# 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

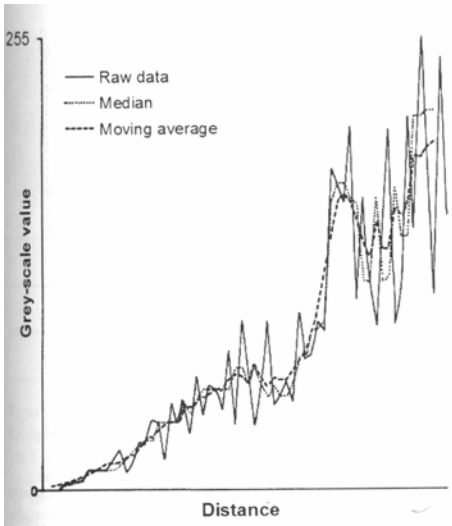
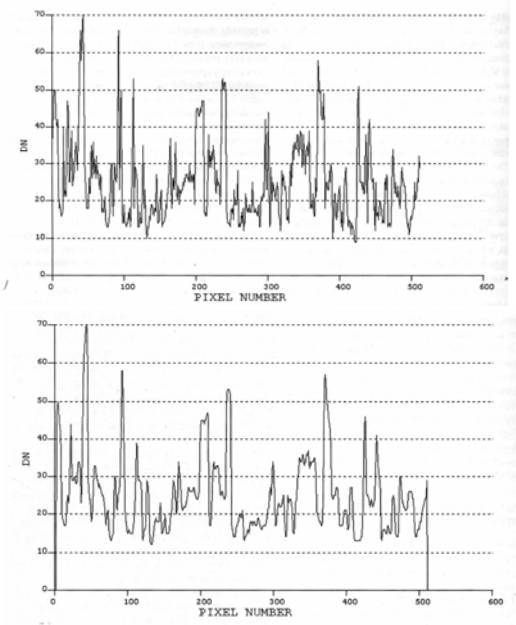



**Figure 7.2** One-dimensional data series showing the effect of median (low-pass) filter and moving average (low-pass) filtering.

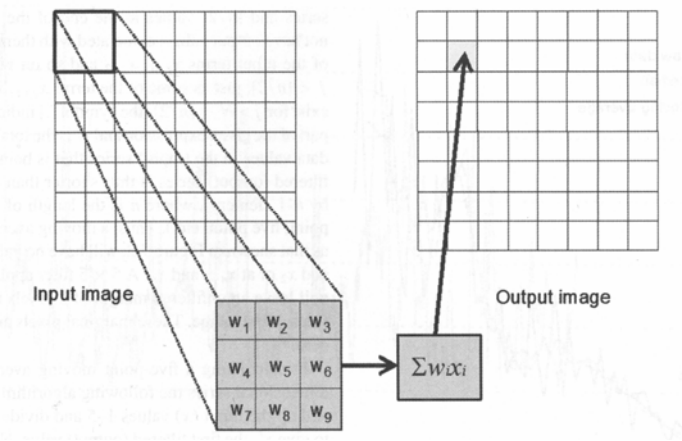
## Moving Average of Scan Line




## 2D Moving Average Filter

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

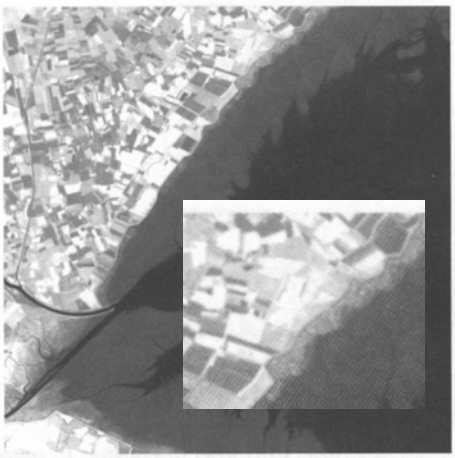
# Spatial Domain Filter



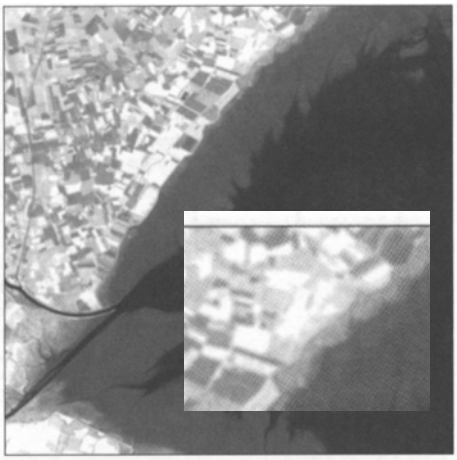

# Moving Average Filter Effects

- 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

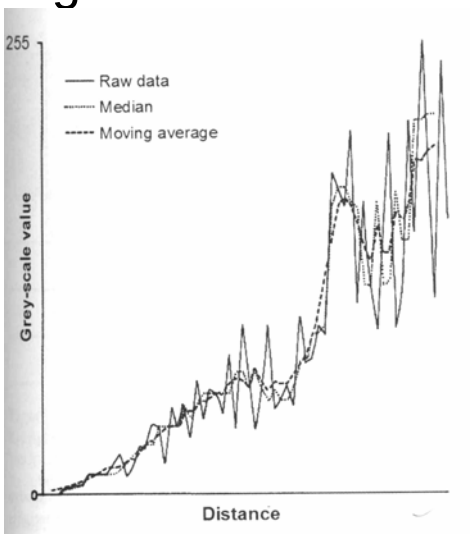



**Figure 7.2** One-dimensional data series showing the effect of median (low-pass) filter and moving average (low-pass) filtering.

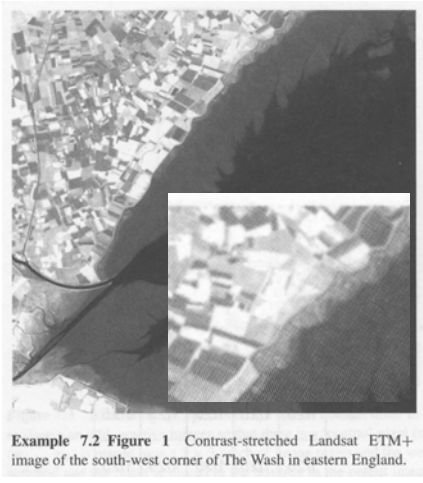
# Adaptive Filters

- 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

# Adaptive Filters



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

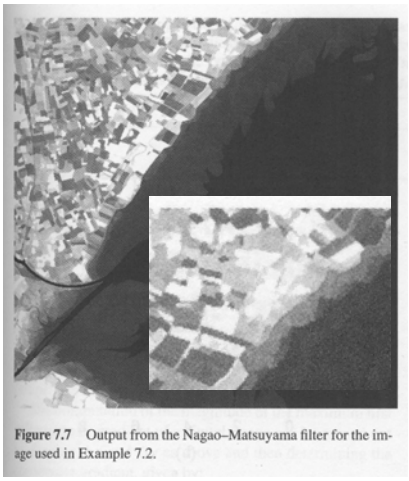


**Figure 7.7** Output from the Nagao–Matsuyama filter for the image used in Example 7.2.

Final PowerPoint Numerical Slide Value

(The End)