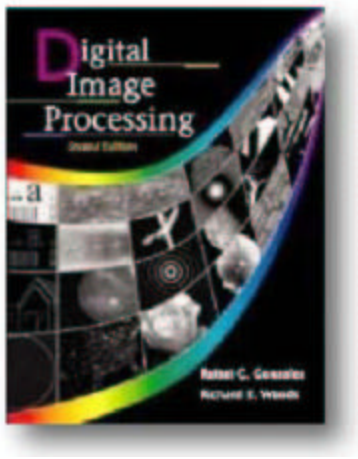


Digital **I**mage **P**rocessing

Chapter 5

“Image Restoration”

Preview

5.1 A model of the Image Degradation/Restoration Process

5.2 Noise Models

5.2.1 Spatial and Frequency Properties of Noise

5.2.2 Some Important Noise Probability Density Functions

Rayleigh Noise

Erlang (Gamma) noise

Exponential Noise

Uniform Noise

Impulse (salt-and-pepper) noise

5.2.3 Periodic Noise

5.2.4 Estimation of Noise Parameters

5.3 Restoration in the Presence of Noise Only-Spatial Filtering

5.3.1 Mean Filters

Arithmetic Mean Filter

Geometric Mean Filter

Harmonic Mean Filter

- What is a **harmonic filter**?

The harmonic mean filter works well for salt noise, but fails for pepper noise. It does well also with other types of noise like Gaussian noise.

- Why doesn't the **Harmonic Mean filter** work well with pepper noise?

Contraharmonic Mean Filter

5.3.2 Order-Statistics Filters

- What are **order filters**?

These filters are implemented by arranging the neighborhood pixels in order from smallest to largest gray-level value and using this ordering to select the "correct" value. Order filters work best with salt-and-pepper , negative exponential, or Rayleigh noise.

- ## *Median Filter*

- ## *Max and Min Filters*

- ## *Midpoint filters*

- ## *Alpha-trimmed Mean Filter*

- ## *5.3.3 Adaptive Filters*

- ## *Adaptive, Local noise reduction filter*

- ## *Adaptive Median Filter*

- ## *5.4 Periodic Noise Reduction by Frequency Domain Filtering*

- ## *5.4.2 Bandpass Filters*

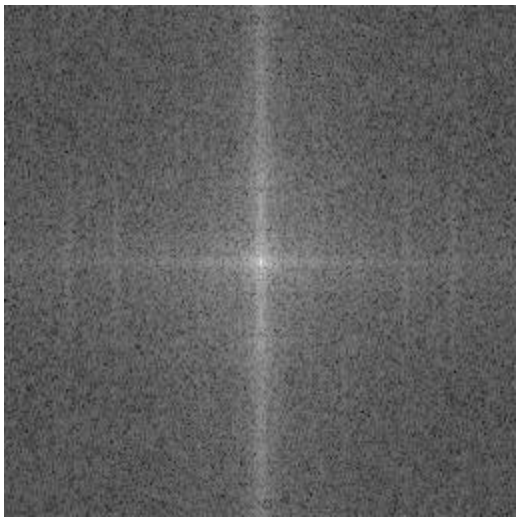
-

5.4.3 Notch Filters

- *What is a notch filter?*

The notch filter is a special form of a band reject filter; instead of eliminating an entire ring of frequencies in the spectrum, it only "notches" out selected frequencies. This type of filter is most useful for an image that has been corrupted with a sinusoidal interference pattern

