Math 155: Homework # 8, due on Friday, March 8

[**1**] Download from the class web page the image Fig5.07(b).jpg (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.

[**2**] Refer to the contraharmonic filter given in Eq. (5.3-6).

(a) Explain why the filter is effective in eliminating pepper noise when Q is positive.

(b) Explain why the filter is effective in eliminating salt noise when Q is negative.

(c) Explain why the filter gives poor results (such as the results shown in Fig. 5.9) when the wrong polarity is chosen for Q.

(d) Discuss the behavior of the filter when $Q = -1$.

(e) Discuss (for positive and negative Q) the behavior of the filter in areas of constant gray levels.

[**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**] Consider a linear, position-invariant image degradation system with impulse response

$$h(x-\alpha, y-\beta) = e^{-[(x-\alpha)^2+(y-\beta)^2]}.$$

Suppose that the input to the system is an image consisting of a line of infinitesimal width located at $x = a$, and modeled by $f(x,y) = \delta(x-a)$, where δ is the impulse function. Assuming no noise, what is the output image $g(x,y)$?

Hint: Use equation (5.5-13) and also that

$$\int_{-\infty}^{+\infty} \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(z-\mu)^2}{2\sigma^2}}\, dz = 1,$$

where μ and σ are constants.