Dynamic Bluescreens

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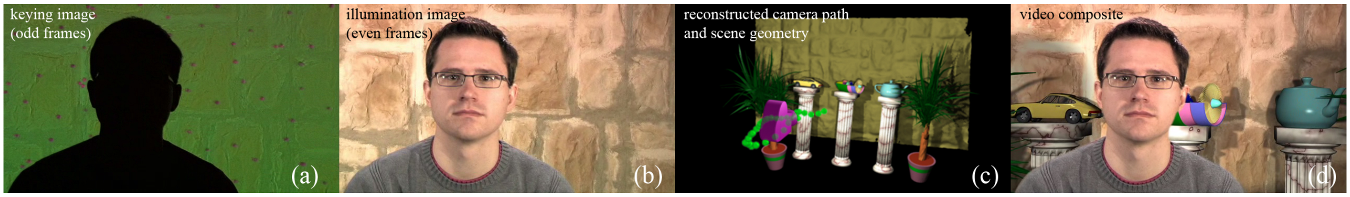

Figure 1: *Odd frames record projected images that neutralize the appearance of a real background surface and display a keying color instead (a). Even frames record the fully illuminated scene without projection (b). Repeating this at HD scanning speed (59.94Hz) and registering both sub-frames during post-processing supports scene reconstruction and camera tracking (c), as well as keying and professional video composition at approximately 30 Hz within real (non-studio) environments (d).*

Abstract

We synchronize cameras and analog lighting with high speed projectors. Radiometric compensation allows displaying flexible blue screens on arbitrary real world surfaces. A fast temporal multiplexing of coded projection and flash illumination enables professional chroma keying and camera tracking for non-studio film sets.

Keywords: Projector-camera systems, keying, tracking, radiometric compensation, temporal multiplexing, video composition.

1 Introduction and Motivation

Blue screens and chroma keying technology are essential for digital video composition. Professional studios apply tracking technology to record the camera path for perspective augmentations of the original video footage. Although this technology is well established, it does not offer a great deal of flexibility. For shootings at non-studio sets, physical blue screens might have to be installed, or parts have to be recorded in a studio separately. We present a simple and flexible way of projecting corrected keying colors onto arbitrary diffuse surfaces using synchronized projectors and radiometric compensation. Thereby, the reflectance of the underlying real surface is neutralized. A temporal multiplexing between projection and flash illumination allows capturing the fully lit scene, while still being able to key the foreground objects. In addition, we embed spatial codes into the projected key image to enable the tracking of the camera. Furthermore, the reconstruction of the scene geometry is implicitly supported.

2 Technical Approach

A high definition 3CCD camera is synchronized with off-the-shelf DLP projectors and a custom-built Osram Ostar (5600K) LED lighting system. The projectors are automatically calibrated to an arbitrary (preferably Lambertian) background surface. The camera is used to scan the sufrace geometry as well its reflectance offline using structured light projection. This data can be applied for special video composition effects, such as occlusions and shadow casts (cf. figure 1d), but is mainly used for real-time per-pixel displacement mapping and radiometric compensation on the GPU during runtime [Bimber et al. 2005]. These image correction techniques widely neutralize the geometric and radiometric structure of the real background surface and lead to appearance of a uniform keying color. Every odd frame is recorded with analog illumination turned off, and the background color being replaced with the keying color (cf. figure 1a). Every even frame records the fully illuminated scene with the projection being turned off (cf. figure 1b). As a first post-processing step, corresponding odd and even frame sequences are time warped by a factor of two to interpolate the intermediate frames. The radiometric compensation ensures a uniform appearance of the keying color throughout the spatially varying background surface and consequently enables an efficient separation of foreground and background. Synthetic feature points integrated into the keying color (cf. figure 1b) allow the reconstruction of the camera path (cf. figure 1c). Tracking and keying together finally support perspective video composition effects within real (non-studio) environments (cf. figure 1d).

3 Results and Outlook

Our current prototype system records 720p frame at the HD scanning speed of 59.94Hz. The uncompressed frames are captured via HD-SDI and recorded to disk. Specular highlights on transparent objects are inconsistent per se, since the positions of projectors and analog light sources in odd and even frames don't match. However, they can be recovered and superimposed in the final composition frame by identifying them in each corresponding even (illumination) frame. The subsequent post-processing steps are fully compatible with common video composition pipelines. We use Autodesk Maya™2008 Unlimited for 3D rendering, its Live™module for match-moving based on the synthetic feature points, as well as Autodesk After Effets'™Time Warp™function for motion interpolation, and DV-Matte Pro™for keying. Our method supports keying that is invariant to foreground colors. Currently we are not only investigating the integration of enhanced patterns into the keying frames that might allow creating environment mattes for refractive objects, but also developing techniques that select optimize keying colors depending on the background.

References

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