Unit 4

Image Restoration

(Part II)

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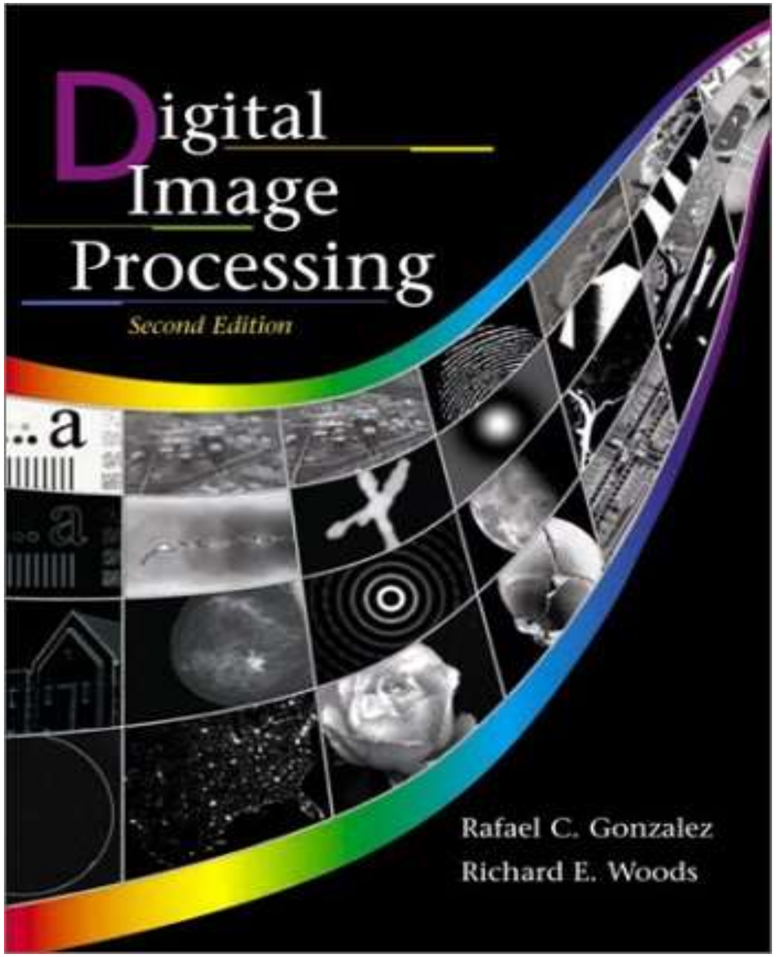
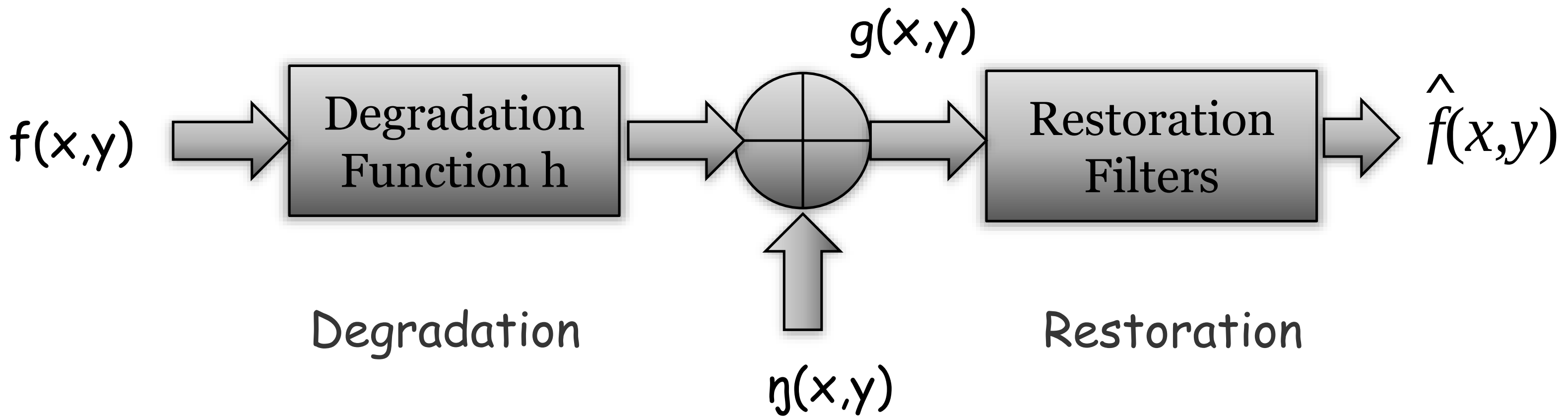
Source: PPT Content



Degradation Model?

