Low Pass Filtering

Why use Low Pass filtering?

• Remove random noise
• Remove periodic noise
• Reveal a background pattern
Effects on images

- Remove banding effects on images
- Smooth out Img-Img mis-registration
- Blurring of image

Types of Low Pass Filters

- Moving average filter
- Median filter
- Adaptive filter
Moving Ave Filter Example

- A single (very short) scan line of an image
- \{1,8,3,7,8\}
- Moving Ave using interval of 3 (must be odd)
- First number \((1+8+3)/3 =4\)
- Second number \((8+3+7)/3=6\)
- Third number \((3+7+8)/3=6\)
- First and last value set to 0

Two Dimensional Moving Ave

![Graph showing one-dimensional data series showing the effect of median (low-pass) filter and moving average (low-pass) filtering.](image)
Moving Average of Scan Line

• Spatial domain filter
• Places average in center
• Edges are set to 0 usually to maintain size

2D Moving Average Filter
Spatial Domain Filter

Moving Average Filter Effects

• Reduces overall variability of image
• Lowers contrast
• Noise components reduced
• Blurs the overall appearance of image
Moving Average images

Example 7.2 Figure 1  Contrast-stretched Landsat ETM+ image of the south-west corner of The Wash in eastern England.

Example 7.2 Figure 2  The image shown in Figure 1 after the application of a $3 \times 3$ moving average filter.

Median Filter

The median utilizes the median instead of the mean.

The median is the middle positional value.
Median Example

• Another very short scan line
• Data set {2,8,4,6,27} interval of 5
• Ranked {2,4,6,8,27}
• Median is 6, central value 4 -> 6

Median Filter

• Usually better for filtering
• - Less sensitive to errors or extremes
• - Median is always a value of the set
• - Preserves edges
• - But requires more computation
Moving Ave vs. Median Filtering

Adaptive Filters

- Based on mean and variance
- Good at Speckle suppression
- Sigma filter best known
  - Computes mean and std dev for window
  - Values outside of +-2 std dev excluded
  - If too few values, (<k) uses value to left
  - Later versions use weighting
Adaptive Filters

- Improvements to Sigma filtering
  - Chi-square testing
  - Weighting
  - Local order histogram statistics
  - Edge preserving smoothing
Final PowerPoint Numerical Slide Value

(The End)