Enabling On-Set Stereoscopic MR-Based Previsualization for 3D Filmmaking

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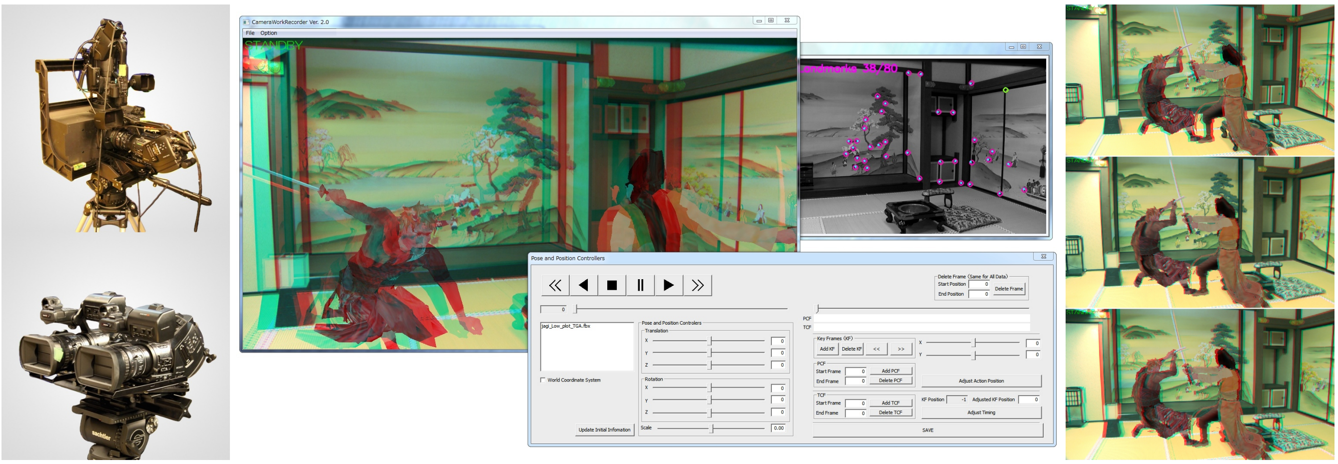

Figure 1: *Left: Our beam-splitter rig and parallel rig has manual controllers of interaxial and convergence (Nac 3D Rig II with two Sony PMW EX-3). Middle: Results and interfaces of CGI characters position and orientation, and animation controls, Right: Instant setups of a rig in MR space enables to confirm expected results in the early stage, Most of the results are represented in color anaglyph for convenience.*

1 Introduction

PreViz is a computer graphics movie that represents desired scenes in preproduction and is useful for sharing the director's imagination among crews. Therefore, film industry looks upon PreViz as one of the most important processes in filmmaking as the processes become complicated [The Previs Society 2011]. Stereoscopic 3D (S3D) movie production not only changed ways of expressiveness but also changed ways of production and tools. Consequently, it requires more careful planning and PreViz is still important. This paper describes a prototype of S3D MR-PreViz system for HD S3D PreViz shooting using mixed reality (MR) technologies in order to facilitate PreViz making in S3D. This system is designed as an extension of MR-PreViz for classic filmmaking [Ichikari et al. 2010].

Live-action shooting in S3D is still challenging in spite of know-how development. Developing intuitive interfaces, a motorized stereo rig [Heinzle et al. 2011] and easy to use editing tools for disparity adjustments [Koppal et al. 2011] are proposed. Our motivation is, however, to offer stereographers the chance to examine properties of a stereo rig and camerawork before production. In this system, stereographers can shoot CGI characters acting on the indoor and outdoor set and on a miniature by themselves. Creating PreViz on their own, and not by animators, must be the most intuitive way. In addition, using actual images embodies depth rather concretely than usual PreViz in S3D.

2 A Workflow of S3D MR-PreViz

S3D MR-PreViz operates in the following procedures: landmark DB (LMDB) construction, setup of a 3D rig, calibration of the cameras and MR-PreViz shooting. See below for further descriptions.

LMDB Construction. This system uses a vision-based tracking method using feature LMDB [Ichikari et al. 2010]. It is therefore necessary to construct the DB for real-time 3D match-move.

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Setup of a Stereo Rig. Setup interaxial distance, convergence of a rig and adjust disparities on a display.

Calibration of the Cameras. Opposed to usual MR systems with a stereo camera such as HMD, use of rigs with controllers of interaxial and convergence depicted in the left of Figure 1 often requires calibration. Taking time for calibration leads to lost of chances of examining other setups and cost directly. Thus, it is necessary to finish calibration as quickly as possible in practice.

MR-PreViz Shooting. After the calibration, MR-PreViz shooting begins. If the result is not expected due to incurrect setup of the rig, it is possible to setup the rig again. Calibration automatically maps the renewed setup to MR space for further examination.

