Computational Photography

Final Portfolio

Sam Chothirakunel Joy

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Assignment #1: Epsilon Photography

Purpose

In this assignment, a novel image is formed by combining images of the same scene through a small variation of a single camera parameter.

Experience

- As this was my first assignment, I learned a lot about handling phone cameras. I especially learned the effects when changing the aperture size, shutter speed and ISO settings.
- I learned how to setup a camera on a tripod which proved useful in ensuring the camera was stationary.
- I experimented with changing the shutter speed and took suitable values that made the images distinct.
- To generate the final artifact, I took the average of all the input images.

Assignment #1: Epsilon Photography

Results

Image 1

Image 2

Image 3

Image 4

Final Artifact

The input images captured differ based on the shutter speed used. The final artifact captures all the grains in the apple visible in some images and not others and vice-versa.

Assignment #2: Camera Obscura

Purpose

In this assignment, a camera obscura is contructed and its operation is documented.

Experience

- It helped me understand the challenges in setting up this primitive version of a camera.
- This assignment takes a considerable amount of time in getting the setup and output right.
- A well lit scene is very important in getting a good image on the screen.
- While setting it up, there would be openings where light would seep through. Black insulation tape would fix this. Hence, it helped me understand how it is important to use the right materials for this experiment.
- I had experimented with changing pinhole dimension which helped me understand its impact on image quality. I learned that as pinhole size increases, the image becomes brighter. However, the sharpness of the image increases and then decreases.

Assignment #2: Camera Obscura

Results

Scene

Setup

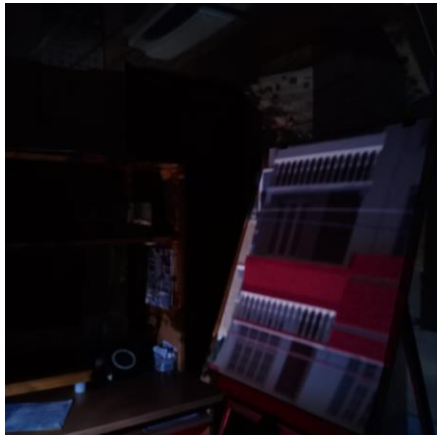
Final Image

Assignment #2: Camera Obscura

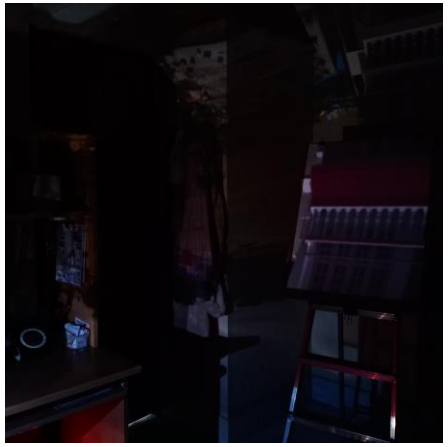
Above and Beyond

For above and beyond section, I varied the distance between the pinhole and screen and captured the effects on the inverted image.

Screen at 50 cm from pinhole



Screen at 100 cm from pinhole



Screen at 200 cm from pinhole

I learned that as the distance of the screen from pinhole is increased, the image becomes darker and every object in the image becomes larger in area.

Assignment #3: Blending

Purpose

In this assignment, a pyramid blending pipeline is to be set up that will allow to combine separate images into a seamlessly blended image.

Experience

- I learned how to use GIMP to create a mask.
- As the mask generation was manual, it made me appreciate the importance of automatic mask generation.
- The practical applications of the concepts of Gaussian and Laplacian Pyramid helped me understand its usefulness in generating a blended image.
- When selecting the input images, I learned how important it was in choosing images with the same lighting conditions. This is because when blending, the final blended image should appear as a single image.

Assignment #3: Blending

Results

White Image

Black Image

Mask

Final Blended Image

Assignment #3: Blending

Above and Beyond

In this section, I experimented with another blending technique called seamless cloning on the same input images.

Seamless Cloning – Normal mode

Seamless Cloning – Mixed mode

Using this technique, the objects merged well into another that is seamless and natural.

