

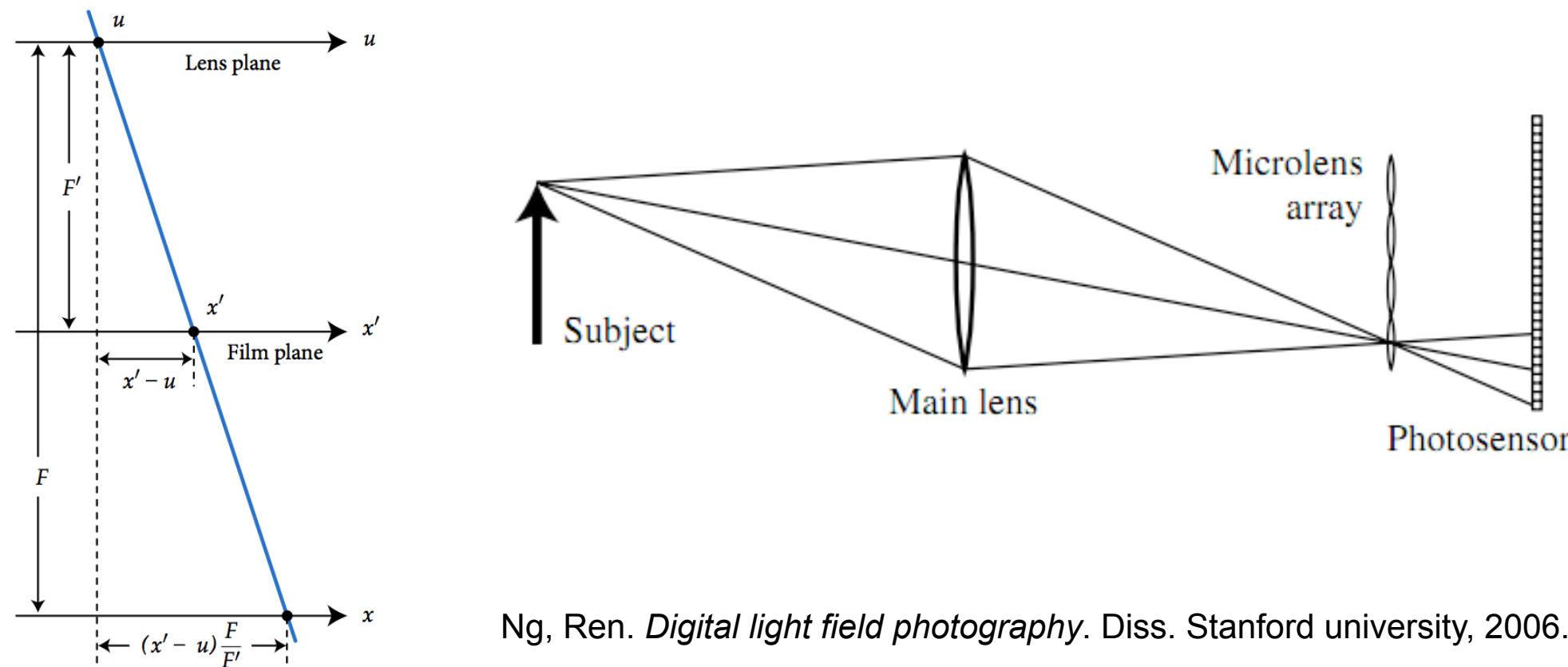
Light Field Dataset Creation and Depth Estimation

Abhilash Sunder Raj, Raj Shah, Michael Lowney
Department of Electrical Engineering, Stanford University

Motivation

Light Field cameras have the ability capture both the intensity and direction of the light striking the sensor. This gives the user the ability to refocus and shift the view point of the image.

Light Fields have a wide range of potential applications from computer vision to virtual reality. Currently there are very few light field images available publicly to researchers. Our goal was to create a dataset of natural images that would contain interesting scenes for others to use.



Light Field Dataset

The images were captured so that they will have the maximal refocus range of the Lytro Illum camera. Currently the dataset consists of over 280 images sorted into 9 categories.

Plants & Flowers Bikes Cars Reflective surfaces Occlusions
Fruits & Vegetables Buildings People Miscellaneous

Example images:

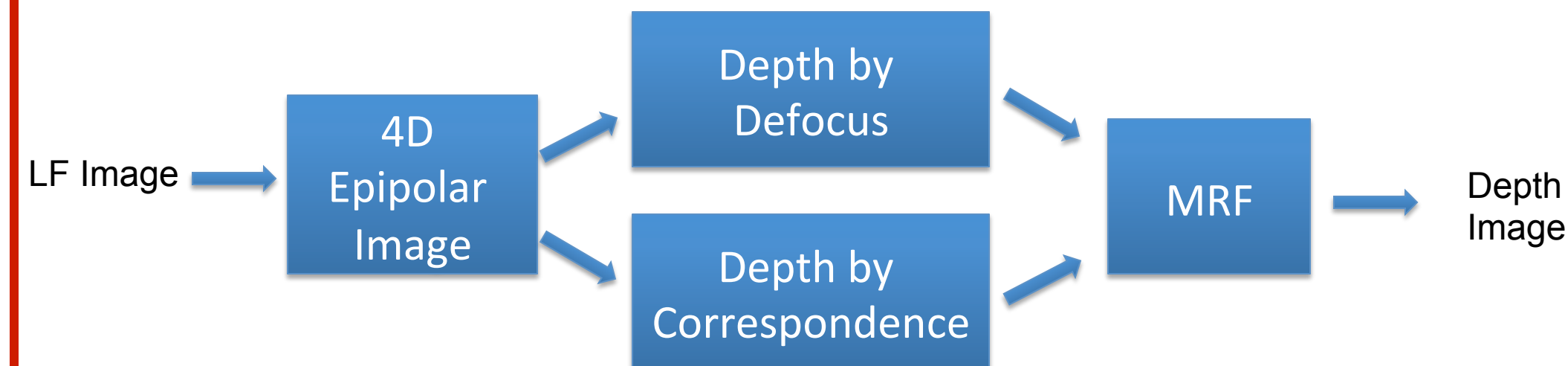
Occlusion image
Left: Near focus
Right: Far focus



