Mid-term Stats

	Average	Max
Class	19.33	24
Grad	20.05	24
Undergrad	16.83	20

Image Enhancements

- Pixel-based:
  - Image spectral enhancement
  - Image transformation (single and multiple bands)
- Kernel-based (spatial domain):
  - Image spatial enhancement
  - Image filtering
    - Image data = Low Freq + High Freq + Noise
    - Image data = Background + Foreground + Noise

Spatial Enhancement/Filtering


LPF


Max

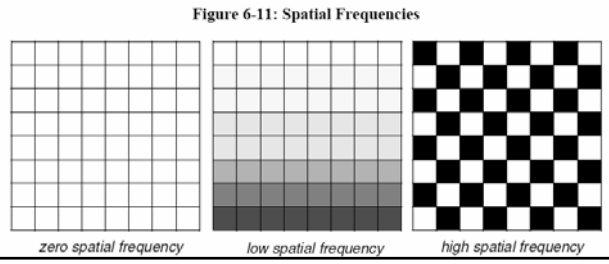

Min


Edge


Surface

Spatial Enhancement

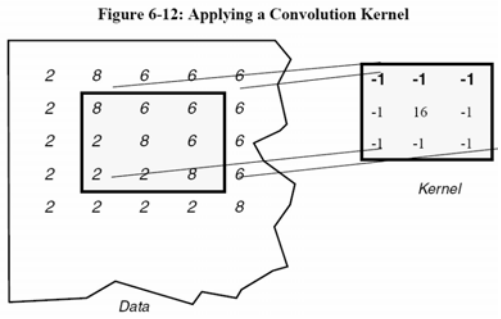
- Spatial enhancement modifies pixel values based on the values of surrounding pixels
- Types of enhancement:
  - Convolution
  - Resolution merge (data fusion)
  - Wavelet Analysis
  - Fourier Analysis



Convolution Filtering

- (Moving window) filtering

  Kernel = filter = moving window



integer [(-1 × 8) + (-1 × 6) + (-1 × 6) + (-1 × 2) + (16 × 8) + (-1 × 6) + (-1 × 2) + (-1 × 2) + (-1 × 8) : (-1 + -1 + -1 + -1 + 16 + -1 + -1 + -1 + -1)]

= int (88 / 8) = int (11) = 11

Types of Kernel

- Kernel coefficients
- Zero-sum
- High-frequency (high-pass)
- Low-frequency (low-pass)
- Adaptive filtering

-1.000	-1.000	-1.000
-1.000	8.000	-1.000
-1.000	-1.000	-1.000

High-pass zero-sum

1.000	1.000	1.000
1.000	1.000	1.000
1.000	1.000	1.000

Low-pass

-1.000	-2.000	-1.000
0.000	0.000	0.000
1.000	2.000	1.000

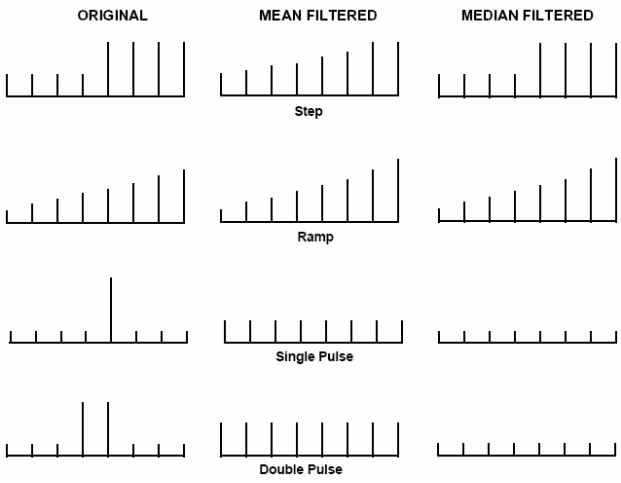
High-pass zero-sum directional

Median Filter

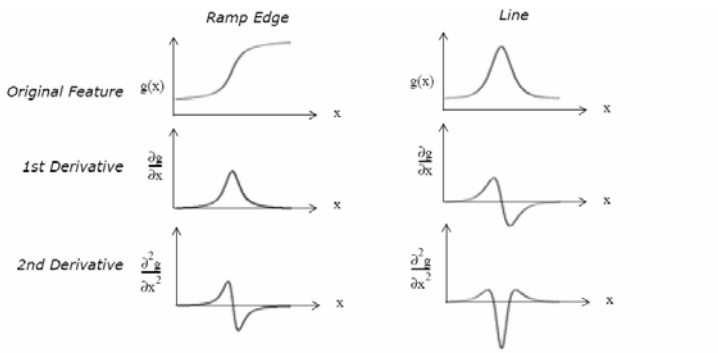
- Keep sharp texture (more original information) of the image than mean.
- Less sensitive to errors/extreme values

{3, 1, 2, 8, 5, 3, 9, 4, 27}

{1, 2, 3, 3, 4, 5, 8, 9, 27}



High-Pass Filter



The 1st-order derivative kernel(s) derives from the simple Prewitt kernel:

$$\frac{\partial}{\partial_x} = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \quad \text{and} \quad \frac{\partial}{\partial_y} = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{bmatrix}$$

The 2nd-order derivative kernel(s) derives from Laplacian operators:

$$\frac{\partial^2}{\partial x^2} = \begin{bmatrix} -1 & 2 & -1 \\ -1 & 2 & -1 \\ -1 & 2 & -1 \end{bmatrix} \quad \text{and} \quad \frac{\partial^2}{\partial y^2} = \begin{bmatrix} -1 & -1 & -1 \\ 2 & 2 & 2 \\ -1 & -1 & -1 \end{bmatrix}$$

Adaptive Filter

- Filter coefficients are adjusted based on DN values in the kernel.
- Lee-Sigma Filter
  - "good" signals are within a 2 standard deviation (2 sigma) range of the image
  - replaces the pixel value with the average of all DN values within the kernel that fall within the designated range (e.g., 2σ).

Advanced Methods

- GLCM (Gray Level Co-occurrence Matrix)
  - Week 9