Assignment #4: Panoramas

Purpose

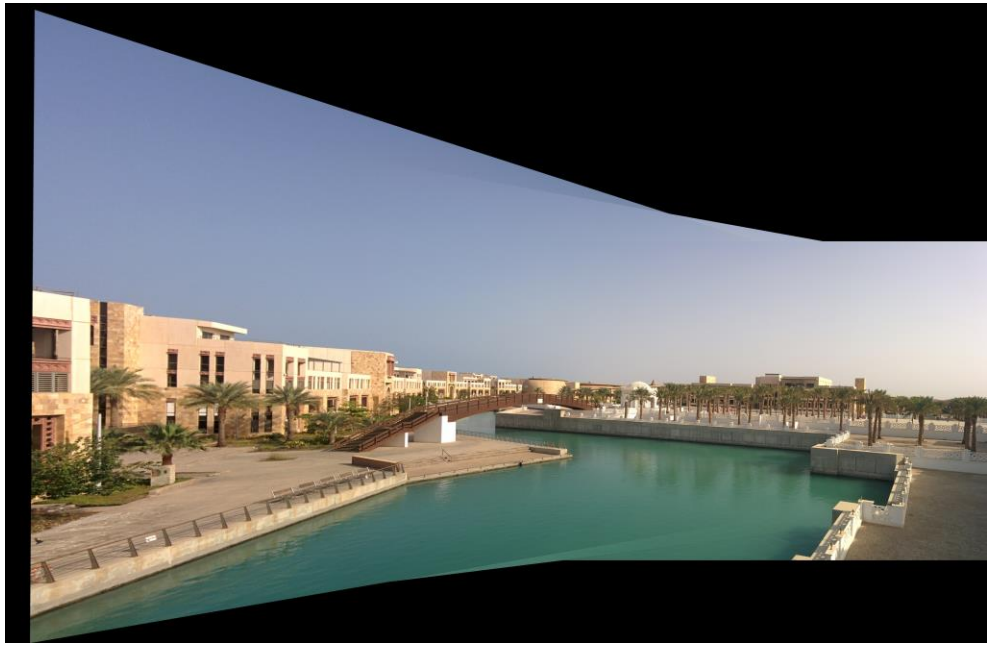
In this assignment, the goal was to align and stich together various images into a panorama.

Experience

- I understood the importance of good feature detection and matching.
- The number of matches were manually determined and hence took a bit of time to get the matching right. I learned its important to find a way to automatically determine the number of matches.
- Implementing homography for this assignment enabled me to understand the concepts. I also allowed to understand its usefulness for panoroma applications.
- A lot of time was spent in removing any visible seams in the final image.
- I learned how to successfully implement alpha blending with cross fading.

Assignment #4: Panoramas

Results



Panoroma from sample images

Panoroma from original images

Assignment #5: HDR

Purpose

In this assignment, the goal is to produce an HDR image using algorithms from the paper "Recovering High Dynamic Range Radiance Maps from Photographs".

Experience

- Implementing the concepts from the paper helped me understand how an HDR pipeline works. Specifically, I understood the importance of radiance Map and response curve.
- I learned that when taking the input images, the aperture and ISO should remain constant and only the exposure times should change.
- It is important that the scene itself has a high dynamic range that can be captured by varying exposure times.
- The final output was a bit washed out and not rich in color. This would be solved through tone mapping.

Assignment #5: HDR

Results

HDR image from sample images

Assignment #5: HDR

Results

1/25s

1/13s

1/6s

1/3s

1/2s

1s

2s

FInal HDR Image

Assignment #5: HDR

Above and Beyond

In this section, I learned and applied Global tone mapping to the HDR image.

The tone mapped image is more rich in color compared to the previous output with no tone mapping.

Assignment #6: Video Textures

Purpose

In this assignment, the goal is to create video textures. This means to identify a part of a video which can generate an infinite loop.

Experience

- As this is the first assingment regarding videos, it helped me understand how a video can be thought of as multiple image frames stacked together to form a video volume.
- I learned the video texture pipeline and concepts such as similarity matrix.
- Finding the right value of alpha that generates the infinite loop takes some amount of time.
- I had to spend considerable amount of time in finding an input video where a video texture could be generated.

