Focus Tracking for Cinematography

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Figure 1: ***Left:*** *A DSLR video rig with an integrated Kinect. The Kinect is used as an external rangefinder and for 6DOF tracking.* ***Center:*** *Continuous focus on a small walnut in a dolly shot (detail from a video).* ***Right:*** *The camera moving very close to the nut and maintaining focus automatically.*

Abstract

Cinematographers primarily use manual control for focusing their cameras because existing autofocus techniques used in photography can't be directly applied to video or motion-pictures and don't provide sufficient artistic control. Adjusting focus therefore remains a key challenge, which limits the possibilities of executing certain shots. For instance, the amount of depth of field used in shots with a moving camera or subject is heavily influenced by how precise focus can be controlled. This work presents a simple method to overcome some of these challenges by tracking the focus with off the shelf sensory equipment and state of the art 3D point cloud processing techniques. The method integrates well with the current workflow of camera operators and their first assistants and even gives them more flexibility than a manually controlled follow focus. To evaluate the feasibility, a fully functional prototype was built and tested with professional camera operators.

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1 Method

A Microsoft Kinect sensor is integrated into a DSLR video rig in a way that it is rigidly mounted in respect to the camera. After intrinsic and extrinsic calibration the captured depth image and resulting point cloud is registered with the image of the DSLR camera. This way, the Kinect can serve as an external active rangefinder with a very high number of meter points. As with a conventional autofocus the camera can be pointed at a certain part in the scene, the distance is measured and the focus is then adjusted accordingly. This is also used to select points in the scene, which are then tracked and continuously kept in focus while moving or panning the camera.

Rather than tracking single points, the pose of the camera itself is estimated. This is done by real-time Iterative Closest Point (ICP) point cloud registration on a GPGPU. This way several static points in the scene can be selected and tracked simultaneously, even if they are temporarily outside of the field of view. The Kinect itself is not able to measure depth in close proximity (approximately half a meter), but because of global registration of the camera, points can be tracked when moving even closer to the lens. This makes the system feasible for continues autofocus in the macro range.

Certain strategies have been implemented to select and interpolate between tracked points for controlling focus. The workflow for the system is to first select a strategy and choose relevant focus points in the scene while setting up the shot. The lens is then controlled fully automatically during the actual recording phase. These simple steps enable precise, fast and complex focusing scenarios.

A key benefit is the seamless integration into existing, well known camera setups. The method works almost intuitively and no complex interaction is needed, as the prototype is literally controlled by a single button. Another benefit is the possibility of operating in low light situations due to the active projection of infrared light used by the Kinect sensor.

2 Conclusion

The method turned out to be feasible and especially useful for panning and tracking shots with a low depth of field, where precise manual focus control would have been impossible or only achievable by complex motion-control. It is also obvious that such focus tracking could be highly useful for Steadicam operators, but this is yet to be tested. Current limiting factors are the time consuming calibration process after modifying the DSLR camera system and that the physical scale of the scene is bounded to a few meters. In the future, the latter could be solved by improving and extending the ICP and reconstruction implementation to work with large scale environments.

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