- Objective: To restore a degraded/distorted image to its original content and quality.



- Spatial Domain: $g(x,y)=h(x,y)*f(x,y)+ \eta(x,y)$
- Frequency Domain: $G(u,v)=H(u,v)F(u,v)+ \eta(u,v)$
- Matrix: $G=HF+\eta$

Image Restoration (Order Statistics Filters)

- Spatial filters that are based on ordering the pixel values that make up the neighbourhood operated on by the filter
- Useful spatial filters include
  - Median filter.
  - Maximum and Minimum filter.
  - Midpoint filter.
  - Alpha trimmed mean filter.

Median Filter

- **Median Filter:**

$$\hat{f}(x, y) = \underset{(s,t)\in S_{xy}}{median}\{g(s,t)\}$$

- Excellent at noise removal, without the smoothing effects that can occur with other smoothing filters
- Best result for removing salt and pepper noise.

Example: Median Filter

2D Median filtering example using a 3 x 3 sampling window:

Keeping border values unchanged

Sorted: 0,0,1,1,1,2,2,4,4

Input

1	4	0	1	3	1
2	2	4	2	2	3
1	0	1	0	1	0
1	2	1	0	2	2
2	5	3	1	2	5
1	1	4	2	3	0

Output

1	4	0	1	3	1
2	1	1	1	1	3
1	1	1	1	2	0
1	1	1	1	1	2
2	2	2	2	2	5
1	1	4	2	3	0

Result Median Filter

Result of Median Filter

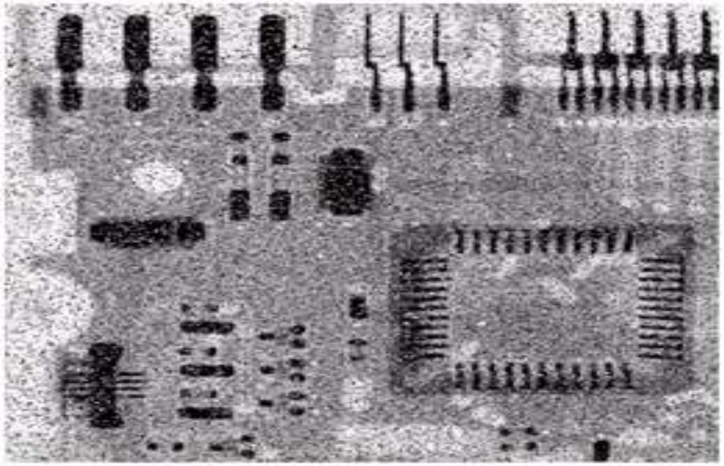


Fig 1: Salt & Pepper noise

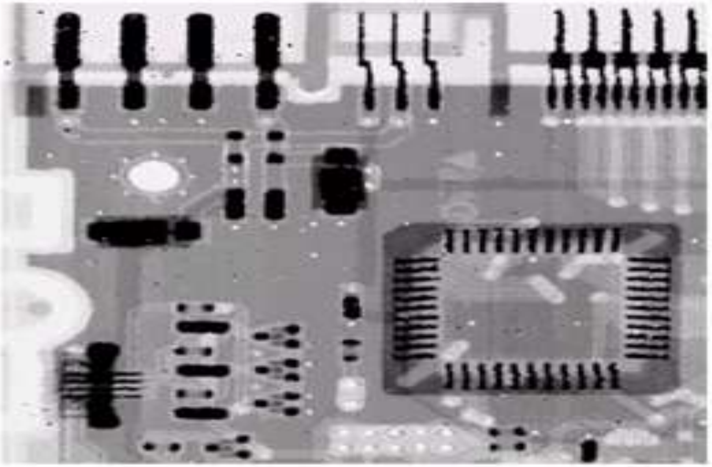


Fig2: Result of 1 pass Med 3*3

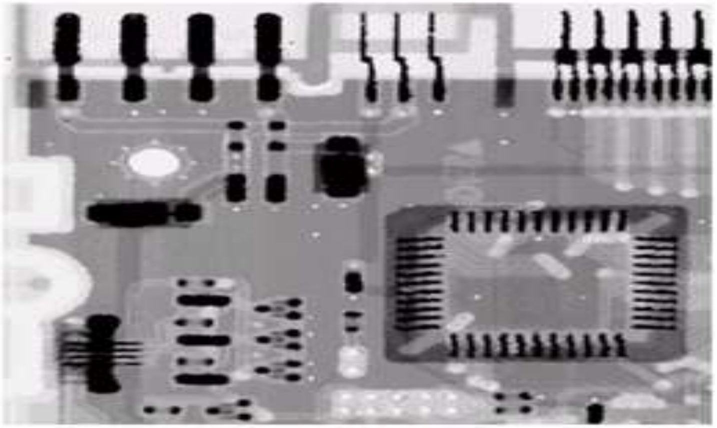


Fig3: Result of 2 pass Med 3*3

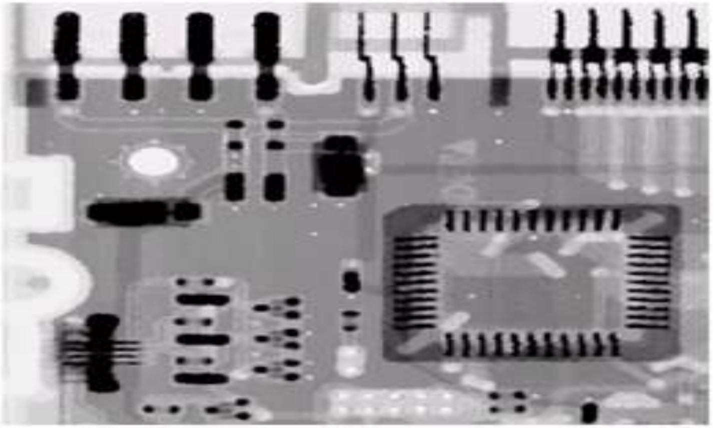


Fig4: Result of 3 pass Med 3*3

Maximum and Minimum Filter

- **Max Filter**:

$$\hat{f}(x, y) = \max_{(s,t)\in S_{xy}} \{g(s,t)\}$$

- **Min Filter**:

