Image Noise Reduction

Concepts

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  - Imaging sensors can be affected by ambient conditions
  - Interference can be added to an image during transmission

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- Common types of image noise include:
  - **Salt and pepper noise:** contains random occurrences of black & white pixels
  - **Impulse noise:** contains random occurrences of white pixels
  - **Gaussian noise:** variations in intensity drawn from a Gaussian normal distribution

Noise Model

- We can consider a noisy image to be modelled as follows:

$$g(x, y) = f(x, y) + \eta(x, y)$$

where $f(x, y)$ is the original image pixel, $\eta(x, y)$ is the noise term and $g(x, y)$ is the resulting noisy pixel

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- If we can estimate the noise model we can figure out how to restore the image

Filtering to Remove Noise

- We can use spatial filters of different kinds to remove different kinds of noise

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This is implemented as the simple smoothing filter

It blurs the image.

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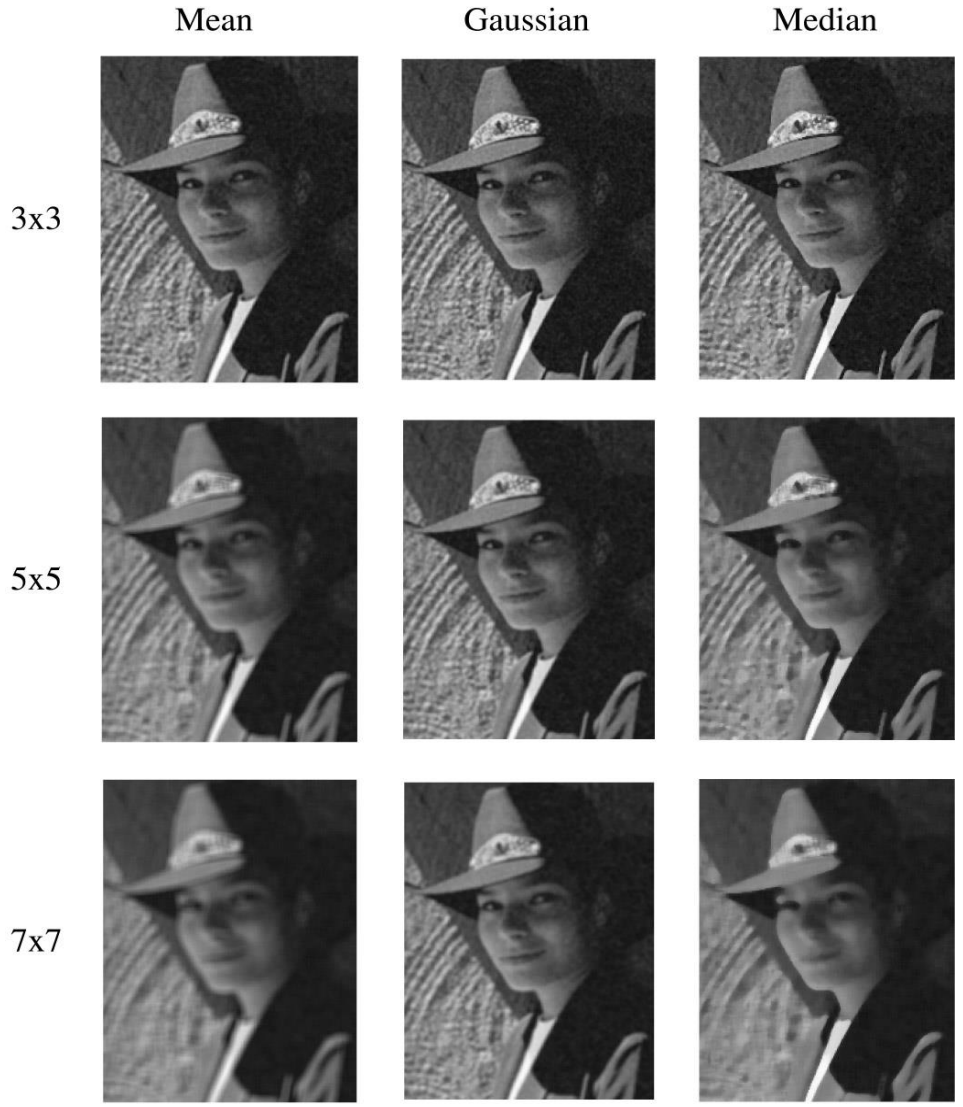
- Excellent at noise removal, without the smoothing effects that can occur with other smoothing filters

