Artificial Refocusing of High Resolution SLR Images from Microsoft Kinect Depth Maps

Christian Castellanos, Andrew Nguyen
Department of Electrical Engineering, Stanford University

Motivation

Refocusing in post processing is a powerful tool for photographers. However, conventional tools for refocusing images in applications such as Photoshop are frequently lackluster. Light-Field photography enables refocusing from a single exposure, but suffers from low resolution and subpar image quality.

Well known solutions for estimating depth information in a scene include structured illumination, ToF, and Light Imaging, Detection, and Ranging (LiDAR). In the latter two methods, scenes are illuminated with a pulse, and the camera measures how long it takes between an the initial pulse of light and the return of the light to the camera. The varying time of flights between the pulses is used to build up a depth map.

Depth information from a scene provides potential for refocusing in the post processing stage. We propose capturing the depth information from a scene with a Kinect, capturing the same scene with a high resolution SLR image, and using an up-sampled depth map to provide user-specified refocusing of specific regions in a high resolution image.

Related Work

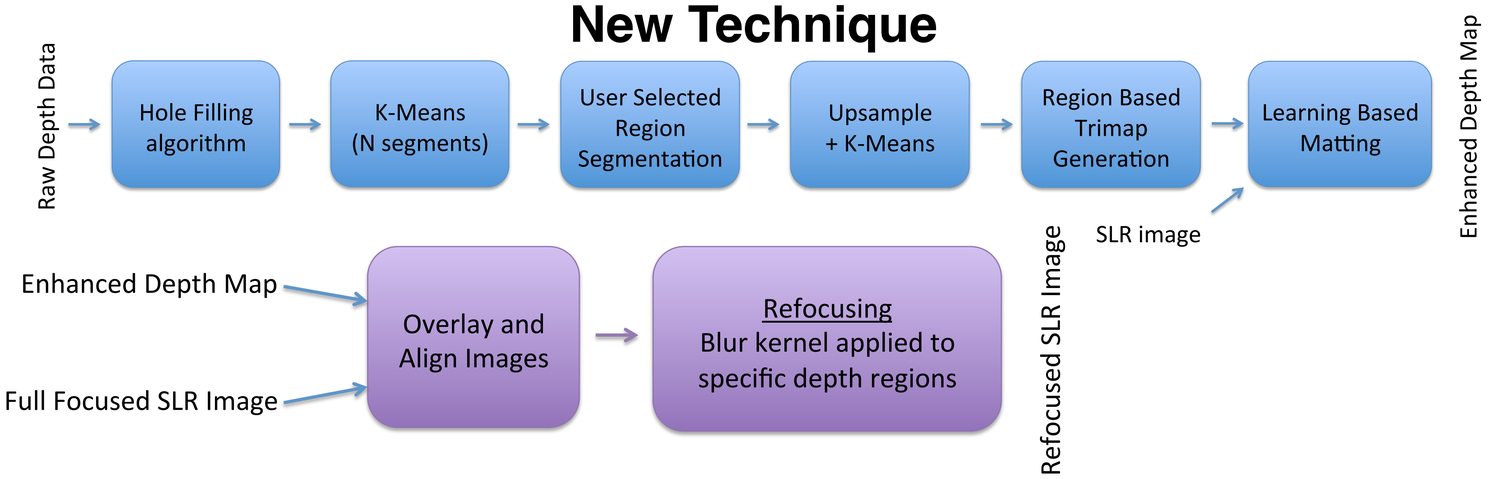
[1] Proposes a novel method for realistically refocusing images through the use of structured illumination of a scene. However, this method suffers in well lit areas, particularly sunlight, and also requires many of the depth measurements to be interpolated due to the sparsity of the dots used to illuminate the scene.

[2] Embraces a similar approach as us, but is much more computationally expensive and requires taking more photographs (HDR) to gather more info. Their goal is beyond depth map generation to digitally changing aperture.

References

[1] Moreno-Noguer, Francesc, Peter N. Belhumeur, and Shree K. Nayar. "Active refocusing of images and videos." ACM Transactions On Graphics (TOG) 26.3 (2007): 67.
[2] Huhle, Benjamin, et al. "Realistic depth blur for images with range data." Dynamic 3D Imaging. Springer Berlin Heidelberg, 2009. 84-95.
[3] Liu, Soulan, Chen Chen, and Nasser Kehtarnavaz. "A computationally efficient denoising and hole-filling method for depth image enhancement." SPIE Photonics Europe. International Society for Optics and Photonics, 2016.
[4] Zheng, Yuanjie, and Chandra Kambhamettu. "Learning based digital matting." Computer Vision, 2009 IEEE 12th International Conference on. IEEE, 2009.
[5] Wiberg, Benjamin. "A Method for Refocusing Photos using Depth from Defocus." Stanford University, Dec. 2016.

New Technique



$$I_F = (I * A) + \mathcal{F}^{-1}(\mathcal{F}(I * (\mathbf{1} - A)) * \mathcal{F}(h))$$

Where $*$ represents element wise multiplication, h is the airy disk kernel, A is the alpha matte from the matting stage, I represents the original SLR image, and $\mathcal{F}(\cdot)$ represents the 2D Fourier Transform operator.

Experimental Results



Low Resolution Depth Map



SLR Image

Alpha Mattes for Focus Regions

Near Focus



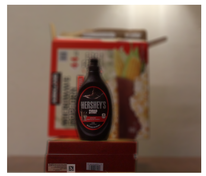
Mid Focus



Far Focus



Refocused SLR Scenes







SLR Scenes, different focuses





