IMAGE SMOOTHING USING SPATIAL DOMAIN

- Image Smoothing is used for noise reduction and blurring operations.

- It takes into account the pixels surrounding it in order to make a determination of more accurate version of this pixel.

1) NEIGHBOURHOOD AVERAGING METHODS

- Concept of processing window is used to define the neighborhood.
- Size of the processing window is often chosen as 3×3 or 5×5,which contains neighboring pixels surrounding a given image.
- For a 3×3 window, templates used include

$$\begin{bmatrix} 0 & \frac{1}{4} & 0 \\ \frac{1}{4} & 0 & \frac{1}{4} \\ 0 & \frac{1}{4} & 0 \end{bmatrix}, \begin{bmatrix} \frac{1}{8} & \frac{1}{8} & \frac{1}{8} \\ \frac{1}{8} & 0 & \frac{1}{8} \\ \frac{1}{8} & \frac{1}{8} & \frac{1}{8} \end{bmatrix}, \begin{bmatrix} \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\ \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \\ \frac{1}{9} & \frac{1}{9} & \frac{1}{9} \end{bmatrix}$$

- Only the third mask contributes to the intensity of central pixel.

- Advantage:- This method is very simple. • Disadvantage:- This method results in blurring of edges in an image.

Original Image Blurred Image

2) THRESHOLD AVERAGING METHODS

- A specific threshold value is chosen in advance and is used to compare with the difference between

resulting intensity and original intensity.

- If the difference is greater than threshold, original value is replaced by averaging result, otherwise original value is retained.

3) GAUSSIAN FILTERING

- It is used to blur images and remove noise .

- Gives more weight at central pixel and less weight to the

neighbors.

- Its convolution kernel is given by

$$h(i,j) = e^{-\frac{i^2+j^2}{2\sigma^2}}$$

where σ -> smoothing parameter used to control the extent of smoothing.

- Larger the value of σ,greater the extent of

smoothing.

$$\frac{1}{273}$$

1	4	7	4	1
4	16	26	16	4
7	26	41	26	7
4	16	26	16	4
1	4	7	4	1

Template with 5×5 window and $\sigma = 1$

Original Sigma = 3

4) MEDIAN FILTERING

- It replaces the value of a pixel by the median of gray levels in the neighborhood of that pixel.
- These filters are effective in presence of impulse noise(salt and pepper noise).

- To perform median filtering:-
  - Sort the values of pixel
  - Determine the median
  - Assign the median value to pixel considered

- Other filters are **min and max filters**.
- **Minimum filter** selects smallest value within the pixel values and **maximum filter** selects largest value within the pixel values.
- **Max filters** are used for finding brightest point in an

image. (it removes salt noise)

- **Min filters** are used for finding darkest point in an image. (it removes pepper noise)

5) WEIGHTED MEDIAN FILTERING

- A template of size 3×3 containing weighted values is assigned.
- Elements of window are rearranged as 1D array following a row column order in such a way that the

intensities in the array repeat according to the corresponding weighting values in the template.

- Array is then sorted in ascending order and median value is used to substitute.