$$\hat{f}(x, y) = \min_{(s,t)\in S_{xy}} \{g(s,t)\}$$

- Max filter is good for pepper noise and min is good for salt noise

Result of Max and Min Filter

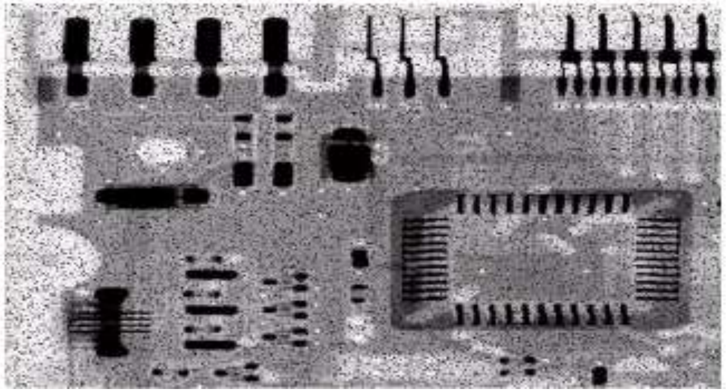


Fig: Corrupted by Pepper Noise

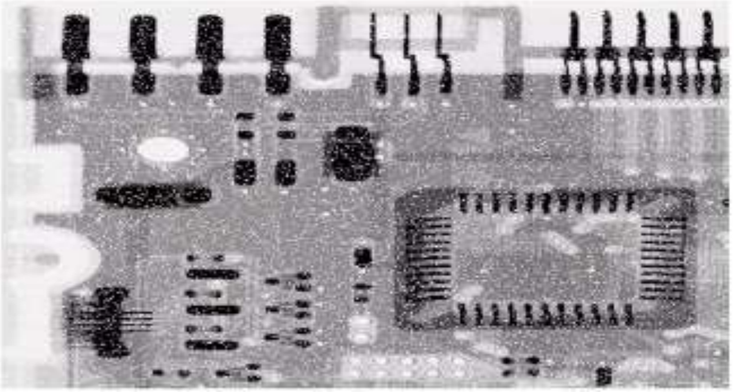


Fig: Corrupted by Salt Noise

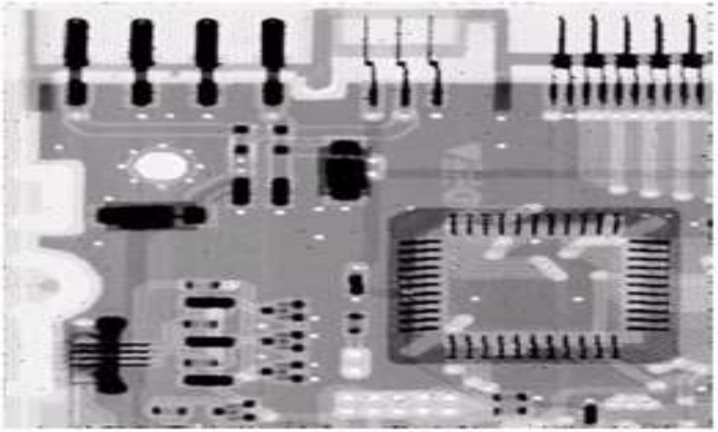


