Comp Photography (Fall 2015) Final Project

Hieu Nguyen
hieu@gatech.edu

Bokeh Panorama

Panoramas are typically used to represent a wide-angle view of a scene, such as an expansive landscape or skyline. *Bokeh* is commonly used in portraiture photography to make the subject stand out against a blurred background. This project attempts to combine these two photographic techniques to create a bokeh panorama, also known as the Brenizer Method.

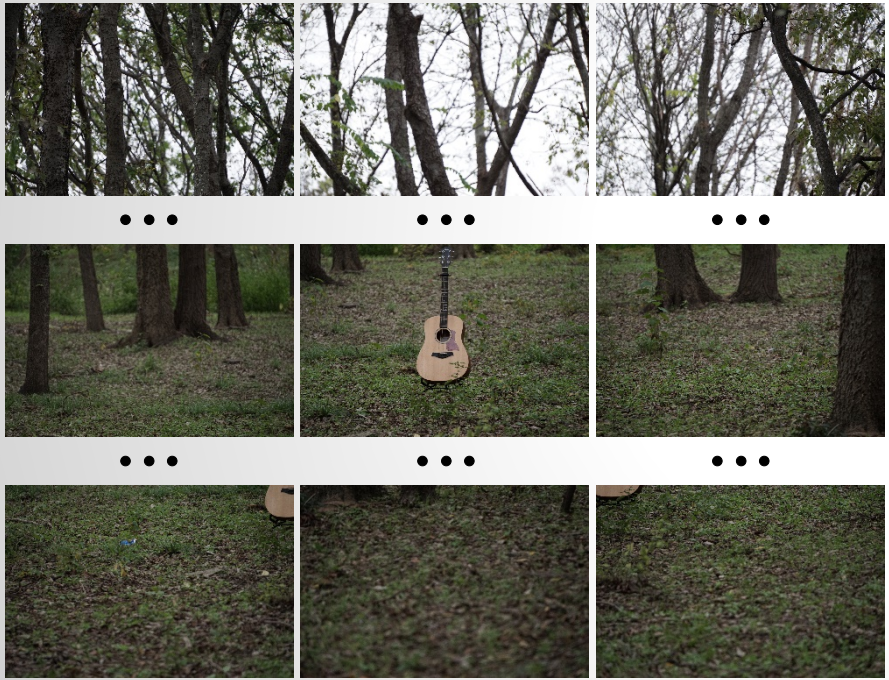
The Goal of Your Project

The motivation for this project was simply just seeing some brilliant examples of the Brenizer Method. Some of my favorite examples are shown here. This photographic technique utilizes panoramic stitching to create stunning portraits with a shallow depth of field and wide angle of view. It provides a way of imitating a generally traditional film-based process with digital equipment. The final result looks like a picture taken with a very large sensor and/or a very fast lens (aperture < f/1).

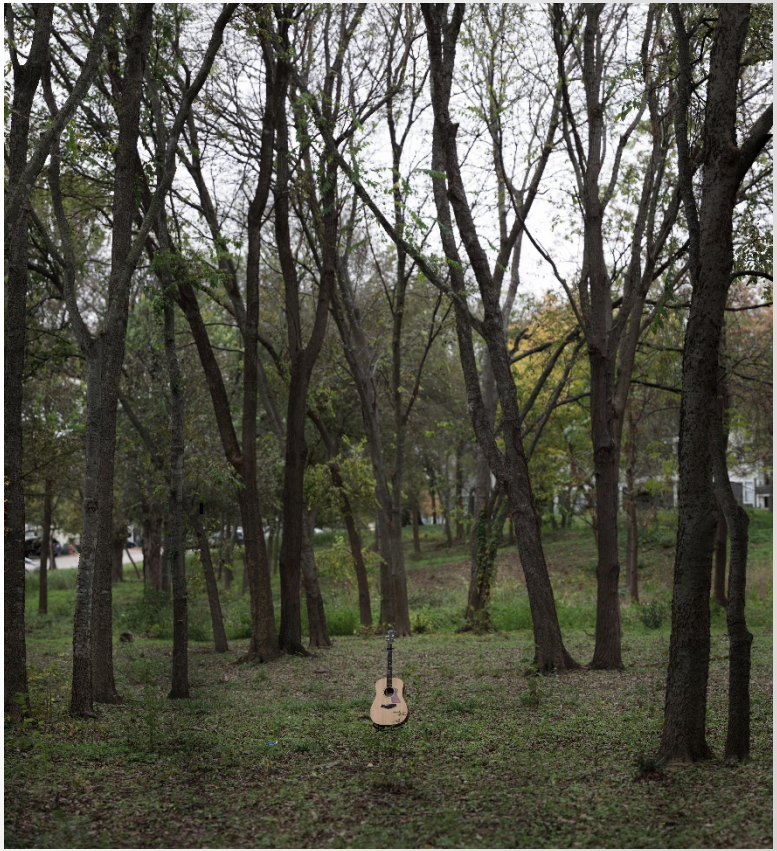
The goal is to do this computationally.

