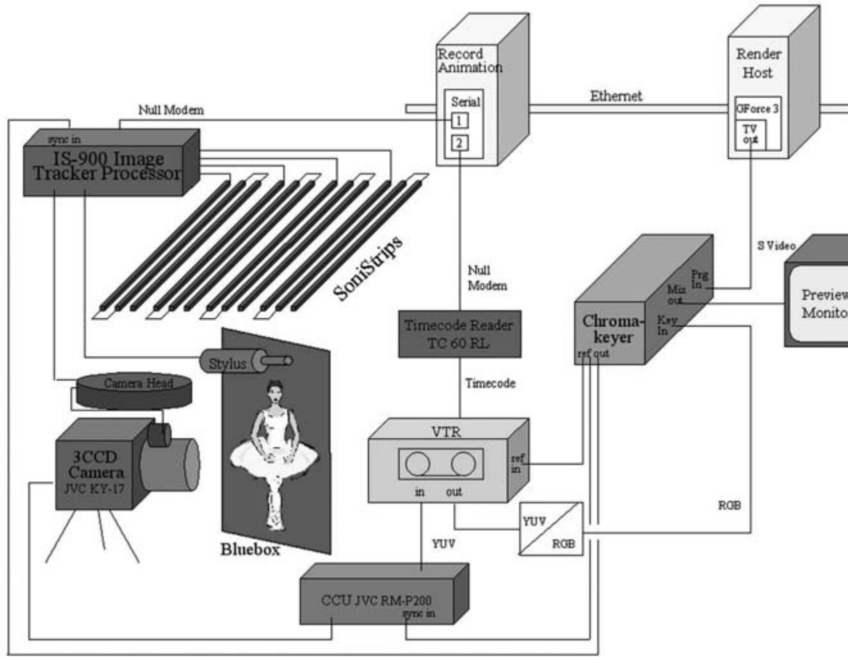

Figure 2: Layout of the interactive virtual studio environment for post production

focusses on the direction from 3D set modelling software to virtual studio systems but not vise versa.

In our approach, we need the opposite direction too, because during real shots all set changes and activities should be recorded as a guideline for the post production. Especially if interactive scenarios are planed, more data than only video and camera tracking must be provided. On the other hand, the strong restrictions for realtime virtual studio productions can be loosened because the computer graphics rendered during the real shots is not taken as a source for further editing. Hence, our production requirements differ to those of usual virtual studio productions or pure post production projects. For our real shots (as opposed to conventional virtual studio productions) we need:

- reduced quality graphics for the preview of the mixed image
- reduced compositing facilities and recording of only the real shots
- additional interaction devices such as a 3D stilus
- enhanced plug-ins for the interaction visualisation in the virtual studio graphics
- realtime recording facilities of camera tracking data, interaction input devices and animation triggers
- a tracking system that is able to track camera movements as well as input device actions
- time code or other synchronisation input for the recorded data
- abilities to output graphic scene contents for the post production
- probably advanced feedback technologies of the virtual set for the actors in the blue room such as in [GKL+03]

Furthermore, there is the need to provide the additionally recorded camera and interaction data for the post production. If the goal is to create high-quality video and audio for contemporary contents (e.g. cinema productions), there is a large number of sophisticated graphics and audio editing tools available. However, since interaction between real and virtual objects is normally not recorded so far, this must be up to now done mostly by hand. In our case, such data are available and there is only the need for some additional routines, for example:

- to convert recorded camera tracking data into virtual camera movements of the modelling software

- to convert recorded interaction data into object movements, animation control, etc.
- to convert virtual studio scene dumps to respective changes of the high quality graphics of the modelling software
- or to assemble the recorded data according to cut lists of the real camera shots

Producing MPEG-4 contents probably needs some more complex conversion routines, because depending on the purpose and the MPEG-4 scene assembly the data creation my vary. If 3D objects, for instance, are supposed to be part of the target scene the production output must create some 3D data whereas the creation of 2D video shapes probably implies some pre-rendering of the virtual scene. In the same way, interactions during the production of the real shots may lead to a creation of Java scripts attached to some MPEG-4 scene objects or just to static object animations triggered by events. To achieve a flexible solution for the virtual studio preview system, a plug-in technology for synchronized data output during the real shots with a flexible interface to access and manipulate scene objects or animations is necessary.

