EE 367 Project Proposal
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Synthetic Depth of Field for All-in-Focus Images

Motivation

A narrow depth-of-field is a desirable photo effect naturally achieved on large aperture cameras. For small cameras, the depth-of-field is very large, which captures images of the scene that are all in focus. Artificially creating narrow depth-of-fields allows users to flexibly modify the effect on post-captured images. Interesting modifications are to change the focal distance on different subjects, the size of the depth of field for various blur intensity, and the shape of the defocus blur to achieve various bokeh shapes.

Overview

The depth of field (DoF) is defined as the range an object is considered “in-focus” by some specified tolerance for blur on a given camera system. When an object is outside the DoF, the it will be blurred, which can be characterized by a convolution by a point spread function (PSF). The blur increases with distance from the focal plane. Implementations from Google’s Portrait Mode [1] use a blur kernel with radius that is proportional to the stereo disparity from the subject. Another method is to simply bucket the depths and apply computed PSFs to each depth slice [2].

In our images, we can only use a depth map that is either taken along with the photo or estimated using a neural network. We can then segment either RGB or depth images to select a focal plane and apply the defocus PSFs.

The main components of this project is to:

a) Construct PSFs that create accurate and appealing defocus blur and potentially bokeh shapes by changing the shape of the PSF kernel.
b) Accurately compute sufficient depth information and segmentation from single images using neural networks.

Final Goals

Our final goal is to have an application that can change depth of field settings on any all-in-focus image. We want to be able to create appealing images and compare results with Google’s portrait mode. Additionally, a stretch goal is to encode the blur with an aperture shape for interesting bokeh shapes.

Milestones and Timelines

There are approximately 4 weeks for this project, therefore I have 3 intermediate goals.

1. Feb 17-24: Implement defocus with simple Gaussian kernels on an image with a given segmented depth map for NYU V2 dataset.
2. Feb 24-Mar 2: Use a depth map estimation neural network such as [3][4] to obtain our own depth map to segment.
3. Mar 2-Mar 6: Try various PSFs to generate bokeh shapes or improve blur quality. Experiment with different photos of scenes.
4. Mar 6-Mar 11: Evaluate results with Google's portrait mode paper. Prepare poster and paper.

References

[1] Synthetic Depth-of-Field with a Single-Camera Mobile Phone: https://arxiv.org/abs/1806.04171

[2] Deep Optics for Monocular Depth Estimation and 3D Object Detection: https://arxiv.org/abs/1904.08601

[3] From Big to Small: Multi-Scale Local Planar Guidance for Monocular Depth Estimation: https://arxiv.org/abs/1907.10326

[4] Code for From Big to Small: Multi-Scale Local Planar Guidance for Monocular Depth Estimation: https://github.com/cogaplex-bts/bts