Showcase what you did. This could be many images, but this single slide should be a good pictorial of your work

Input



Output



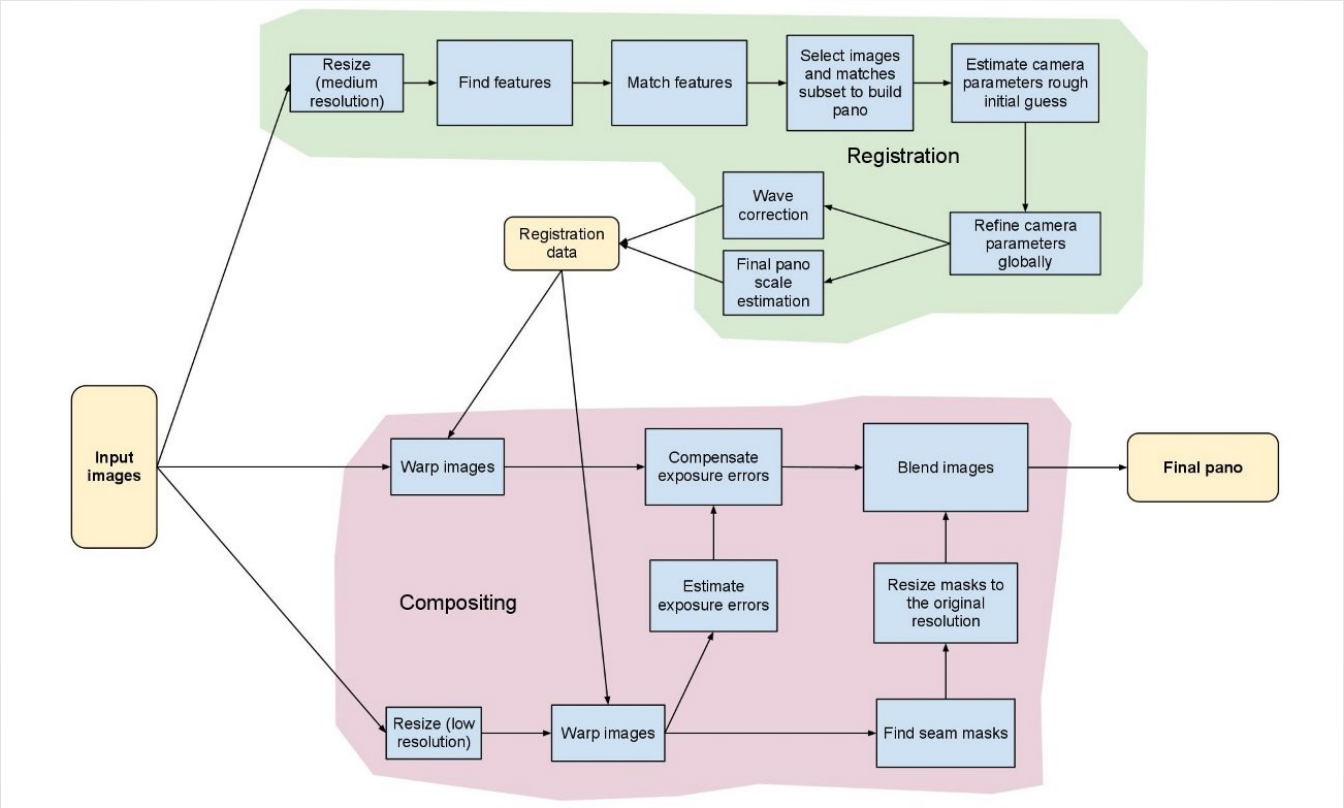
Showcase your pipeline

The high level pipeline is very similar to the panorama pipeline used in Assignment 8. However, for bokeh panorama, the input images are critical. For the best results, the inputs must have uniform exposure. This can be accomplished by locking manual camera settings such as white balance, ISO, aperture, shutter speed, and focus. I utilized my camera's Auto Exposure Lock (AEL) button to maintain the same exposure between shots. It is important to keep the camera stationary (e.g. tripod) and overlap each frame to improve feature matching in the stitching process. I also used my longest lens at the widest aperture to help reduce parallax errors.