Fig: Filtering Above,3*3 Max Filter

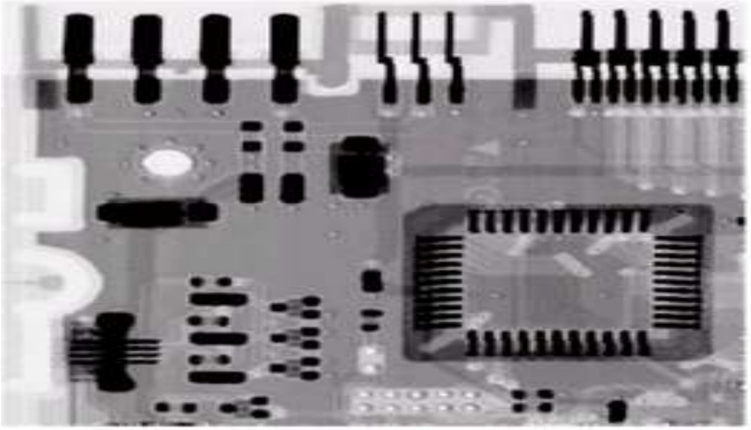


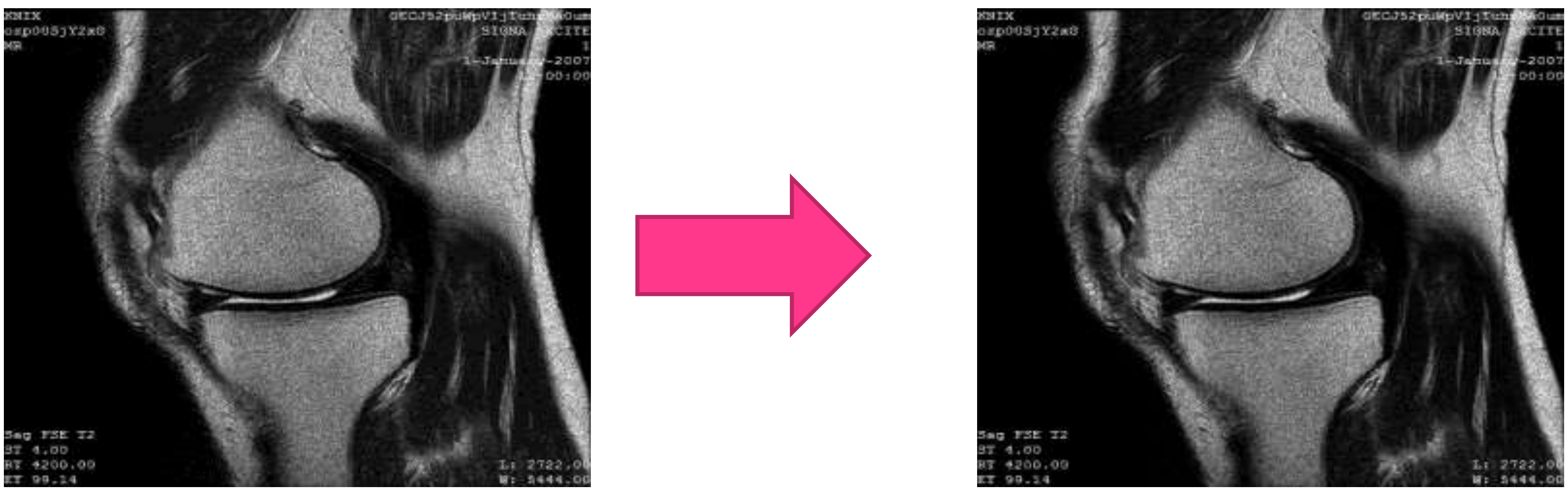
Fig: Filtering Above,3*3 Min Filter

Midpoint Filter

- **Midpoint Filter:**

$$\hat{f}(x,y) = \frac{1}{2}\left[\max_{(s,t)\in S_{xy}}\{g(s,t)\} + \min_{(s,t)\in S_{xy}}\{g(s,t)\}\right]$$

