CSCE 448/748 - Computational Photography

Assignment 1

Deadline: Jan. 29th

1 Goal

In this project, you will work in groups of at most 3 to design a pinhole camera. All the team members get the same grade. The pinhole camera (also called the "camera obscura") is essentially a dark box with a pinhole on one face and a screen on the opposite face. Light reflecting off an object is directed through the pinhole to the screen, and an inverted image of the object forms on the screen. The caveat is that it is hard to see the image formed with the naked eye. To be able to see the image, we will use a digital camera with a long exposure time (15-30 seconds) attached to the pinhole camera. A diagram of the setup is shown in Fig. 1.

2 Task 1

Follow the steps below to build your pinhole camera:

- Find a cardboard box. It does not have to be too big, but it does have to ultimately be "lightproof"; a shoebox will work fine. The cardboard box should be such that the distance between the pinhole and the screen is longer than the minimum focus of the digital camera, so you do not get a blurry image.
- Obtain a digital camera with the ability to capture images with long exposure time (15 to 30 seconds). Note that with certain apps you can capture long exposure images even with your smartphones.
- Determine which face of the box should be your screen. Cover the inside of this face with white paper; printer paper is fine.
- Cover the rest of the faces on the inside with black paper. Use duct tape (best to use black tape) to make sure the papers are stuck to the box.
- Create the pinhole on the opposite face of the screen. Putting the pinhole directly on the cardbox is not a good idea since **1)** the cardboard is thick which limits the field of view of your camera and **2)** this design is not flexible and won't let you try capturing images with different pinhole sizes. To alleviate this issue first cut a hole in the box and cover this hole with card paper. The pinhole will be punched into the card paper. This way you can change your pinhole by changing the card paper.
- Next to the hole for the card paper, cut a hole for the digital camera's aperture. The camera aperture should fit snugly into the hole, so the light doesn't get in. The digital camera's hole should not be too far from the pinhole, since the camera's field of view may not be wide enough to capture the screen's image: you may have to angle the digital camera a bit towards the pinhole. Figure out the appropriate settings for the digital camera (i.e., long exposure time), and make sure it is charged before you duct tape it. **Make sure the camera is focused on the back of the box, otherwise you get blurry images no matter what the size of the pinhole is.**
- Duct tape your box (black tape is the best) to make your box light proof.

3 Task 2

Follow the steps below to capture images using your pinhole camera

- Take the setup to a nice sunny area.

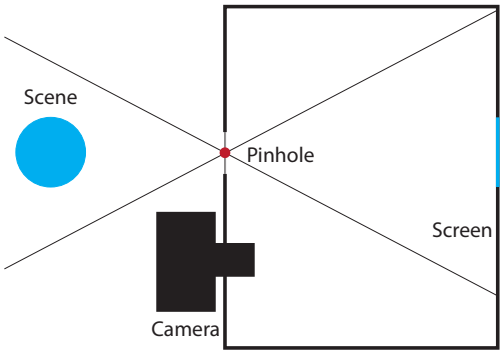

Figure 1: Pinhole camera

- Point the pinhole in the direction of an object of interest.
- Set up the digital camera so that it will capture a long exposure image.
- Shoot, and hold still for 15-30 seconds. The exposure time depends on the brightness of the scene and the size of the pinhole.

Use three size of the pinhole, e.g., 1 mm, 3 mm, and 5 mm. Note that, these are just suggestions. The point is to capture images with small, medium, and large pinhole sizes. You don't need to measure the diameter of the hole to be exactly these values. Make your design so that you can easily switch between card papers with different hole sizes. For all three pinhole sizes capture two scenes (6 images). Also capture an image of the scene with your cellphone to be able to compare it to your captured images.

4 Extra Credit

- Perform light painting. You can use the camera (not the pinhole one) to capture these images. Show two examples.
- Build stereo pinhole camera to create an anaglyph image. Make sure you capture an anaglyph image and not two separate images with different filters. Also you do not need to perform any correspondence, disparity, or depth estimation.

5 Write up

For each scene include four images (three images for the three pinhole sizes and an image of the scene with cellphone camera) in your report. Specify the settings for each image, i.e., pinhole size, exposure. You need to analyze the images by discussing the effect of the pinhole size on the image quality and required exposure time. You should also include images of your pinhole camera itself. If you do any of the extra credit items, you need to include and discuss them in your report.

6 Graduate Credit

Graduate students have to do both extra credit items to get the full credit.

7 Deliverables

For this assignment you only need to submit a report in the pdf format. **Make sure you have written the name of all your team members on top of the report. Otherwise, no grade can be given to the other team members.** Only one student will submit the report through Canvas on behalf of the entire team. All the team members will receive the same grade.

8 Ruberic

Total credit: [100 points]

[40 points] - Designing the pinhole camera
[40 points] - Capturing images of two scenes with three different pinhole sizes
[20 points] - Analyzing the results

Extra credit: [10 points]

[02 points] - Light painting
[08 points] - Stereo pinhole

9 Acknowlegements

This project is derived from Alexei A. Efros Computational Photography course with permission.