3 Workflow

In order to produce any content in a virtual studio for post production, the system supports the recording of the video material and the recording of all animation data, e.g. animation of virtual objects and the animation of the virtual camera. Video and animation data has to be recorded with time code data to address real and virtual images in the compositing process. In our system all animation data is recorded into one data file. The virtual background is rendered by using this data with an offline rendering tool. For this porpose the animation data has to be converted into a file format which is supported by the offline render software. The virtual studio sofware 3DK supports conversion of animation data into different file formats which are used by the most common rendering tools. Before rendering, the modelling and the animation is enhanced while using a billboard with the video inside of the modelling software (e.g., Maya or 3d studio max) for previewing. After rendering of the virtual set offline, a compositing tool can be used to isolate the foreground of the bluebox recording and to put the virtual and real part of the scene together.

In order to convert the full production to MPEG-4 file format, 3DK's MPEG-4 plugin can be used to export the static part of the scene description to a BIFS[1] text file. Alternatively, especially when preview and final rendering model are different, it is most convenient to retrieve a basic scene description from the modelling software by exporting the scene to the VRML format. The text file is then enhanced by additional nodes to represent the whole scene that is produced in the virtual studio, including animated objects and interactivity. In contrast to conventional television broadcast, with a MPEG-4 based, object-oriented transmission the foreground and background image produced in the virtual studio have to be composited in the player. An advantageous way to achieve this is to encode the foreground image as an arbitrarily shaped, i.e. a non-rectangular video object, being shaped according to the key mask retrieved from the chromakeyer used in the virtual studio. This video object is positioned in the scene as a flat geometry. The software MPEG-4 player developed by the IAVAS project [iav04] is capable of playing back such video objects. To have a congruent visual impression the virtual viewpoint's parameters have to be updated with the tracking data from the real camera at a constant frame rate of 25 Hz. The tracking data have to be preprocessed before they can be appended to the scene description as BIFS updates: To avoid a flickering presentation the noisy data have to be smoothed; redundant data records are eliminated and the orientation data are converted from euler-angles to quaternions [Sho94]. Image and movie textures as well as audio are encoded with standard MPEG-4 tools. For local interactivity the MPEG-4 standard provides a set of BIFS nodes that allow for user input and conditional execution of BIFS commands. Depending on the player's capabilities an interactive experience for the user can easily be created with these nodes. Once the scene description is prepared, it is compiled to a `.mp4` file using a BIFS encoder like `mp4tool` or `mp4box` [Duf03, gpa04].

4 Interaction

While our previous prototype used a standard PC keyboard for interaction control of terrain visualation as part of weather report programs [GWH03], devices like a stylus (see also Figure 1) had become a sophisticated natural input device for a moderator. The con-