- Good for random Gaussian and uniform noise



Alpha-Trimmed Mean Filter

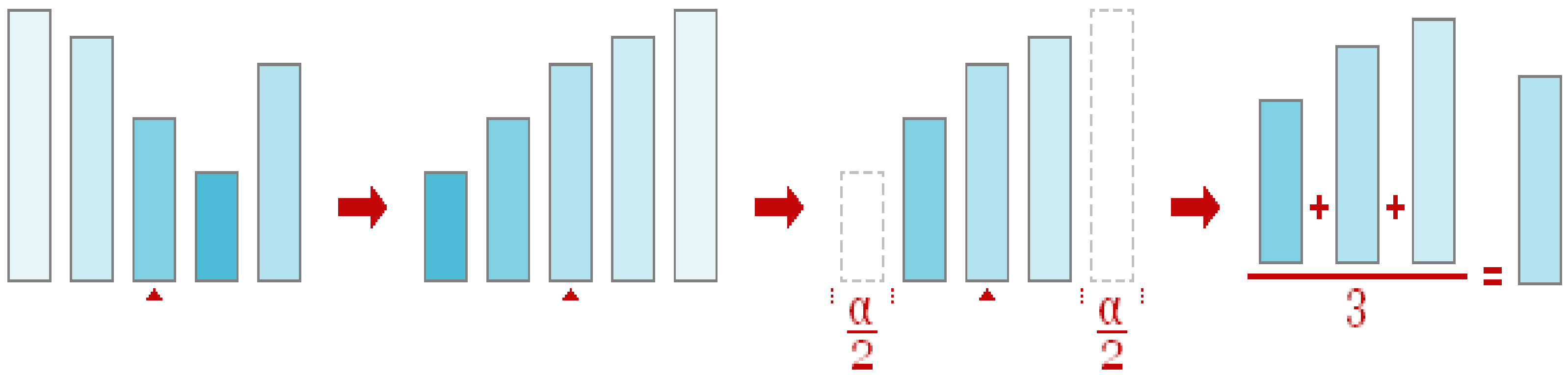
Alpha-trimmed mean filter is windowed filter of nonlinear class, by its nature is hybrid of the mean and median filters. The basic idea behind filter is for any element of the signal (image) look at its neighborhood, discard the most atypical elements and calculate mean value using the rest of them. Alpha you can see in the name of the filter is indeed parameter responsible for the number of trimmed elements.

- **Alpha-Trimmed Mean Filter:**

$$\hat{f}(x,y) = \frac{1}{mn-\alpha} \sum_{(s,t)\in S_{xy}} g_r(s,t)$$

- Here deleted the $\alpha/2$ lowest and $\alpha/2$ highest grey levels, so $g_r(s, t)$ represents the remaining $mn - \alpha$ pixels

Alpha-Trimmed Mean Filter



- **Alpha-trimmed mean filter algorithm:**
  - Place a window over element;
  - Pick up elements;
  - Order elements;
  - Discard elements at the beginning and at the end of the got ordered set;
  - Take an average— sum up the remaining elements and divide the sum by their number.