In general, this system enables stereographers to repeat trial and error for examining setups of rig properties and camerawork on a 3D display in real time by repeating calibration and shooting phases after LMDB construction phase. The system's interfaces are depicted in the middle of Figure 1. This system composes a PC size workstation with a 3D display, rigs and calibration boards, and is, therefore, portable.

3 Technical Details

Calibration. Calibration phase has two modes: Instant calibration and accurate calibration. The former uses ARToolKitPlus [Wagner and Schmalstieg 2007]. Using a fiducial marker is also useful for adjusting disparities on a display at the same time by holding it at a convergence point. The latter uses a method proposed by Z. Zhang [1999], which requires multiple checkerboard images and takes approximately 30 seconds to calibrate. For accurate and effective checkerboard detection, this system finds the images in each quadrant to cover a wide range of the screen. These two modes are the alternatives depending on time. Each calibration estimates rotation and translation matrices from the calibration board to right and left camera: R_R, R_L and t_R, t_L respectively. Then convergence and interaxial is calculated by $R_R R_L^{-1}$ and $t_R - R_R {R_L}^{-1} t_L$ respectively.

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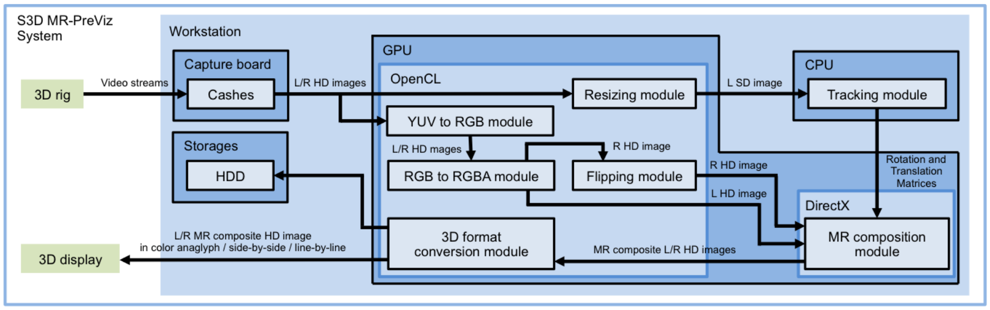

Figure 2: *Dataflow of S3D MR-PreViz system.*

Figure 3: *3D format conversions and switching, Top: Color anaglyph, Middle: Side-by-side,Bottom: Line-by-line.*

Figure 4: *Examples of the Results of S3D MR-PreViz, Top and middle rows: Different setups in the same camerawork (Top: 6.0 cm of interaxial and 1.5 degrees of convergence, Middle: 6.0 cm of interaxial and 2.5 degrees of convergence), Bottom: On a miniature set using the same CGI data.*

Real-Time MR Composition in HD and in S3D. It is crucial for real-time processing to accomplish real-time 3D match-move and outputting results in HD and in S3D at the same time. This system enables real-time processing by the combination of CPU and GPU/GPGPU. GPGPU is manipulated by OpenCL and is used for all additional image processing from conventional MR-PreViz system: YUV to RGB conversion, RGB to RGBA conversion, flipping for beam-splitter rig, resizing and S3D format conversion. The data flow is shown in Figure 2.

First, YUV video streams from a stereo rig are inputted to the capture board in the workstation. The video stream from left camera is used for tracking. The left image is resized to SD due to computationally expensive tracking. Next, images are converted to RGB and then to RGBA for superimposing CGI over both HD images using rotation and translation matrices from the tracking on CPU. Finally, MR composite images are converted to a 3D format. In this case, the formats are color anaglyph, side-by-side, or line-by-line (shown in Figure 3). These conversions work in real time so this system is compatible with various types of 3D displays.

4 Results and Futureworks

In S3D MR-PreViz system, CGI characters were superimposed onto video streams and placed on desired positions on a 3D display. Setups of rig parameters were properly and interactively mapped to MR space as depicted in the right of Figure 1. The average of frame rates was 24.4 FPS and thus satisfies movie frame rates. It was, therefore, possible to interactively shoot HD (720p) PreViz movies in S3D, as depicted in Figure 4. Consequently, S3D MR-PreViz system effectively functioned as interactive previsualization system, achieved satisfying results as its first step and was proven useful for S3D PreViz making.

However some scenes showed inconsistency of disparities between real objects and virtual objects due to geometric inconsistency and occlusion problem. Future work will include improvement of the tracking method using a stereo camera. Use of an additional camera and epipolar constraints will support robust feature tracking and 3D reconstruction. In addition, range images obtained by stereo-pair matching would help for solving occlusion problem.

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