

Panorama Light-Field Imaging

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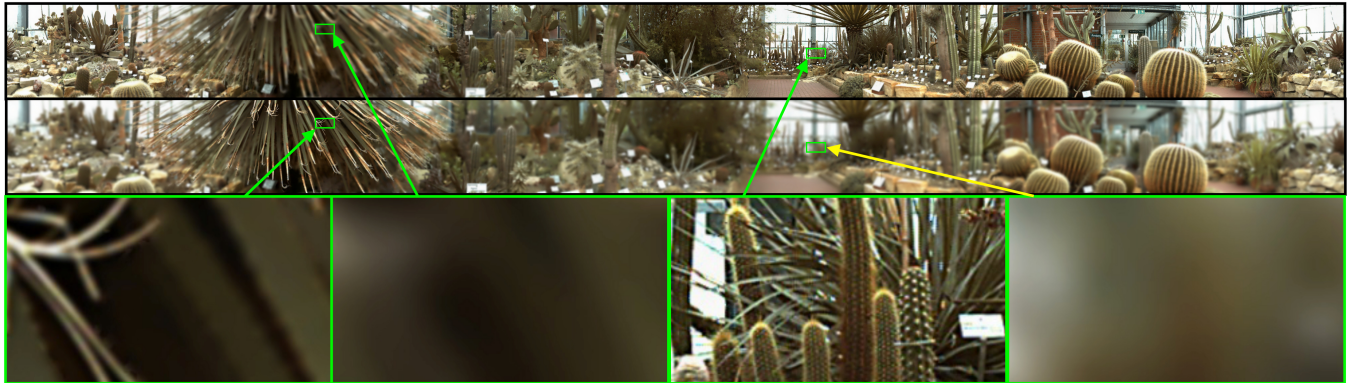


Figure 1: Images rendered from a 22 MPixels (spatial resolution: 17885x1275 pixels) panoramic light field at different focus settings (far: top, near: center), and close-ups in native resolution (bottom). We thank the Raytrix GmbH for capturing and providing the raw data.

Abstract

We present a first approach towards panorama light-field imaging. By converting overlapping sub-light-fields into individual focal stacks, computing a panoramic focal stack from them, and converting the panoramic focal stack back into a panoramic light field, we avoid the demand for a precise reconstruction of scene depth.

CR Categories: I.4.1 [IMAGE PROCESSING AND COMPUTER VISION]: Digitization and Image Capture; I.3.3 COMPUTER GRAPHICS: Picture/Image Generation

Keywords: light fields, computational photography, panorama

1 Introduction

With increasing resolution of imaging sensors, light-field photography is now becoming increasingly practical, and first light-field cameras are already commercially available (e.g., Lytro, Raytrix, and others). Applying common digital image processing techniques to light-fields, however, is in many cases not straight forward. The reason for this is, that the outcome must not only be spatially consistent, but also directionally consistent. Otherwise, refocussing and perspective changes will cause strong image artifacts. Panorama imaging techniques, for example, are an integral part of digital photography – often being supported by camera hardware today. We present a first approach towards the construction

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of panoramic light-fields (i.e., large field-of-view light-fields computed from overlapping sub-light-field recordings).

2 Our Approach

We capture overlapping sub-light-fields of a scene during a cylindrical or spherical camera motion and convert each sub-light field into a focal stack using synthetic aperture reconstruction. For light-field cameras that directly deliver a focal stack, this step is not necessary. Next, we compute an all-in-focus image for each focal stack by extracting and composing the highest-frequency image content throughout all focal stack slices. The registration and blending parameters are then computed for the resulting (overlapping) all-in-focus images. For this, we apply conventional panorama stitching techniques, such as SURF feature extraction, pairwise feature matching and RANSAC outlier detection, bundle adjustment, wave correction, exposure compensation, and the computation of blending seams. The registration and blending parameters that were derived for the all-in-focus images are now applied to all corresponding slices of the focal stacks. We use a four dimensional (three rotation and focal length) motion model for registration and multi-band blending for composition. The result is a registered and seamlessly blended panoramic focal stack that can be converted to a light field with linear view synthesis, as described in [Levin and Durand 2010]. Since we chose an intermediate focal stack representation, common image panorama techniques can be applied for robustly computing a panoramic light-field without a precise reconstruction of scene depth. However, the focal stack of a scene covers no more than a 3D subset of the full 4D light field. This limits our current approach to Lambertian scenes with modest depth discontinuities. In future, we will investigate panorama light-field imaging techniques that are applicable directly to 4D ray-space.

References

- LEVIN, A., AND DURAND, F. 2010. Linear view synthesis using a dimensionality gap light field prior. In *Computer Vision and Pattern Recognition (CVPR), 2010 IEEE Conference on*, 1831–1838.