Original Image



Spectrum of original image

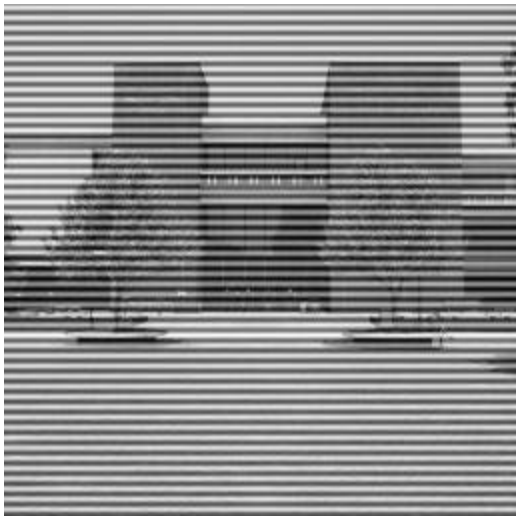
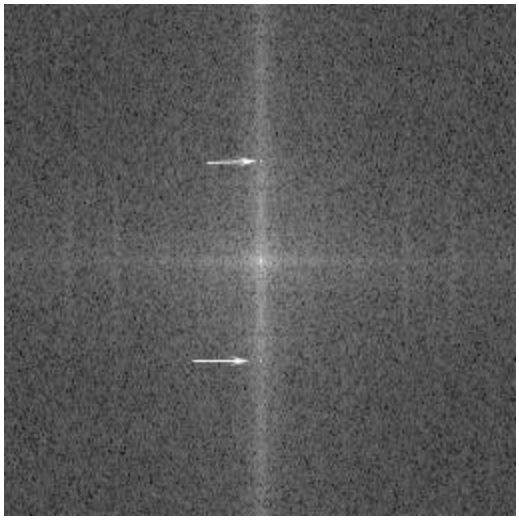
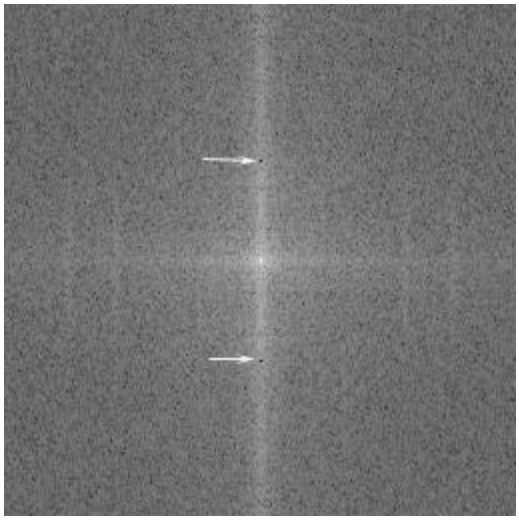


Image corrupted with sinusoidal noise



Spectrum of corrupted image; arrows point contribution from interference

Image restored by notch filtering



Spectrum of filtered image; arrows point to masked sinusoidal contribution

Image further enhanced with histogram techniques

5.4.4 Optimum Notch Filtering

5.5 Linear, Position-Invariant Degradations

5.6 Estimating the Degradation Function

5.6.1 Estimation by Image Observation

Further Reading

Questions

- What is meant by “Salt and Pepper” noise?

- When would you use the harmonic mean filter?

An image with only “salt” noise or an image with Gaussian noise. The harmonic mean filter does not work well with images that have pepper noise.

- What is the effect of increasing the size of a filter kernel (i.e. from 3x3 to 5x5 or 7x7 down to a 5x5) ?

-

Questions From the Book

1. *The white bars in the test pattern shown are 7 pixels wide and 210 pixels high. The separation between bars is 17 pixels. What would this image look like after application of*
   (a) A 3x3 Arithmetic mean filter?
   (b) A 7x7 AMF?
   (c) A 9x9 AMF?

2. *Repeat problem 1 using a geometric mean filter.*

3. *Repeat Problem 1 using a harmonic mean filter.*

4. *Repeat Problem 1 using a contraharmonic mean filter with Q=1.*

5. *Repeat Problem 1 using a contraharmonic mean filter with Q=-1.*

14. *Show that the Fourier Transform of the 2-D continuous sine function*

$$f(x, y) = A * \sin(u_0 x + v_0 y)$$

is a pair of conjugate impulses

$$F(u,v) = -j\frac{A}{2}\left[d(u - \frac{u_0}{2p}, v - \frac{v_0}{2p}) - d(u + \frac{u_0}{2p}, v + \frac{v_0}{2p})\right]$$

Hint: Use the continuous version of the Fourier transform in Eq. (4.2-3), and

express the sine in terms of exponentials.

References

Woods, Richard, Gonzalez, Rafael, "*Digital Image Processing*", Second Edition, Prentice Hall