Exam 1

Submission: Submission deadline is Monday, April 5, before class.

Requirements: The exam has 3 questions (each is worth 100/3 points). The exam is open book and open web, but you need to cite all the materials (books, web pages, etc) that you referred to. Take-home exams may not be discussed. No collaboration is allowed. You should include the following two statements on the front page of your exam write-up, which you need to sign physically or electronically:

1. "Below is a listing of the sources I used for this open book, open web test:"

2. "I affirm that I did all the work for this exam myself, and did not receive help from anyone else. I also did not give help on this exam to anyone else in the class. Signature: _____ Date:_____"

Problem 1 *Pinholes*

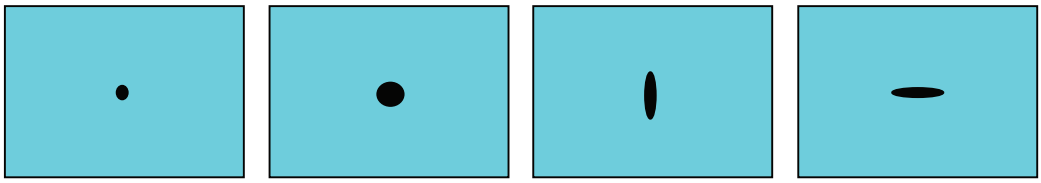

Figure 1: Each image corresponds to the frontal view of a pinhole camera with different shapes for the apperture.

Consider a pinhole camera in which we change the geometry of the aperture as shown in figure 1.

Take an image and consider that it is situated in front of the pinhole camera. Simulate the images that would be taken by the pinhole camera for each of the four aperture shapes.

It is not important to take into account the exact size of the aperture. I only expect that you provide images that illustrate the qualitative behavior of each aperture shape and to describe the reasoning behind your result.

Problem 2 *Textons*

This problem consists in computing textons given an image. You should use the image midterm.png.

1. Apply Sobel operators (x and y directions) to the image. Let's call the outputs, M_x and M_y. Plot the results and attach it.

2. Suppose the result from part (a) as M_x and M_y. Compute orientation based on this (i.e. $\theta = \tan^{-1}(\frac{M_y}{M_x})$). Plot the result and attach it.

3. Discretize the orientation into 8 different angles.

4. For each pixel, compute a descriptor that will be the histogram of orientations in a neighborhood of 11×11 pixels. Orientations should only contribute to the histogram if the magnitude M at each pixel is above some threshold (you have to handpick this threshold).

5. Using K-means, cluster those vectors into 5, 10 and 50 textons. For each setting, assign textons to each pixel, plot the result and attach it.

Please submit all the figures and codes in addition to any comments.

Problem 3 *3D*

1. Show that the vanishing points of lines on a plane lie on the vanishing line of the plane.

2. Show that, under typical conditions, the silhouette of a sphere of radius r with center $(X, 0, Z)$ under perspective projection is an ellipse of eccentricity $X/(X^2 + Z^2 - r^2)^{0.5}$. Are there any circumstances under which the projection could be a parabola or hyperbola?