Result: Alpha-Trimmed Mean Filter

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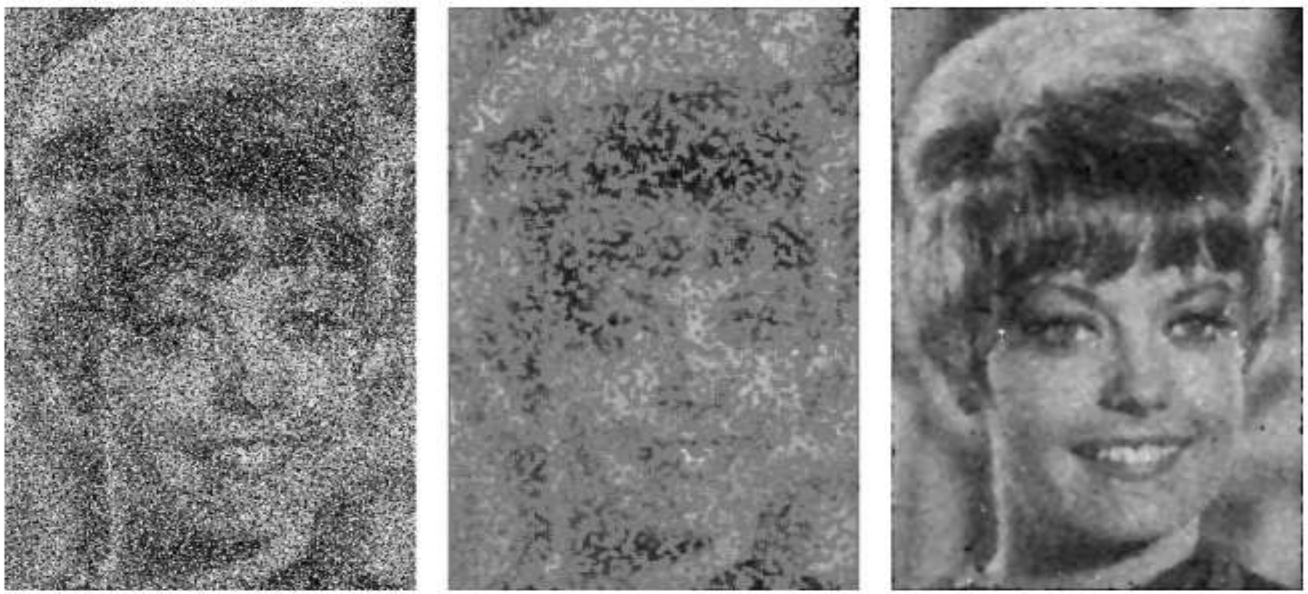
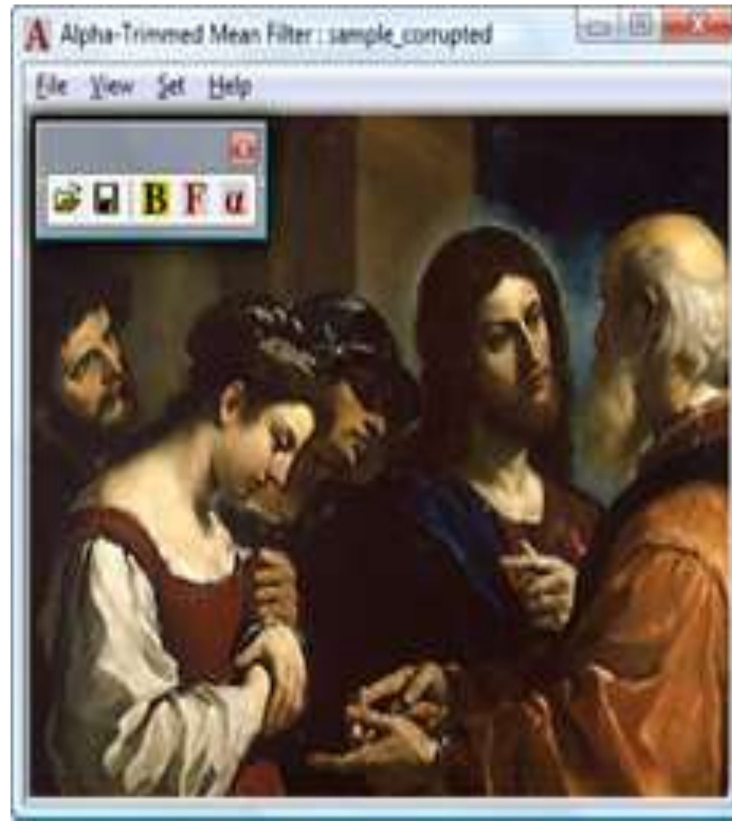
Adaptive Alpha-Trimmed Mean Filters Under Deviations From Assumed Noise Model

Remzi Öten, *Member, IEEE,* and Rui J. P. de Figueiredo, *Life Fellow, IEEE*



Result: Alpha-Trimmed Mean Filter



Detail: https://bit.ly/2pWALSx

Periodic Noise

- Typically arises due to electrical or electromagnetic interference.
- Gives rise to regular noise patterns in an image
- Frequency domain techniques in the Fourier domain are most effective at removing periodic noise