Showcase your pipeline

The stitching algorithm I developed for Assignment 8 was not good enough to process the amount and types of input images for this bokeh panorama. However, the high level concepts are still there. Feature detection and matching, homography projection, warping, and blending. I took advantage of OpenCV's Stitcher class, which brings in a more robust pipeline for registration and compositing. It includes advanced features such as wave correction, exposure compensation, and seam masking. I also tried stitching with Microsoft's Image Composite Editor (ICE), and also stitching from video.

OpenCV's Stitching Pipeline



Showcase your pipeline

The result from the stitching process is then cropped to an appropriate dimension to avoid undesired holes or warping effects. I also experimented with ICE's auto complete feature. This auto complete software is able to identify patterns in the image and fill in the gaps (similar to Adobe Photoshop's content-aware fill).

Showcase your pipeline

The output image is then exported to disk, ready to be viewed and shared on teh interwebs!

What is the best way to see your project?

Here are some of my results:

- Between Two Trees (49 image bokeh panorama)
- If a Guitar Falls in a Forest (99 image bokeh panorama)
- Cloudy Hat (31 image bokeh panorama)
- Saw on Fence (8 image bokeh panorama)

Full resolution cropped outputs:

- https://drive.google.com/folderview?id=0B-9-oKYR8vK2TUd0LVZhdkx2TDA&usp=sharing

What worked

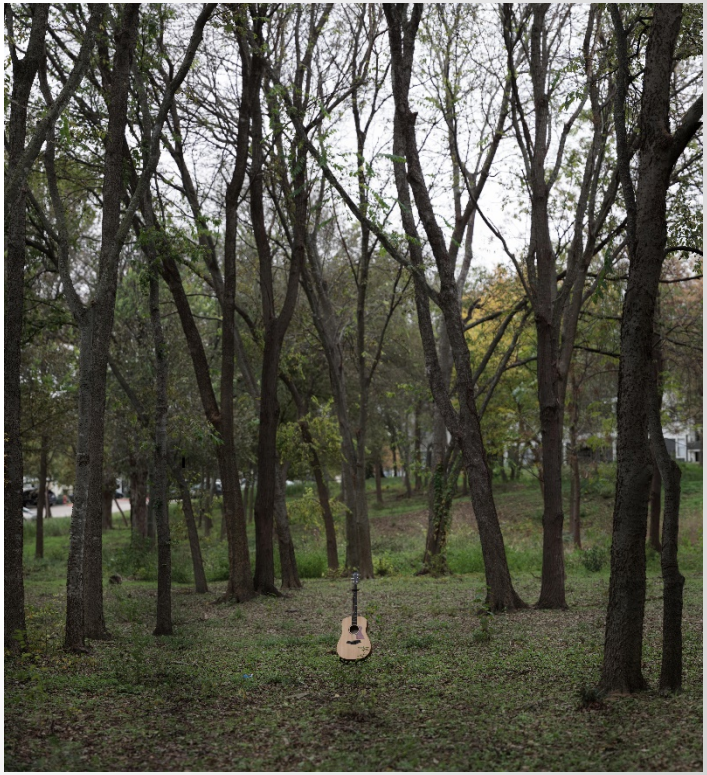
The stitching process was successful for the most part. I based my code off OpenCV's C++ stitching_detailed example. This code was able to handle multiple images in different orientations without any problems. My algorithm from Assignment 8 fails for multiple images not in a cylindrical order, and the blending was subpar. With OpenCV's stitcher class, the blending is seamless! The final output bokeh panoramas look great and are much higher resolution than their single shot counterparts. I love the Brenizer Method's effect on portraits; it really brings out the subject in an artistic, aestetically-pleasing way.

What did not work? Why?

There were some instances where I needed to adjust the input files or tweak the stitching parameters (such as warp_type) to generate a useable output. A lot of trial and error went into playing with the OpenCV stitcher class. There were several exceptions thrown and errors of insufficient memory. For the OutOfMemoryError cases, I turned to Microsoft ICE to perform the stitching. It is a more robust software that resizes images and manages memory better, handling nearly 100 images for my “If a Guitar Falls in a Forrest” bokeh panorama. However, on the low end, my OpenCV code had faster execution times than ICE, probably due to ICE’s graphical user interface attributes.

Comparison with Single Shot

It may be difficult to tell here, but the bokeh panoramas result in a higher resolution image with a more shallow DOF and wider angle of view, when compared with a single shot. Can you tell which is which?



