Light Field Reconstruction from Focal Stack based on Depth Estimation

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Motivation

Light field photography can record not only the intensity of light projected on camera film or sensor but can also record the direction from which the light travels. Light fields can be captured by varying camera position or using microlens, which can be costly and poor resolution. Because a focal stack is a 3D projection of light field, we expect to recover light field from focal stack.

Workflow

The workflow was adopted from [1]

focal stack

Depth map

All-in-focus

$L_{u,v}(x - su, y - sv)$

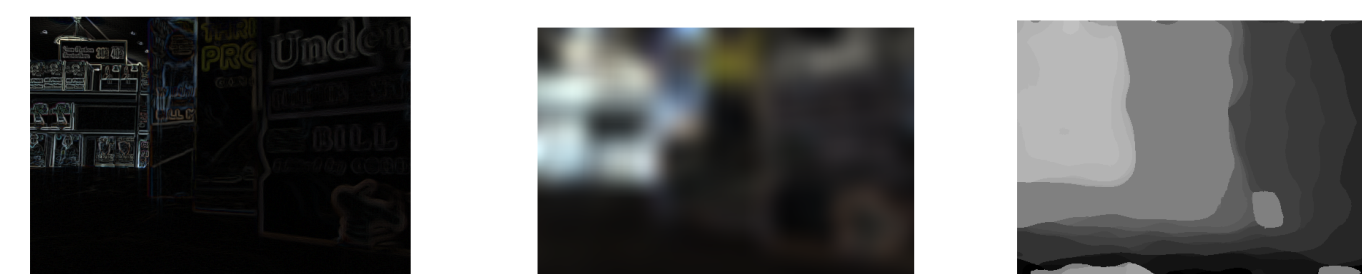Shifted and focused

$L(x, y, u, v)$
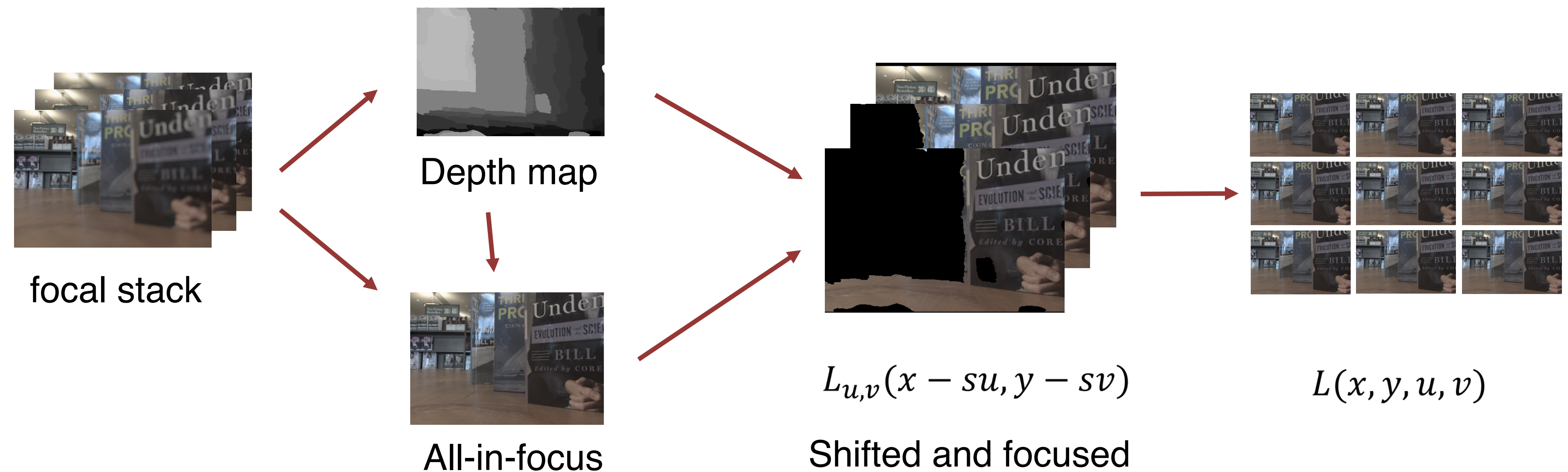
Related Work

[1] Mousnier, A & Vural, E & Guillemot, Christine. (2015). Partial light field tomographic reconstruction from a fixed-camera focal stack.
[2] Levin, Anat & Durand, Fredo. (2010). Linear View Synthesis Using a Dimensionality Gap Light Field Prior.

Proposed depth estimation

Gaussian-blur the gradient and pick the label with highest blurred gradient

Find edge using kernel of 3x3

1	2	1
1	1	3
2	3	1

Labels

$\odot$

0.5	0.6	0.3
0.4	0.3	0.2
0.4	0.5	0.4

True gradient

scores
1: 1.9
2: 0.7
3: 1.0

If the % of highest score is greater than a threshold, convert the kernel to that label
If it encounters an edge, this should set a boundary.

Experimental Results

Inaccurate depth estimation can easily cause artifacts at boundary. The estimation is challenging when the image is in low resolution. However, the inner object region is more accurately imaged.
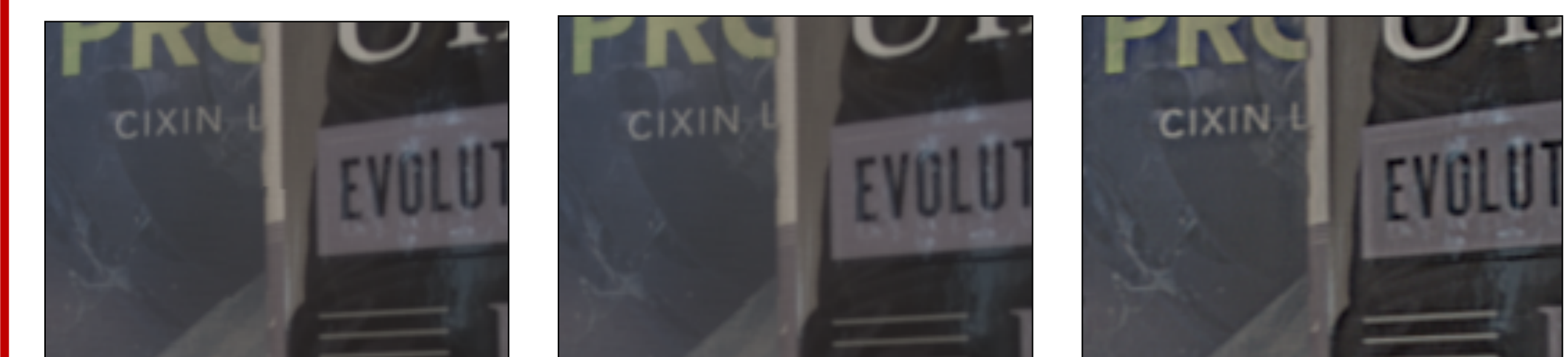
Depth estimation

Original light field

Deconvolution method in [2]