Continuous Foreground Extraction with Flash and No-flash Image Pairs

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1 Summary

The primary objective of this project is to build a continuous foreground extraction algorithm with flash and no-flash pairs with a tunable depth parameter d. I plan to take a few pictures in flash and no-flash pairs that have multiple layers of depth from the camera and will try to extract each layer from the scenes.

2 Background

Existing foreground extraction framework only works when the foreground in the pictures is very far away from the background so that the flash effect is very different between foreground and background(essentially a binary distinction). However, in some cases the foreground is not so far from the background. As a result, the flash still has some influence over the part with deeper depth instead of zero influence in the previous assumption. As a result, the definition of background and foreground is not as clear as before. Instead, I will try to come up with a a discrete and tunable parameter d, which controls the amount of info we need in the foreground.

This project is very intriguing and complex based on multiple reasons. First, there are indeed some practical applications in real life. For instance, if Bob stands in front of Lincoln's statue(which is partially affected by the flash), and there are many skyscrapers in the far end. Traditional foreground extraction may only include Bob in the picture. But if we relax our distinction in the standard algorithm to some extent, we can also include Lincoln's statue. The core challenge is, how do we define and integrate this "relaxation" into mathematical computations to the existing foreground/background segmentation algorithm?

3 Resources

3.1 Hardwares

I have the access to all the problems below.
(1) Nikon d3500 for taking flash/no-flash pairs of pictures.
(2) A Tripod

3.2 Papers

This paper formulates foreground/background segmentation as a binary labeling problem. Basically we want to find the set of labelings that minimizes the energy of an Markov Random Field.

Sun, Jian, et al. "Flash Cut: Foreground Extraction with Flash and No-Flash Image Pairs." 2007 IEEE Conference on Computer Vision and Pattern Recognition, 2007, https://doi.org/10.1109/cvpr.2007.383080.

3.3 Misc.

I plan to use the same set of python libraries as we did in previous homework as of right now. There is also no use of codebases and I will develop everything from scratch.

4 Goals and Deliverables

4.1 100% goal

(1) Get a binary labeling algorithm works to the extent that it captures the foreground **somewhat** accurately, since implementing all parts of the paper can be very challenging given the existing time frame and complexity.
(2) Twist the binary labeling algorithm and add the control parameter d into the system.
(3) Show the control parameter works as expected **to some extent** by presenting the output pictures produced by the same flash/ambient pairs.

4.2 125% goal

(1) Get a binary labeling algorithm works to the extent that it captures the foreground **very** accurately, which requires all the implementation details in the paper.
(2) Twist the binary labeling algorithm and add the control parameter d into the system.
(3) Show the control parameter works as expected by presenting the output pictures produced by the same flash/ambient pairs.
(4) Discuss the pros and cons of my new implementation, such as accuracy, computational costs, extendability, etc.

5 Schedule

5.1 11/07

Write through the paper again to fully understand the algorithm and corresponding mathematical challenges.
Compute the foreground flash term E_f, which consists of histogram classifications of pixels of separate channels. This term tends to label the pixel with significant appearance change as foreground.

5.2 11/14

Compute the background flash term E_m. It tends to label the pixel with good matching ans small appearance changes as background.
If time allows, compute the color term E_c, which models the foreground and background color likelihoods in the image.

5.3 11/21

Try to come up with a way to solve the system of equations, which means finding a set of binary labeling the minimize the total energy function.

5.4 11/28

Come up with a way to integrate the parameter d into the energy functions so that the output binary labeling changes as we expected.

5.5 12/05

Take a few set of flash/ambient pairs of pictures that have multiple depth layers. Test my implementations on these picture pairs to make sure they work as expected.

5.6 12/12

Finish up my analysis and report and get ready for presentations.