CSCI 5980: Assignment #1

Camera Obscura

1 Submission

- Assignment due: Jan 26 (11:55pm)
- Individual assignment
- Write-up submission format: a single PDF up to 3 pages (more than 3 page assignment will be automatically returned.).
- Submission through Moodle.

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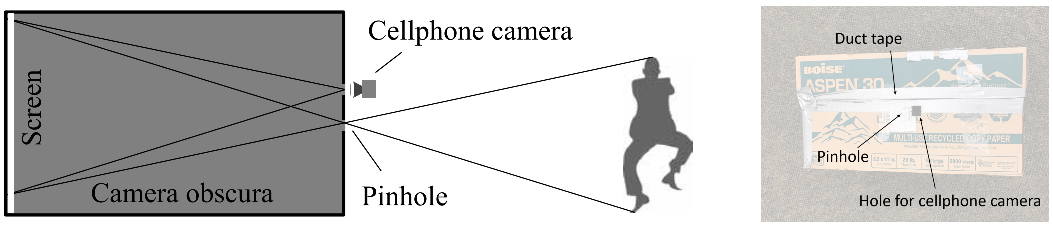
2 Designing Camera Obscura



(a) Camera obscura (b) Example design

Figure 1: You will design a camera obscura with your cellphone.

In this assignment, you will design a camera obscura with your cellphone camera. The camera obscura is a dark chamber (box) with a small pinhole where light is mapped to the other side of the chamber (screen). This creates an upside-down image.

1. Build a lightproof dark chamber: the chamber will be only illuminated by the light from the pinhole. Play with different size of chambers if possible. Cover the screen with a white paper and the rest of insider surfaces with black papers. Be creative!
2. Make a pinhole on the other side of the screen. Start with a small hole (diameter<1mm) and adjust the size of the hole to get more light. Trade-off is that the bigger hole, the brighter image but blurrier.
3. Set the camera focal length to the manual mode (AF→MF) and adjust the focal length to see an object at the distance between the pinhole and the chamber screen.
4. Set the camera sensitivity (>ISO 800).
5. Set the camera exposure time (>8 sec).
6. Make an additional hole where your cellphone camera can look inside. Locate your cellphone camera close to the pinhole without occluding pinhole. Make sure this hole is completely light sealed.
7. Take a picture and adjust the pinhole size and camera settings to make better sharp image.

For an Android phone, you can control the exposure time and sensitivity easily. Camera FV-5 Lite is an app to grab a long exposure image. For iOS, the exposure control is highly limited. There are apps that simulate the long exposure effect by taking many images. This creates a noisy image. You may borrow an Android phone or old digital camera. You can also refer to the website: `http://graphics.cs.cmu.edu/courses/15-463/2015_fall/hw/proj5-camera/`.

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Note: Lighting is extremely important. Given Minnesota's weather, it is difficult to find a nice cloudless day. Plan outside data capture on sunny day ahead.

Write-up:

(1) Describe your design (dimension) with images and your camera setting. Share your awesome photos.

3 Where am I?

(a) Lateral view (b) Camera obscura image (c) Original image

Figure 2: You will your camera obscura to estimate depth.

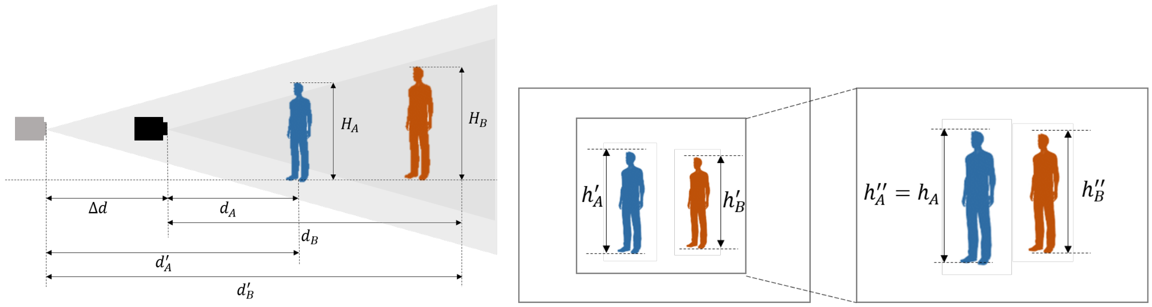
Using this camera obscura, you will estimate the depth of a 3D object (from pinhole). You will take a picture containing your two friends (A and B) whom you know their height in meter where they will stand at different distance from the camera as show in Figure 2(a).

Write-up:

(1) Given the height of A in meter (H_A) and pixel (h_A), derive and compute the distance from A to the pinhole.

(2) Given the height of B in meter (H_B) and pixel (h_B), derive and compute the distance from B to the pinhole.

Note: You can measure pixel distance using an image viewer software, e.g., irfanview, or MATLAB.



(a) Geometry (b) Image cropping

Figure 3: You will your camera obscura to estimate depth.

4 Dolly Zoom

You will simulate the Dolly zoom effect using your camera obscura. You will take at least two pictures with different camera locations, e.g., taking 5 step back, Δd, as shown in Figure 3(a). A and B will appear smaller than the first image as $\Delta d > 0$. You can apply the zoom-in effect by scaling and cropping the image such that A appears the same as shown in Figure 3(b). You may find a reference from here: `http://www-users.cs.umn.edu/~hspark/CSci5980/Lec1_Supp_DollyZoom.pdf`.

Write-up:

(1) Predict the height of B in the second image given h_B in the first image. Reason about the prediction. *Hint: You may need to compute* Δd *with the information in the second image.*

(2) Confirm the prediction by measuring the height of B in the second image.

Useful MATLAB functions:
(a) *Load image*: im = imread(filename).
(b) *Save image*: imwrite(im, filename).
(c) *Resize image*: im = imresize(im, scale).
(d) *Display image*: imshow(im) or imshow(filename).
(e) *Measure the distance in image*: display the image in a figure, select the data cursor icon in the figure toolbar, and click on the image to get the coordinates of certain pixels. Calculate the distance with the pixel coordinates.