

**CS 378 / CS 395T Computer Vision**  
**Fall 2007**  
**Problem set 0**

Submit all of your responses for this problem set as hardcopy.

**Part 1. Concept questions: Image formation**

Answer the following questions.

1. Use the perspective projection equations to explain why, in a closeup picture of a (frontal) face, the nose appears much larger than the rest of the face.
2. Explain why in theory a pinhole camera has an infinite depth of field. Why isn't it practical to achieve this?

**Part 2. Exercises: Using Matlab.**

For information about the CS department's computer labs and/or to setup a new UNIX account, go to <http://www.cs.utexas.edu/facilities/computing/>.

If you are unsure what a Matlab function does, check the reference manual (at the command line, type 'help' and then the command name).

1. Read over the provided Matlab introduction code and its comments. Open an interactive session in Matlab and test the commands by typing them at the prompt. Make a note of any commands or outputs that are unclear. (Skip this step if you are already familiar with Matlab.)
2. Describe (in words where appropriate) the result of each of the following Matlab commands. Try to determine the output without entering the commands into Matlab.
  - a. `>> rand(4)`
  - b. `>> randperm(4)`
  - c. `>> a = [1:100];`  
`>> b = a([1:2:end]);`
  - d. `>> f = [101:200];`  
`>> g = find(f > 175);`  
`>> h = f(g);`

e. `>> sum(5.*ones(1,5))`

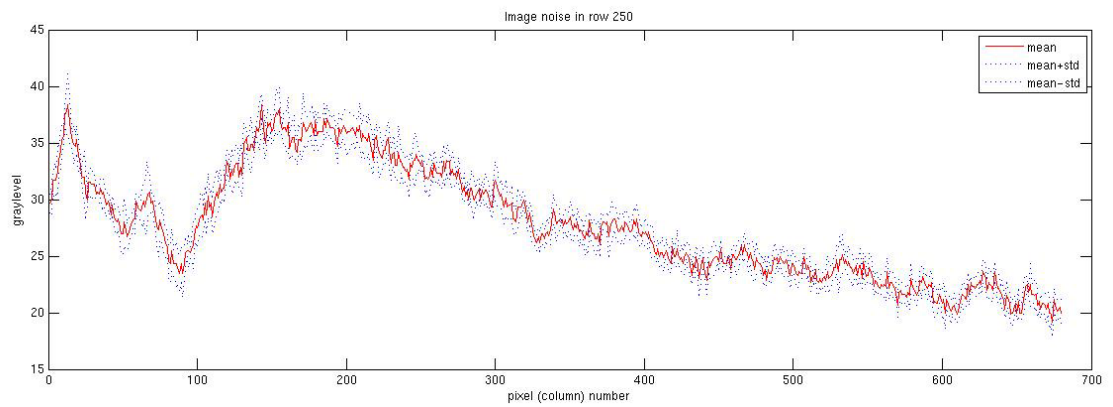
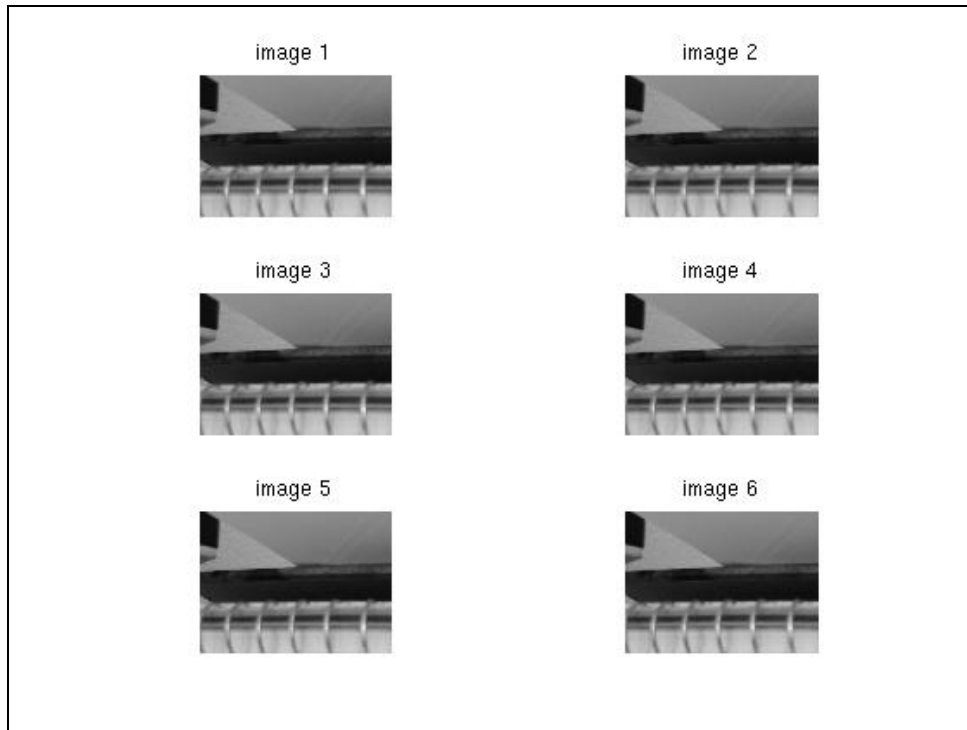
3. Given a 100 x 100 matrix A representing a grayscale image, write a few lines of code to do each of the following. Try to avoid using loops.
  - a. Plot all the intensities in A, sorted in increasing value.
  - b. Display a histogram of A's intensities with 20 bins.
  - c. Create and display a new binary image the same size as A, which is white wherever the intensity in A is greater than a threshold t, and black everywhere else.
  - d. Display the top left quadrant of A.
  - e. Generate a new image (matrix), which is the same as A, but with A's mean intensity value subtracted from each pixel. Set any negative values to 0.
  
4. Noise in the imaging sensor will affect the pixel intensity values we obtain. Even a sequence of images of the same static scene taken from a stationary camera will exhibit some variation in the pixel values at the same position in the image raster. Image acquisition noise is one reason it is dangerous to rely solely on pixel-level measurements to evaluate an image.

For this exercise, write a Matlab program to estimate an imaging system's acquisition noise based on a sample of frames captured from a static scene. For a given image position, treat the pixel measurements over time as noisy instantiations of a random variable. For a given sequence, measure the mean brightness of each pixel and its standard deviation (noise).

Test your program on the provided (six) images of a static scene.

- Use 'subplot' to display all of the images in one figure.
- Estimate the noise at each pixel across the sequence.
- Compute the average and maximum noise level across the entire image.
- Plot the mean graylevel and noise for a given scanline (row) in the image.

Turn in hardcopy of your code and screenshots of the figures generated. See example figure outputs below.



[This exercise adapted from Trucco & Verri, Chapter 2.]