Assignment #6: Video Textures

Results

Output from sample images

Link: https://drive.google.com/file/d/1EES7tZuhVA_ouIwrR-j13REwR5gBETHO/view?usp=sharing

Output from original images

Link: https://drive.google.com/file/d/1FSlBJHnX4zVbl884NRFUVLRb53eeCtuG/view?usp=sharing

Assignment #5: HDR

Results

1/25s

1/13s

1/6s

1/3s

1/2s

1s

2s

FInal HDR Image

Midterm Project

Purpose

In this project, the goal is to replicate results of the papers "Seam Carving for Content-Aware Image Resizing (2007) – Shai Avidan and Ariel Shamir" and "Improved Seam Carving for Video targeting (2008) – Michael Rubinstein, Shai Avidan and Ariel Shamir"

Experience

- The implementation details of the seam carving techniques were quite vague. Hence, it was a challenge coming up with the right assumptions in order to accurately replicate the results.
- The paper never explcitly mentioned what gradient function to be used. Hence, I had to experiment with various edge detectors such as sobel, scharr, etc.
- While doing seam insertion, the images contained a lot of artifacts. I realized that the seam positions needed to be readjusted as the oroginal position is lost during seam removal.
- The sizes of the target images were not explicitly mentioned. So, I made a guess as to the size to be targeted.

Midterm Project

Results

Fig 5 (2007)

Fig 8c (2007)

Fig 8d (2007)

Fig 8f (2007)

Midterm Project

Results

Fig 8 (2008), backward

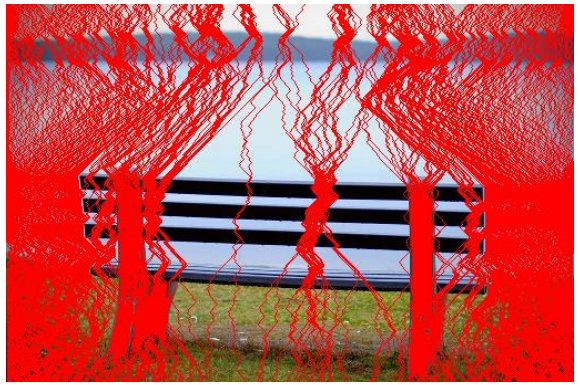


Fig 8 (2008), backward, seams

Fig 8 (2008), forward

Fig 8 (2008), forward, seams

Midterm Project

Results

Fig 9 (2008), backward, shrink

Fig 9 (2008), forward, shrink

Fig 9 (2008), backward, expand

Fig 9 (2008), forward, expand

Final Project

Purpose

In this project, various techniques that combine the strengths of flash and no flash images are analaysed in detail. This includes denoising and detail transfer, white balancing, continuos flash adjustment and red-eye correction. It is shown how these techniques can synthesize new images that are of higher quality than the originals. This project is based on the paper **Digital Photography with Flash and No-Flash Image Pairs** by Selinski et al[2].

Experience

- This paper was very interesting. I was able to replicate the results of all the techniques on the author's images and three of them on original inputs.
- There were times when the paper was quiet vague as to the implentation of a concept. In such scenarios, I would do my own research and finally narrow it down to one implentation that ultimately produced satisfactory outputs.
- As the images were quite large for processing, I used numba to speed up the process.
- Denoising and detail transfer was the most time consuming of all techniques as it had many sub parts to implement.
- While detail transfer was straightforward, the challenge was in getting the shadow mask right. I had to experiment with various morphological operations such as erosion and dilation to get a good result.
- Like details transfer, red-eye correction involved spending some time on morphological operations in order to get a good result.

Final Project

Results

Denoising and Detail Transfer

No flash

Flash

Denoised image with detail transfer

Final Project

Results

White Balancing

No flash

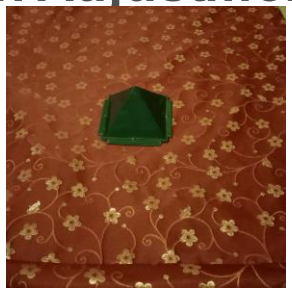
Flash

White balanced image

Final Project

Results

Continuous Flash Adjustment



No flash

flash

Alpha = -0.5

Alpha = 0

Alpha = 0.25

Alpha = 0.5

Alpha = 1.0

Alpha = 1.5

Final Project

Results

Red-Eye Correction

No flash

Flash

Corrected Image