[1] Binary Format for Scenes

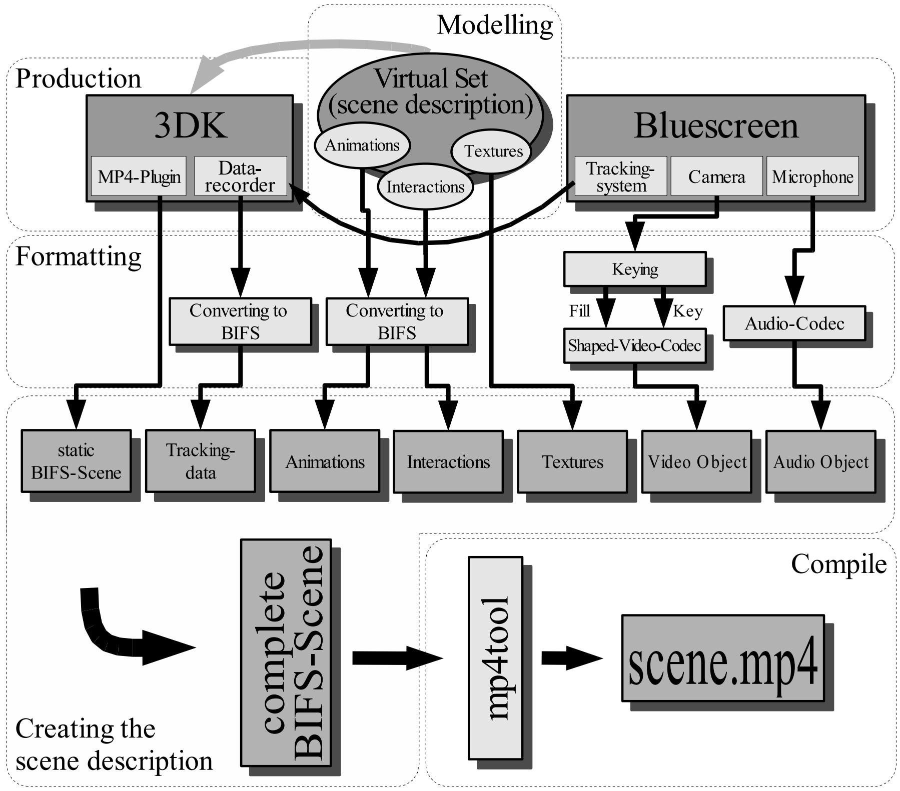

Figure 3: Workflow for converting a production in a virtual studio environment into a `.mp4-file`.

trol moves from behind the scene to the front of the camera. So the moderator can live interact with the information shown for the viewers.

In a virtual studio interaction with the virtual set always contains animation. In order to achieve an interaction with any virtual object this object has to be animated by modifying its position, orientation, dimension, shape or color according to the process of interaction. As shown in [Tha92] different user interfaces are used to support different interaction metaphors to animate virtual objects.

In the process of production and broadcasting the content which was produced in such an interactive virtual studio for post production, there are three possible types of actions to animate virtual set objects. On the one hand there is the operator in the virtual studio who can manipulate any parameter of the scene graph during the production. On the other hand the presenter or actor of the scene is able to interact with the set by using special input device. Interactive virtual studios for post production must record this animation data of virtual objects and must support a realtime preview of the scene which accounts for the interaction and gives a visual feedback to the actors. The third kind of action is triggered by the broadcast audience itself. The delivered content can be locally manipulated by the audience, if an interactive TV format is used in the broadcasting process [Von01].

5 Implementation and system design

The virtual studio software 3DK, developed at the Fraunhofer Insitute for Media Communication, is used for preview rendering and production control. The intersense IS-900 SCT driver was integrated by the plugin interface directly into the scenegraph for the virtual set. Stylus and user control is managed by the user interface that controls the rendering engines over IP network.

6 Test Production

For evaluation, test, and demonstration, we produced a short science-fiction scene in our virtual studio. In this production the actor uses a 3D device (stylus) to control/animate a tractor ray. The realtime preview of the preliminary scene accounted for the animation of the virtual ray in Figure 4 and is used to judge the credibility of the output. In the offline rendering we coupled the animation of a space ship with one end of the animated tractor ray to achive an animation of the space ship according to the movement of the tractor ray themed the movement of the 3D interaction device.

Figure 4: Realtime preview of a science fiction scene: The actor animates a tractor ray with a 3D interaction device.

7 Conclusion and future trends

Realtime interaction in live virtual studio production changes the way how data can be presented. Up-to-date visualization of complex data sets with direct interaction control is another step forward in the broadcasting business. In our virtual studio installation we have made the first steps for the integration of interaction input devices and the recording of additional data for typical post production scenarios. From the practical point of view, there is mainly the need of approrpiate conversion and integration routines for existing post production tools. In this case, interactive virtual set applications can facilitate the interaction of real and virtual objects.