Plant image
Left: Near focus
Right: Far focus



Depth Estimation



We followed the depth estimation procedure suggested in [1]. To calculate depth, we refocus the image by applying different shifts to the epipolar image.

$$L_{\alpha}(x, u) = L_0(x + u(1 - \frac{1}{\alpha}), u)$$

Depth from defocus:

The depth is inferred from the shift that results in the highest gradient value for a local neighborhood.

$$D_{\alpha}(x) = \frac{1}{|W_D|} \sum_{x' \in W_D} |\Delta_x \bar{L}_{\alpha}(x')|$$

$$\alpha_D^*(x) = \operatorname{argmax}_{\alpha} D_{\alpha}(x)$$

Depth from correspondence:

Depth is measured by finding the variance in pixel intensity as the views points of the camera change.

$$\sigma_{\alpha}(x)^2 = \frac{1}{N_u} \sum_{u'} (L_{\alpha}(x, u') - \bar{L}_{\alpha}(x))^2$$

$$C_{\alpha}(x) = \frac{1}{|W_C|} \sum_{x' \in W_C} \sigma_{\alpha}(x')$$

$$\alpha_C^*(x) = \operatorname{argmin}_{\alpha} C_{\alpha}(x)$$

Combining the Cues:

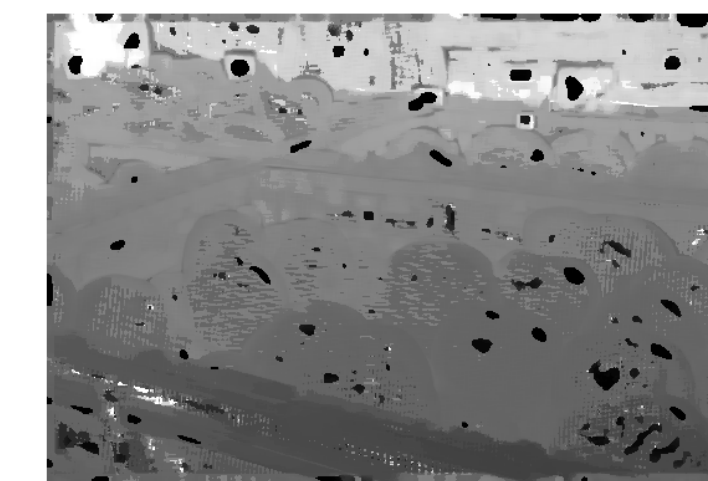
The final depth image is created selecting the depth from defocus and correspondence that minimizes a cost function. This optimization is done using a Markov Random Field.

[1] Tao, Michael, et al. "Depth from combining defocus and correspondence using light-field cameras." *Proceedings of the IEEE International Conference on Computer Vision*. 2013.

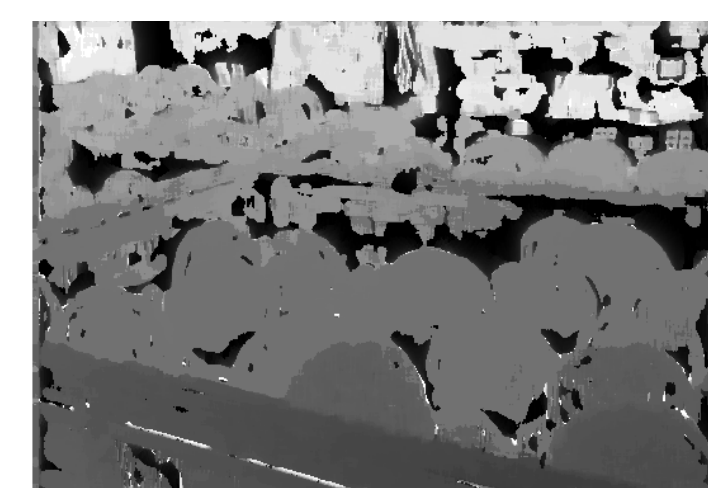
Results



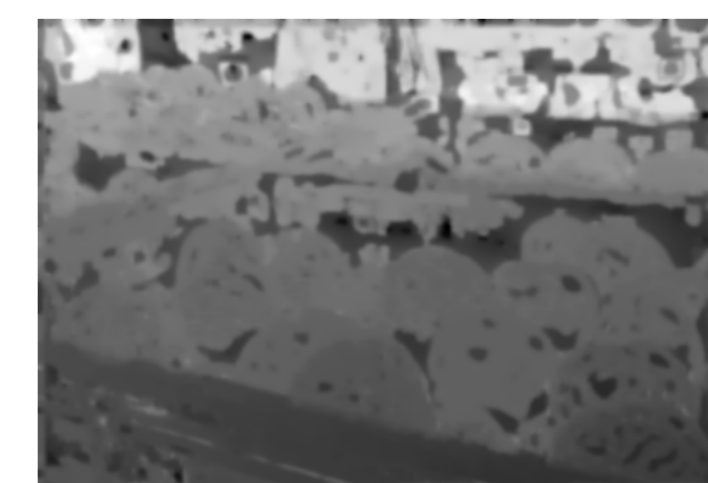
RGB Image



Correspondence



Defocus



Our Depth Map



Lytro's Depth Map



RGB Image



Correspondence



Defocus



Our Depth Map



Lytro's Depth Map