EE367 Project Proposal: Seeing Through Obstruction

Wanling Liu
liuwl@stanford.edu
Department of Electrical Engineering
Stanford University

Ye Li
liye5@stanford.edu
Department of Electrical Engineering
Stanford University

Kefan Wang
kefanw@stanford.edu
Department of Electrical Engineering
Stanford University

Motivation

When capturing images through a fence, it is pretty hard to recover the background scene without attenuation caused by the foreground fence. For example, surveillance cameras would encounter such issue if it is ill-placed behind some obstructions, and the resulted scene may lose its valuable information. Another common situation is that when we take photos in zoos or courts, we want to get rid of the fence to get the clear and undistracted scene. Fortunately, with a light field camera, such grid-patterned fence can be digitally removed thanks to the various perspectives that a single shot can provide. We are going to seek out an optimized solution utilizing the Lytro images to remove the unwanted obstructions and preserve the background information as perfect as possible.

Related Work

Removing obstructions has been actively investigated in different aspects with various algorithms. In the papers [Gu+09] and [FS03], researchers discuss how to remove occluders when we have images captured by different apertures. In [Liu+08], authors designed a three-step algorithm to remove the fence-like occlusions in images, and in [MLY13], they researched on the removal of fence-like occlusions in videos, based on the fact that those fence-occluded pixels tend to appear later in the temporal dimension. In [McC14], the author raised an algorithm that can optimize the fence mask through propagation, using RMS difference as the evaluation metric. In [Xue+15], researchers proposed a computational approach to remove reflecting or occluding elements from a short image sequence captured with camera slightly moved and recover the desired background scene.

Project Overview

It is common to face the problem of unwanted obstructions when we are taking photos, and light field cameras or videos can capture image sequences from different points of view, which gives us a way to recover the obstruction-free images. In this project, we are going to implement different algorithms to investigate image recovery in different occlusion circumstances: regular or irregular (with some deformation), thin or thick (can be measured by relative coverage) occluders in the position between the sensor and objects (extra investigation would be to test the validity of occluders between objects). We will also fine-tune parameters, and potentially modify and improve the algorithms to achieve better results. Our evaluation metrics would take different aspects into account: MSE (pixel difference), PSNR (image fidelity), SSIM (structural similarity) and S-CIELAB [ZW+96] (spatial and chromatic encoding of the image by the human eye). Our final goal would be to generate results that have high quality in terms of both evaluation metrics and human perceptions.

Data

We can use data from `https://sites.google.com/site/obstructionfreephotography/`, which has the captured video sequence, sampled frames. We will also take photos by ourselves to better control the occluders.

Approaches

Image de-fensing [Liu+08] We will adjust the method used in [Liu+08]. This is a three-step algorithm: 1) finding lattice: implement the iterative algorithm described in [Hay+06]; 2) separating foreground and background: construct masks using k-means to separate foreground and background; 3) filling the background with textures: implement texture filling method proposed in [CPT04].

Digital masking[McC14] The basic idea of this approach is to find the foreground mask by propagation through all sub-aperture images. It is searching for a shift value to obtain a least RMS difference in the masked pixels. Then the clean background can be rendered using this mask.

Algorithm pipeline from [Xue+15] Xue et al [Xue+15] proposed a two-step algorithm pipeline for obstruction-free photography: initialization and iterative optimization. For initialization, edge pixels are extracted from the input images to calculate the motion vectors and each pixel is assigned to either the obstruction layer or the background layer. With interpolation, we would obtain a preliminary estimation of motion fields for background and obstruction layer. Then in optimization stage, motion fields, background and obstruction components are updated iteratively until convergence.

Timeline

Starting from Feb 10th to Mar 10th:

Week 1 (Feb 10th - Feb 16th): Taking photos using Light Field camera with different kinds of occluders (and potentially taking some short videos in case that we do the obstruction removal in videos).

Week 2 (Feb 17th - Feb 23rd): Discuss and implement 1-2 algorithms from papers with potential improvement.

Week 3 (Feb 24th - Mar 1st): Optimize and compare results, and extend it to video de-fencing.

Week 4 (Mar 2nd - Mar 10th): Continue working on algorithms and optimization. Wrap up our results and complete the final report.

References

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