EE367 Project Proposal

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Motivation

My objective is to create an ISET simulation model for a stereo camera that allows us to predict the camera output when placed in scenes. The simulation can be a valuable tool for computational imaging tasks. For example, it could be used to evaluate camera calibration methods or depth estimation algorithms. I intend to focus on one application: to use the simulation to evaluate a blur kernel estimation method.

For this project I will be working with Dr. Joyce Farrell and Prof. Brian Wandell. I am working with the JedEye stereo camera made by Fengyun Vision.

Related Work

A simulation of the image processing pipeline of a digital camera has been achieved previously [1]. I will be relying on the framework provided by Farrell et.al in the paper "Digital camera simulation" to build a similar simulation for a stereo camera. For spectral and noise calibration of the sensors, I plan to perform the experiments laid out by Farrell et. al in the paper "Sensor calibration and simulation" [2]. The manufacturer has kindly provided us with Zemax files, allowing us to model the optics of the stereo camera.

The optics of a camera intrinsically creates some blur in the image, and finding the PSF accurately is important to perform deconvolution. Estimating the PSF using only captured images is an ill-posed problem that receives a lot of interest [3]. With a complete simulation of a stereo camera, I can compare the performance of the PSF estimation algorithm to the ground truth PSF obtained using Zemax. I intend to use the PSF estimation method described by Mosleh et.al in their paper [3].

Project Overview

The project has the following subgoals:

1. Estimate spectral and noise characteristics of image sensor.
   This section of the project was completed as a previous course project. The details can be found here: sensor characterization
2. Validate sensor characteristics using a Macbeth Color Checker target under multiple illuminations
3. Obtain blur kernels using the Zemax files for the JedEye lens. This will serve as the ground-truth PSF.
4. Validate the blur kernel using simple targets eg. slanted line, checkerboard

5. Implement a blur kernel estimation method relying on captured images (I plan to collaborate with Rose Rustowicz for this implementation). Compare it to the ground-truth PSF.

Milestones

Feb 16 - Complete validation of sensor characteristics under different illuminants
Feb 23 - Derive PSFs using Zemax lens files
Mar 2 - Validate PSFs using target images
Mar 9 - Implement non-blind PSF estimation, compare to derived PSFs
Mar 16 - Final report due for EE367

References

[1] J. Farrell, P.B. Catrysee, B. Wandell. “Digital camera simulation”. Applied Optics. 51(4)80-90. (2012).
[2] J. Farrell, M. Okincha and M. Parmar. “Sensor calibration and simulation." Proc. SPIE 6817. 68170R (2008).
[3] Moseh,A.,Green,P.,Onzon,E.,Begin,I.,Langlois,J.,”Camera Instrinsic Blur Kernel Estimation: A Reliable Framework” IEEE CVPR (2015)