2.4 IMAGE ENHANCEMENT

1. Overview

2. Grayscale transformations

3. Linear filtering

4. Nonlinear filtering

Overview of Image Processing Strategies

- Enhancement
  - degradation not well defined
  - criteria for improvement only qualitatively stated

- Restoration
  - detailed model for degradation
  - process image to maximize mathematically specified performance measure

- Reconstruction
  - generate image from non-image data, or image information that is quite different from final desired form
  - detailed mathematical description of process by which data was obtained

Examples

- Enhancement
  - contrast stretching
  - sharpening
  - smoothing

- Restoration
  - deblurring of mis-focused images
  - deblurring of images degraded by motion
  - removal of clouds and haze from images of ground terrain obtained from air- or space-borne platform

- Reconstruction
  - computed tomography
  - synthetic aperture radar
  - magnetic resonance imaging
  - descreening

Types of Enhancement Operations

- Grayscale transformations

- Spatial filtering
    - Linear filtering
    - Nonlinear filtering

Preliminaries

- Digital Image

$$f[m,n], 0 \leq m \leq M-1, 0 \leq n \leq N-1$$

  $M \times N$ array of integers - each taking on a value between 0 (black) and 255 (white) (8 bits/pixel)

- Histogram

  Density function describing the distribution of gray values in the image

$$h_f[b] = \frac{1}{MN} \{\text{No. pixels } (m,n): f[m,n] = b\}$$

$$h_f[b] = \frac{1}{MN} \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} \delta[f[m,n] - b], \quad 0 \le b \le 255$$

properties:

a. $0 \le h_f[b] \le 1$

b. $\sum_{b=0}^{255} h_f[b] = 1$