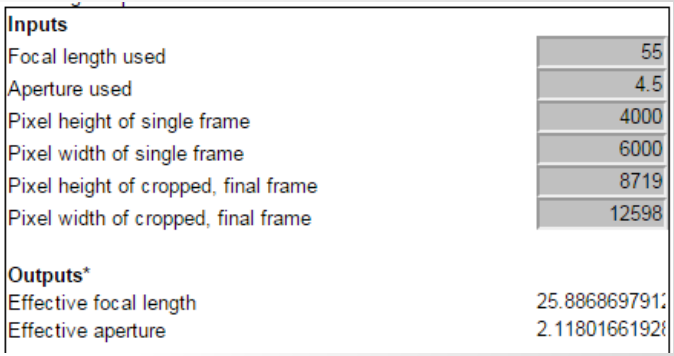
Comparison with Single Shot

Effective Lens

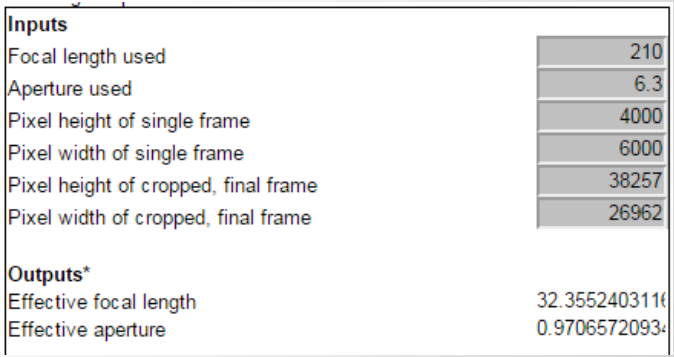
Brett Maxwell has a calculator on his website that tells you the focal length and aperture that your bokeh panorama has effectively accomplished when stitching multiple photos together. This is the lens that would be needed to achieve the same photo (composition, perspective, and depth of field) in a single shot.

My camera is a Sony a6000 with Sony 18-55mm, f/3.5-f/5.6 and 55-210mm, f/4.5-f/6.3 lenses.

For my “If a Guitar Falls in a Forest” panorama, the effective lens is a 32.35mm, f/0.97! The cheapest 35mm, f/0.95 lens I found was $600 on eBay.



Inputs	
Focal length used	55
Aperture used	4.5
Pixel height of single frame	4000
Pixel width of single frame	6000
Pixel height of cropped, final frame	8719
Pixel width of cropped, final frame	12598
Outputs*	
Effective focal length	25.886869791
Effective aperture	2.1180166192



Inputs	
Focal length used	210
Aperture used	6.3
Pixel height of single frame	4000
Pixel width of single frame	6000
Pixel height of cropped, final frame	38257
Pixel width of cropped, final frame	26962
Outputs*	
Effective focal length	32.355240311
Effective aperture	0.9706572093

ICE Auto Complete

Microsoft ICE has an auto complete feature, which is able to identify patterns in the stitched image and fill in the gaps. This allows for a larger region to be cropped, accounting for image sections that might have been missed in the input process.

Bokeh Panorama from Video

Microsoft ICE has a neat feature that allows you to create a panorama from a video. I took a video with locked exposure settings and panned around the entire scene. The result turned out great! It also allows for auto complete. ICE is really cool!

Conclusion

I enjoyed this project because I really wanted to explore the Brenizer Method. I've got a low-tier camera with a couple of mountable lens options, but I'm too cheap to invest in better equipment. The Brenizer Method allows you to effectively emulate these complex, expensive photography setups to achieve an impressive portrait.

In the future, I'd like to explore automating the input process. It can be quite cumbersome to take a collection of images, keeping the camera very still. This does not bode well for moving subjects or brief moments. Perhaps there is a good way to do this on smartphone cameras, in conjunction with the phone's accelerometer, magnetometer, and gyroscope sensors.

I'd also like to try photographing humans with this method.

References / Pointers

Background Info:

- https://en.wikipedia.org/wiki/Brenizer_Method
- https://www.flickr.com/groups/brenizermethod/
- http://brettmaxwellphoto.com/Brenizer-Method-Calculation/

Stitching:

- http://docs.opencv.org/2.4/modules/stitching/doc/stitching.html
- http://research.microsoft.com/en-us/um/redmond/projects/ice/

Bokeh Panorama Examples from “Goal” Slide:

- http://www.samhurdphotography.com/2012/editorial/epic-portait-george-Clooney
- https://www.flickr.com/photos/keochkeriandavid/
- http://www.kolor.com/wiki-en/action/view/Autopano_Brenizer_Method

Team

Unfortunately, this was a solo project.

Credits/Thanks

Thanks to Prof. Essa and the TA’s for a great course! I’ve been taking pictures for pretty much my entire life, but I now finally understand how digital photography works. My future photographs will definitely benefit from the things I’ve learned.

This was my first semester in the OMSCS program, and I loved it!