Stock Sawasdee
EE 367 Project Proposal

Project title
Light Field Reconstruction from Focal Stack

Motivation
Conventional photography is an imaging process that captures light projected on a 2D plane. This process compresses the information about direction from which the light travels. Light field photography is a technology that allows us to record light directions, which turns the data from a compressed 2D image into a 4D light field data. Light field data can be used in many ways such as depth estimation and 3D scene reconstruction.

A plenoptic camera is a popular tool to capture light field data. Most camera One type of plenoptic cameras uses micro-lens in front of a sensor to capture light field. However, plenoptic cameras are sometimes complicated to manufacture and have to sacrifice resolution over more dimensions of data.

The idea behind this project is to reconstruct focal stack of images taken by a conventional camera at different focal distances.

Related Work
Because focal stack (3D) is a projection of a light field data (4D), reconstruction of a full light field data from a lower ranked data is theoretically impossible unless some assumptions are made. Some past studies approached the problem by reconstruct only partial light field by estimating depth [1] while some studies treated the problem as an ill-posed inverse problem where regularization term such as TV is added to the objective function [2] or by limiting the bandwidth of a filter function using a truncated window function [3]. The latter two methods require understandings of 4D FFT and Fourier Slice Theorem.

Project overview
In this project, I will explore the preceding methods by implementing these reconstruction algorithms on Matlab and apply them on a focal stack data set. For the first method, I need to implement a depth estimation algorithm, which I will use a gradient based algorithm to find object in focus at each focal distance and create a depth map. From the depth map, I will map each pixel into L(x,y,u,0) space and create perspective shift for display. For the second and third methods, I will formulate iterative solving scheme following the corresponding papers.

Milestones
2/13 Project proposal
2/20 Experiment with depth estimation and partial light field reconstruction
2/27 Regularized reconstruction method
3/5 Filtered backprojection method
3/13 Project poster presentation
3/16 Project report due

References
[1] Mousnier, A & Vural, E & Guillemot, Christine. (2015). Partial light field tomographic reconstruction from a fixed-camera focal stack.

[2] Pérez, F., et al. "Lightfield Recovery from Its Focal Stack." *Journal of Mathematical Imaging and Vision*, vol. 56, no. 3, Nov. 2016, pp. 573–90, doi:10.1007/s10851-016-0658-4.
[3] Chang, Liu & Qiu, Jun & Jiang, Ming. (2017). Light field reconstruction from projection modeling of focal stack. *Optics Express*. 25. 11377. 10.1364/OE.25.011377.