Dense Stereo Event Capture for James Bond, Quantum of Solace

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Figure 1: *Multi-view performace capture.*

1 Introduction

Filming your lead actor jump out of an aeroplane without a parachute presents insurmountable safety problems for any attempt at an entirely practical shoot. However, if the production insists that a live action solution must be pursued, how can a convincing sequence be created?

Double Negative VFX and the production crew of the 22$^{\text{nd}}$ James Bond movie, Quantum of Solace, safely filmed Daniel Craig and Olga Kurylenco in free fall by recording the actors performing suspended in the air stream of a wind tunnel normally used to train skydivers.

Controlling the lighting and the camera's position within the confines of the small tunnel presented a new set of problems. These were overcome by employing a dense stereo system to recover the surface geometry of the performers, allowing us to relight and rerender the action from a novel camera position without recourse to a fully CG solution.

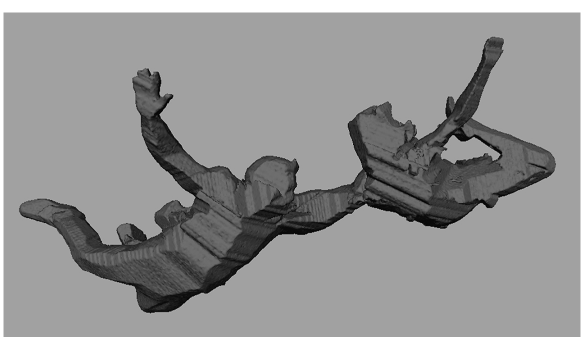

Figure 2: *Volume carved visual hull.*

2 Exposition

Fifteen cameras (8 Dalsa 4K Origin and 7 Sony Cinealta) were positioned in the viewing portholes of the wind tunnel and electronically synchronised. The lighting was arranged to be as diffuse and as bright as possible, allowing narrow shutter angles to reduce motion blur and small apertures to maximise depth of field. Sharp, low noise images were essential for the geometry recovery to be effective.

The initial stage in geometry reconstruction was building the visual hull of the actors based on their silhouettes. The volume is divided into a grid and voxels lying outside the silhouette of the performers as viewed from one or more cameras are carved away.

The next stage involved using the image texture data to form the detailed surface. Inspired by methods published by stereovision research groups (see presentation slides for references) the visual hull was represented as a level set within a volumetric grid. This allowed us to evolve the surface without getting involved in the complexity of a mesh with changing topology. We developed our own error function based on optical flow data computed from images reprojected via the surface. The interface was evolved along the error function gradient in an iterative process until the reprojection error was minimized.

The resulting surface, a complete and closed mesh, was typically accurate to better than 1cm, was low in noise and clutter and suitable for texturing by image projection from the witness camera array. Since texturing the surface was done with photographic data the model was immediately photorealistic without requiring sophisticated material and lighting shaders. Basic lighting effects consistent with direct sunlight could be then synthesised and added and the scene could be rendered from a virtual camera move designed in post production to meet the needs of the action sequence.

3 Conclusion

Dense stereography has been successfully demonstrated as an effective method for recording the foreground surface geometry of a dynamic scene. The geometry is sufficiently accurate to allow a photoreal reconstruction of the scene from novel viewpoints and under synthetic lighting conditions.

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