Even for future data formats such as MPEG-4 the creation of additional data during the real shots improves the post production work. However, adopting virtual studio systems and integrating interaction information to such data formats needs more developing efforts.

Using such a system also implies a change in the workflow, because there is a bigger focus on interaction and respective meta data handling. On the other hand, this leads to a higher merge of real and virtual scene part interplay.

Further research can be investigated for more sophisticated interactive scenarios such as a live production for a remote interaction with the TV viewer. In this case, reliability of the production system becomes more important again. Another direction for usage of the interactive virtual set applications could be the creation of (cross-media) content such as audio/video broadcast together with internet presence. Here, an implementation of a multiple content creation for the various formats might become interesting.

8 Acknowledgments

This work were performed in the framework of a collaboration aggrement of the Fraunhofer Institute of Media Communication and the FH Düsseldorf, University of Applied Sciences, fostering the development of virtual studio technology with joint projects and providing an educational environment. We would like to thank the IAVAS team for providing us with the I3D player[2], which was essential for the MPEG-4 related work of our project.

References

[Duf03] Claude Dufourd, *École nationale supérieure des télécommunications*, `http://www.comelec.enst.fr/~dufourd/mpeg-4/`, October 2003, Claude Dufourd's MPEG-4 pages at ENST.

[GAB+98] Simon Gibbs, Costas Arapis, Christian Breiteneder, Valio Lalioti, Sina Mostafawy, and Josef Speier, *Virtual studios: An overview*, IEEE Multimedia **5** (1998), no. 1, 18–35.

[GKL+03] O. Grau, R. Koch, F. Lavagetto, M. Milne, E. Murphy, M. Price, O. Razzoli, A. Sarti, L. Spallarossa, S. Tubaro, and J. Woetzel, *New production tools for the planning and the on-set visualization of virtual and real scenes*, September 2003.

[2] `http://www.iavas.de/`

[gpa04] *GPAC Project on Advanced Content*, `http://gpac.sourceforge.net`, June 2004, OpenSource project, developing the OSMO4- MPEG-4 player and a toolset including the BIFS-Encoder MP4Box.

[GWH03] Arnfried Griesert, Oliver Walczak, and Jens Herder, *Interactive realtime terrain visualization for virtual set applications*, Journal of the 3D-Forum Society, Japan **17** (2003), no. 4, 20–26, ISSN 1342-2189.

[Her01] Jens Herder, *Interactive content creation with virtual set environments*, Journal of the 3D-Forum Society, Japan **15** (2001), no. 4, 53–56.

[iav04] *IAVAS*, `http://www.iavas.de/`, June 2004, Interactive AudioVisual Application Systems, home of the I3D player.

[Mos00] Moshe Moshkovitz, *The Virtual Studio Technologie and Techniques*, Focal Press, Butterworth-Heineman, 225 Wildwood Avenue Woburn, MA 01801-2041, 2000, ISBN 0-240-80425-2.

[Sho94] Ken Shoemake, *Graphics Gems IV*, ch. Euler Angle Conversion, pp. 222–229, Academic Press Professional, Boston, 1994, ISBN 0-12-336155-9.

[Tha92] Daniel Thalmann, *Using Virtual Reality Techniques in the Animation Process*, International Conference ”Virtual Reality Systems”, School of Oriental Studies University of London, May 1992.

[Von01] Wolfgang Vonolfen, *Using Virtual Studios for Interactive Digital TV*, Journal of Three Dimensional Images **15** (2001), no. 4, 47–56, ISSN 1342-2189.

[WR00] Dean Wormel and Mark Read, *Unified Camera, Content and Talent Tracking in Digital Television and Movie Production*, InterSense Inc., NAB 2000, Las Vegas, 2000.