A Preliminary Analysis of Top3DSet Virtual Studio System Applications: Postprint

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Abstract

Virtual studio systems represent a novel category of video production apparatus. Compared with traditional video production facilities and broadcast studios, virtual studios are characterized by lower video production costs, convenient background replacement, and the capacity to facilitate principal creators in better actualizing their creative vision, thereby enabling creators' innovative thinking to be less constrained by production budgets and environmental limitations. This introduces new developmental directions for program production and facilitates improved production and broadcasting of video programs.

Full Text

A Brief Analysis of the Application of the Top3DSet Virtual Studio System

Abstract: The virtual studio system represents a novel video production device. Compared with traditional video production rooms and studios, virtual studios offer lower production costs, convenient background replacement, and enable creative personnel to better express their innovative ideas without excessive constraints from production budgets or environments. This brings new development directions for program production and facilitates improved video program creation and broadcasting.

Keywords: Virtual Studio; Tracking Technology; Operational Functions

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Virtual studio video production technology essentially integrates traditional video production techniques with modern computer image processing technologies. In conventional video production applications, the foreground and background lack correlation, resulting in an inability to maintain correct perspective relationships. This creates the visual discomfort of foreground elements appearing to float over the background. Virtual studios employ tracking technology, enabling production staff to analyze camera operating parameters via computer. Combined with shooting requirements, precise calculations of camera position, zoom focal length, panning duration, and other data ensure virtual scenes transform along designed paths. The background automatically generates linkage signals with the foreground and composites with foreground signals through a chroma keyer, creating an immersive realistic environment.

2.2 Full-Scene Real-Time 3D Rendering

The Top3DSet system is built upon Microsoft's latest rendering platform, incorporating numerous advanced computational methods and technologies. Extensive optimization algorithms ensure full utilization of the RT3D video server's hardware rendering capabilities. Trilinear filtering and full-scene anti-aliasing technology produce smoother, more refined images. MipMap processing technology is employed for scene object texture mapping, preventing image defocus when the camera pushes in too close and eliminating jitter in processed dynamic images, thereby ensuring video program fluidity.

2.3 Real-Time Adjustment and WYSIWYG Editing

The Top3DSet system enables timely adjustments to animation design and virtual object design in videos, enhancing animation realism while precisely combining scene signals. The system can automatically generate object masks based on virtual object positions, ensuring correct occlusion relationships between elements within the video.

2.4 High-Precision Optical Camera Parameter Tracking

Video production personnel can use photoelectric sensors to convert camera pan, tilt, and zoom movements into electrical signals. Based on acquisition and encoding of these signals, they can establish guidelines for mobile camera equipment, achieving effects such as dolly, zoom, and pan operations. Moreover, these sensors offer high tracking precision and rapid parameter processing, ensuring video playback remains free of stuttering or tearing even during rapid camera operations including dolly, zoom, pan, tilt, and focus adjustments.

2.5 Real-Time Compositing of Talent and Virtual Scenes

Top3DSet Dual-Channel Dual-Camera Virtual Studio System Structure Diagram 2 [Figure 2: see original paper].Top3Dset Virtual Studio System Functional Characteristics

2.1 Timeline-Based Animation Editing

The Top3DSet system introduces timeline-based animation editing technology, greatly simplifying video broadcast parameter adjustment. All elements within a scene can have their 3D motion trajectories, movement postures, and scaling parameters pre-edited along the timeline with real-time preview, achieving true WYSIWYG editing effects.

2.6 Foreground Depth Key

The Top3DSet system can generate partial 3D scenes and apply them before talent in the video, performing automatic depth processing on these 3D scenes. This enhances talent flexibility in video production and ensures correct scene perspective relationships during camera position switching.

2.8 Automatic Masking and Lighting Processing

The Top3DSet system imposes no restrictions on camera occlusion layers. In virtual studios, if the distance between virtual scenes and virtual cameras is smaller than that between actual talent and cameras, virtual objects automatically appear before the talent; otherwise, they appear behind. Additionally, the system includes eight built-in virtual lights, allowing independent control of position, color, and attenuation for each light, with the ability to operate along specified trajectories, enriching lighting effects for video production.

3. Top3DSet System Workflow

3.1 Modeling

Virtual studio scene models are created according to program characteristics and director requirements. Universal modeling software such as 3D Max or Maya can be used for modeling, with final models exported in 3DSg format for system compatibility.

3.2 Broadcast List Creation

The broadcast list is a comprehensive term in the Top3DSet virtual studio system that integrates scenes, objects, and broadcast schedules. Upon system startup, appropriate scene models are automatically selected from the corresponding material library and added to the view editing area. Screens and special effects devices are then selected from the material library and added to the timeline editing window, where they can be modified according to video production requirements to form a complete virtual studio ready for video production.

3.3 System Equipment Parameter Adjustment

To ensure optimal performance of all virtual studio equipment, relevant personnel must inspect device parameters and operating status. Inspections should first verify genlock signals, video signals, camera operating parameters, camera switching flexibility, chroma keyer performance, video compositing effects, and input/output video functions. Subsequently, virtual scenes, talent, lighting, and other elements are confirmed to ensure successful program recording.

3.4 Program Recording

Personnel can instantly edit program schedules or open previously edited schedules. Before entering playback mode, tracking initialization and positioning must be performed. Virtual scenes, large screens, special effects, and other parameters are adjusted as needed. After completing initialization and positioning, the tracking system is activated. The tracking system enables virtual camera lenses to move in sync with real camera lenses during dolly, pan, and tilt operations, maintaining correct perspective relationships between foreground and background.

4. Lighting Considerations

4.1 Key Light Processing

In key light processing for virtual studios, lights are generally positioned lower to prevent primary shadows on talent that would affect output image quality. Main light sources are not recommended in studio interiors, as improper application may cause discrepancies between actual and virtual light sources, potentially impacting computer image processing results.

4.2 Backlight Processing

In traditional studios, backlight is typically stronger than key light to enhance talent clarity. However, in virtual studios, backlight application must adapt to virtual scenes. Excessive backlight intensity can cause inconsistency between virtual scene lighting and the blue screen, affecting subsequent blue-screen keying technology. Insufficient backlight creates a phenomenon where talent foreground appears pasted onto the background, compromising visual aesthetics. Lighting managers must therefore adjust backlight intensity according to actual conditions.

4.3 Side Light Processing

Side light is essential in virtual studio lighting management because virtual system chroma keyers employ blue elimination circuits that automatically remove blue light reflected from talent clothing by the blue screen, which would otherwise darken talent edges. Side light addresses this issue.

4.4 Reflected Light Processing

Reflected light processing aims to prevent reflected light from talent clothing and transparent virtual objects from affecting blue screen operation, thereby avoiding highlight points in the blue screen that would compromise image quality.

With the deepening development of computer virtual reality technology, virtual studios have gradually become an important means of television program production, widely applied in news, education, interviews, variety shows, and other programs. Virtual studio technology achieves breakthroughs in shooting time, space, and stage art limitations through real-time stitching and fusion of captured footage with virtually constructed models, dramatically saving space, manpower, and material costs while achieving leapfrog development in stage effects.

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Note: Figure translations are in progress. See original paper for figures.