Computer Projects # 3

[1] Periodic Noise Reduction Using a Notch Filter

(a) Write a program that implements sinusoidal noise of the form given in Problems Set #3: $n(x, y) = A\sin(2\pi u_0 x + 2\pi v_0 y)$. The input to the program must be the amplitude, A, and the two frequency components u_0 and v_0.

(b) Download image 5.26(a) of size $M \times N$ and add sinusoidal noise to it, with $v_0 = 0$. The value of A must be high enough for the noise to be quite visible in the image (for example, you can take $A = 100$, $u_0 = 134.4$, $v_0 = 0$).

(c) Compute and display the degraded image and its spectrum (you may need to apply a log transform to visualize the spectrum).

(d) Notch-filter the image using a notch filter to remove the periodic noise.

[2] Download Fig5.07(b).jpg from the course webpage (X-Ray image corrupted by Gaussian noise).

(a) Write a computer program to implement the arithmetic mean filter of size 3x3. Apply the program to the image Fig5.07(b).jpg

(b) Write a computer program to implement the geometric mean filter of size 3x3. Apply the program to the image Fig5.07(b).jpg

(c) Explain your results. Evaluate the SNR (signal-to-noise-ratio) for both results in (a) and (b) (before denoising and after denoising). Note, higher SNR, better denoised image. Let $\hat{f}$ be the denoised image, and f the clean true image. Then $SNR = 10\log_{10}\frac{\sum_{x,y}(\hat{f})^2}{\sum_{x,y}(f-\hat{f})^2}$. To evaluate the SNR before denoising, substitute $\hat{f}$ by g in the above formula.

[3] (a) Download from the class web page the image Fig5.08(a).jpg (X-Ray image corrupted by pepper noise). Write a computer program that will filter this image with a 3x3 contraharmonic filter of order 1.5.

(b) Download from the class web page the image Fig5.08(b).jpg (X-Ray image corrupted by salt noise). Write a computer program that will filter this image with a 3x3 contraharmonic filter of order -1.5.

[4] Parametric Wiener Filter

(a) Implement a motion blurring filter as in Problems Set #3.

(b) Blur image 5.26(a) in the +45o direction using $T = 1$ ($a = b = 0.1$).

(c) Add a very small amount of Gaussian noise of 0 mean to the blurred image. For this, you can use the Matlab command:

J = imnoise(I,'gaussian',0,v) adds Gaussian white noise of mean 0 and variance v to the image I (the parameter v needs to be specified). The default is zero mean noise with 0.01 variance.

(d) Restore the image using the parametric Wiener filter given by

$$\hat{F}(u,v) = \Big[\frac{1}{H(u,v)}\frac{|H(u,v)|^2}{|H(u,v)|^2 + K}\Big]G(u,v) = \Big[\frac{\overline{H(u,v)}}{K + |H(u,v)|^2}\Big]G(u,v),$$

where K is a specified constant, chosen to obtain best visual results.