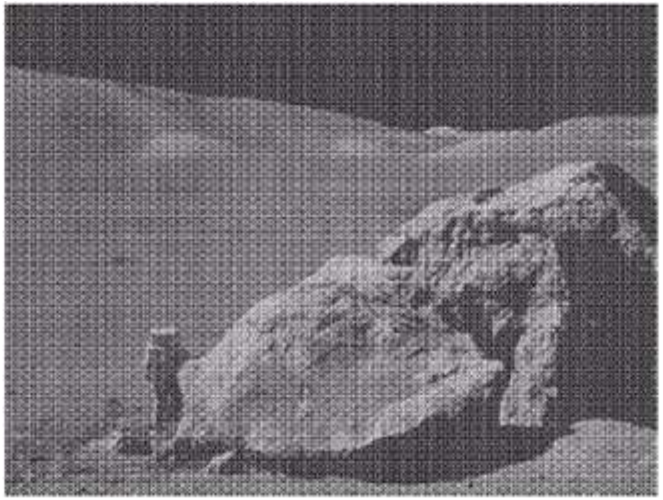


Fig: periodic Noise

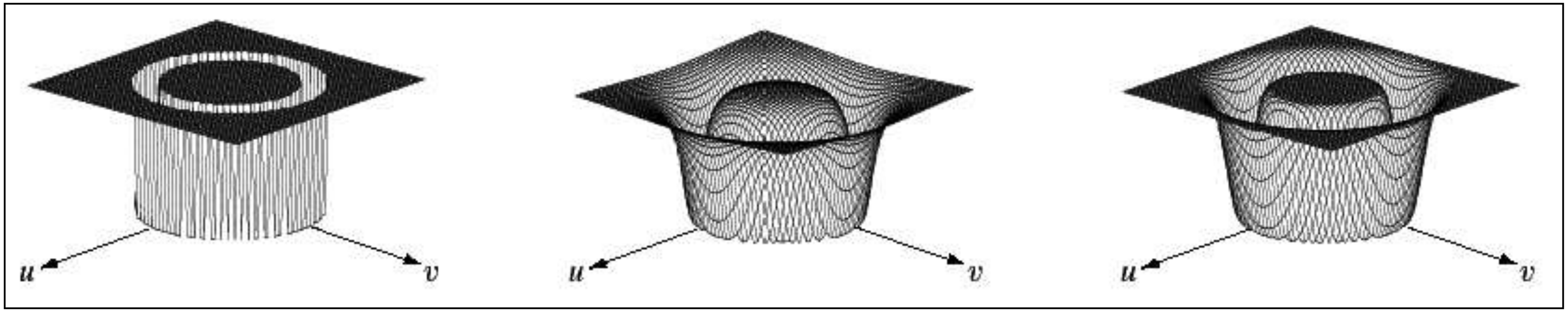
Band Reject Filters

- Removing periodic noise form an image involves removing a particular range of frequencies from that image.
- Band reject filters can be used for this purpose.
- An ideal band reject filter is given as follows:

$$H(u,v) = \begin{cases} 1 & \text{if } D(u,v) < D_0 - \frac{W}{2} \\ 0 & \text{if } D_0 - \frac{W}{2} \le D(u,v) \le D_0 + \frac{W}{2} \\ 1 & \text{if } D(u,v) > D_0 + \frac{W}{2} \end{cases}$$

Band Reject Filters contd..

- The ideal band reject filter is shown below, along with Butterworth and Gaussian versions of the filter.

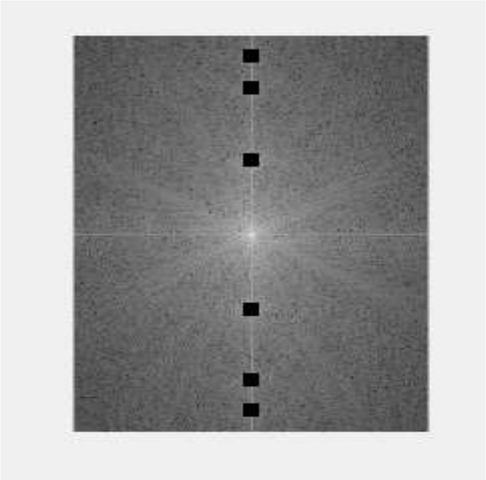


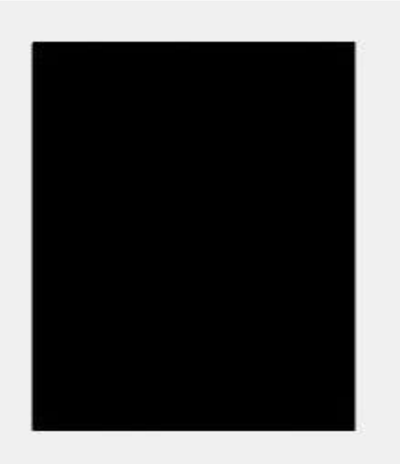
Ideal Band Reject Filter

Butterworth Band Reject Filter (of order 1)

