

Homework #4
Due Fr. 3/04

You must turn in your code as well as output files. Please generate a report that contains the code and output in a single readable format.

Visit the book website to download companion software, including all the example problems.
<http://www.wiley.com/WileyCDA/WileyTitle/productCd-1118414322.html>

Test Images

Download the sample images from the class website
<http://www.ee.unlv.edu/~b1morris/ee482/docs/hw04>

1. (KLT 11.4)
2. Histogram Equalization
 - (a) Perform histogram equalization on the `jetplane.png` image using 256, 128, and 64 bins. Compare the original image and the histogram equalized images by plotting the corresponding histograms and images side-by-side in a 2×2 subplot matrix for each of the bin sizes.
 - (b) Perform the equalization in 32×32 blocks. Display the output image. You will find `blockproc.m` useful.
3. Noise Filtering
 - (a) Consider image `DSCN0479-001.JPG` as a perfect image. Add white Gaussian noise with variance 0.005. Smooth with a 3×3 and 7×7 box filter and a median filter. Compute the mean squared error (MSE)

$$MSE = \frac{1}{MN} \sum_m \sum_n (I_1(m, n) - I_2(m, n))^2$$

and the peak signal-to-noise ratio (PSNR)

$$PSNR = 20 \times \log_{10}(255/\sqrt{MSE})$$

for the noise reduced images. Which filter has the best results based on the error measures? How do the results compare visually?

- (b) Repeat (a) with salt and pepper noise with noise density 0.05.
 - (c) Do the filtering again but this time on a real noisy image `DSCN0482-001.JPG` obtained at higher ISO. Compare the results visually only this time. Which filter works best for “real” noise? How much time does each type of filter require (use `tick.m` and `toc.m`)?
4. Spatial Domain Filtering

The following question operates on the `city.jpg` image.

 - (a) Perform image smoothing using a 7×7 averaging filter and a Gaussian filter with $\sigma = 0.5$ and 3. Compare the outputs.

- (b) Perform edge enhancement using the Sobel operator (Matlab's default parameters). Repeat using the Laplacian and Laplacian of Gaussian operators. Compare the outputs. Be sure to read the help info for `fspecial.m`.

5. Frequency Domain Filtering

The following question operates on the `city.jpg` image.

- (a) Find the Fourier transform of the image. Be sure to center the frequencies using `fftshift.m`.
- (b) Perform image smoothing in the frequency domain using the filters defined in the previous problem. Compare the output images from the two methods (spatial and frequency).
- (c) Perform edge enhancement using the filters defined in the previous problem.
- (d) Define a lowpass filter in the frequency domain with radius of 1/4 the height. Display the LP filter in the frequency domain and show the result of filtering the input image.
- (e) Repeat with a rectangular filter with the same dimension as the ideal lowpass. Compare the results between the ideal filter and the rectangular approximation.

6. DCT

The following question operates on the `jetplane.png` image.

- (a) Write a function to compute the DCT coefficients for the image as described in Figure 11.12.
- (b) Give the coefficient output for block 3523 (raster scan ordering). Show the output both as a raw matrix and as the zig-zagged ordered vector.
- (c) Repeat for block 2637. Compare the outputs of the blocks and comment on results.