**EE475 Fall’18**

**Homework 4**

In problems 1-3

* Do the operations without zero padding directly in the frequency domain. The distortion ensuing from circular convolution is less important than the extra effort to interpolate spectra to the desired size.
* It is best if you shift your spectra by 180o so that DC is in the center. Similarly, your filters should be shifted to where M and N are the image dimensions as stated in the problems.

1. **Unsharp Masking and High-Boost Filtering:** Consider the 503x720 X-ray image of the chest (chestXray). Enhance the image using the Gaussian high-pass filtering approach. Recall that unsharp masking of an image is obtained as

where

1. Use a Gaussian high-pass filter , where . You can choose within 5% to 10% of the long image dimension of the image. Plot the corresponding filter mask as a heat map.
2. Plot the result of filtering with a Gaussian high-pass filter. Let 0 be represented as gray value (e.g., 80 or 128) and plot the absolute values of the GHPF output
3. Plot the result of unsharp masking the image, i.e., k=1 and the result of high-boost filtering for 1.6.
4. Histogram equalize the results of step c) and plot the results.

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1. **Moiré Noise Removal:** Consider the newspaper image with moiré pattern (car-moire-pattern).
2. Plot the magnitude spectrum in perspective.
3. Identify the prominent spectral peaks: find their center points of the peaks interactively on the magnitude spectrum and estimate their diameters to contain most of the energy, e.g., 3 dB points.
4. Design a notch filter (NP: notch-pass) to extract the moiré pattern. You can use a Butterworth notch filter . Choose n = 4 and D according to your estimate of the diameters above. Note that if there is a spectral peak at (u,v) = (k,l), then there must be also a notch filter placed at (-k,-l). Furthermore, there should be such a notch filter pair for every spectral peak involved. Plot the extracted moiré pattern.
5. Plot the image with the moiré pattern removed.

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1. **Deblurring:** Images can be degraded due to various environmental conditions and/or instrumental or imaging imperfections. If we can model the degradation, then we have a chance to recover the original image under certain noise conditions. Consider the 688x688 book-cover image.
2. Consider the model of an atmospheric turbulence where k controls the severity of the degradation. Set k = 0.0025. Add white Gaussian noise *N(0, 625)* to this image.
3. Plot side by side the original and the blurred & noisy version of the book-cover image.
4. Apply directly the inverse filter and also apply it with a cutoff frequency at radius 70 using a Butterworth low-pass filter of order 10. Comment on why low-pass filtering, which is expected to degrade the image, actually improves greatly the result of deblurring.
5. The image is degraded by camera motion and by AWGN *N(0, 625)*. The model for linear camera motion distortion is where a, b denote the rate of motion along x and y directions and T the diaphragm aperture time. Take a= b = 0.1 and T = 1 sec. Plot the original and degraded images side by side.
6. Restore the image by direct inverse filtering and by Wiener filter, e.g., eq. 5.8.6.

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1. **Importance of the Phase**
2. Reconstruct Trump from phase-only spectrum and magnitude-only spectrum,
3. Reconstruct Erdogan from phase-only spectrum and magnitude-only spectrum,
4. Reconstruct Trump from Erdogan’s phase spectrum and Trump’s magnitude spectrum
5. Reconstruct Erdogan from Trump’s phase spectrum and Erdogan’s magnitude spectrum
6. A few comments