Gaussian Band Reject Filter

Periodic Noise: Band Reject Filters





Detail
https://bit.ly/2RTMzBJ

Result of Band Reject Filter

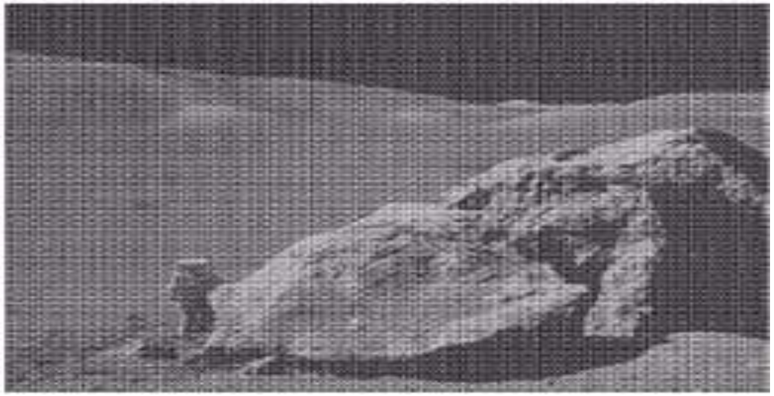


Fig: Corrupted by Sinusoidal Noise

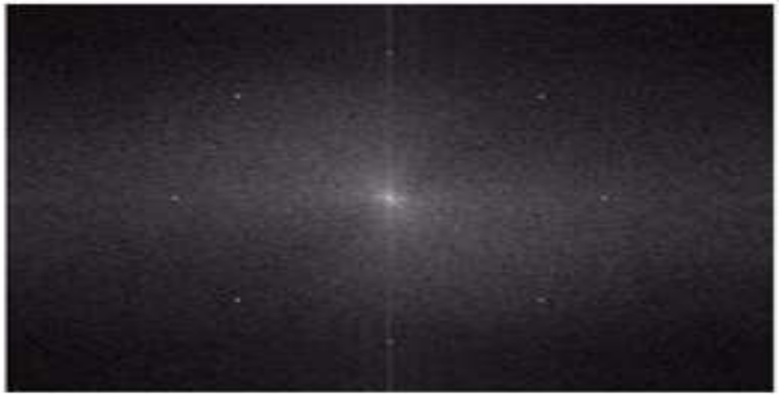


Fig: Fourier spectrum of Corrupted Image

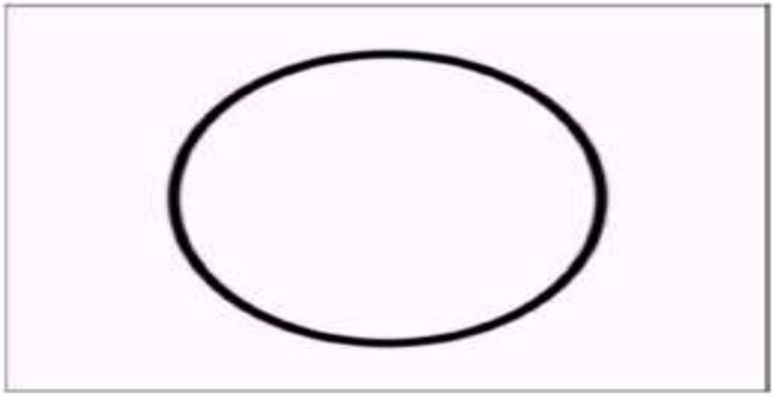


Fig: Butterworth Band Reject Filter

Fig :Filtered image


Lets Stop
Here

Conclusions-What we have learnt…

- Restore the original image from degraded image, if u have clue about degradation function, is called image restoration.
- The main objective should be estimate the degradation function.
- If you are able to estimate the H, then follow the inverse of degradation process of an image.
- Weather spatial or frequency domain.
  - Spatial domain techniques are particularly useful for removing random noise.
  - Frequency domain techniques are particularly useful for removing periodic noise.

Advanced Image Restoration

- **Adaptive Processing**
  - ✓ Spatial adaptive
  - ✓ Frequency adaptive

- **Nonlinear Processing**
  - ✓ Thresholding, coring …
  - ✓ Iterative restoration

- **Advanced Transformation / Modeling**
  - ✓ Advanced image transforms, e.g., wavelet …
  - ✓ Statistical image modeling

- **Blind Deblurring or Deconvolution**

Thank You
for
Your Attention!

kalyan5.blogspot.in