- Particularly good when salt and pepper noise is present

Comparison: Gaussian noise

Comparison: Gaussian noise



Comparison: Salt & Pepper Noise

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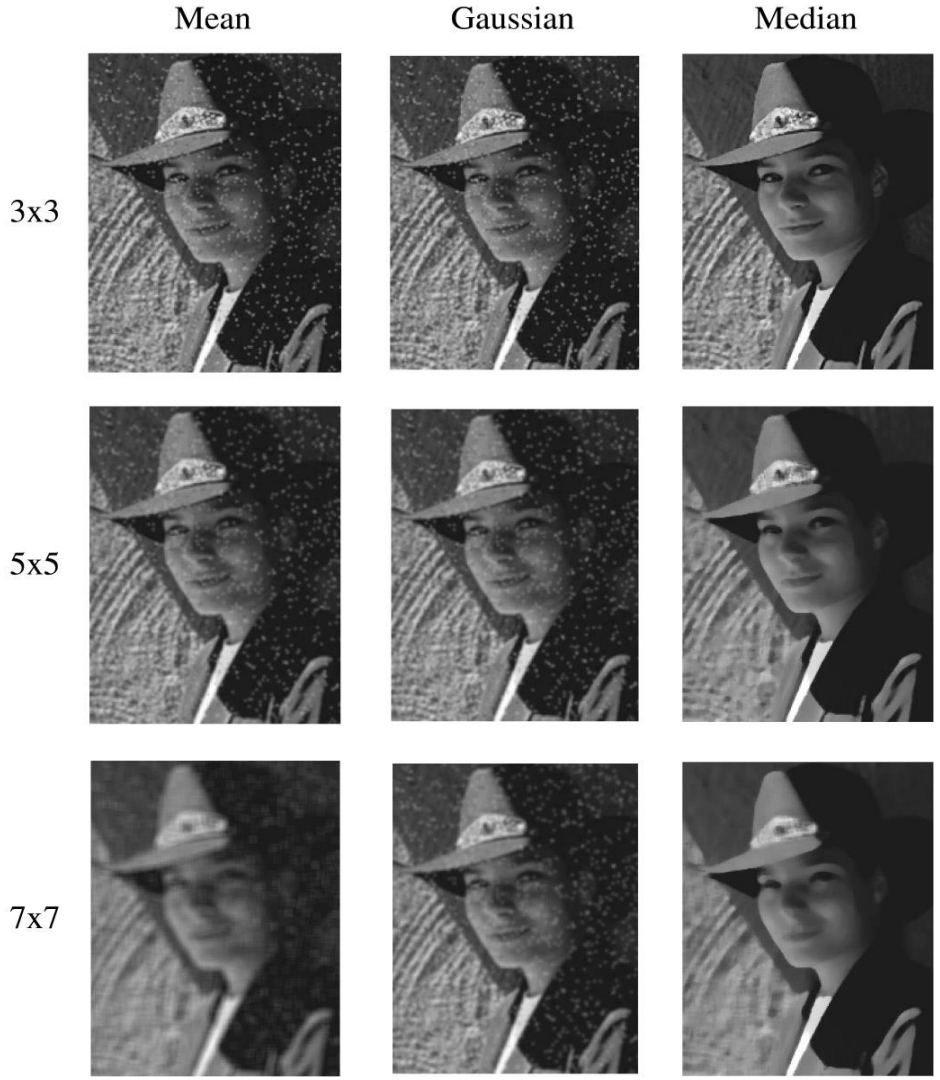

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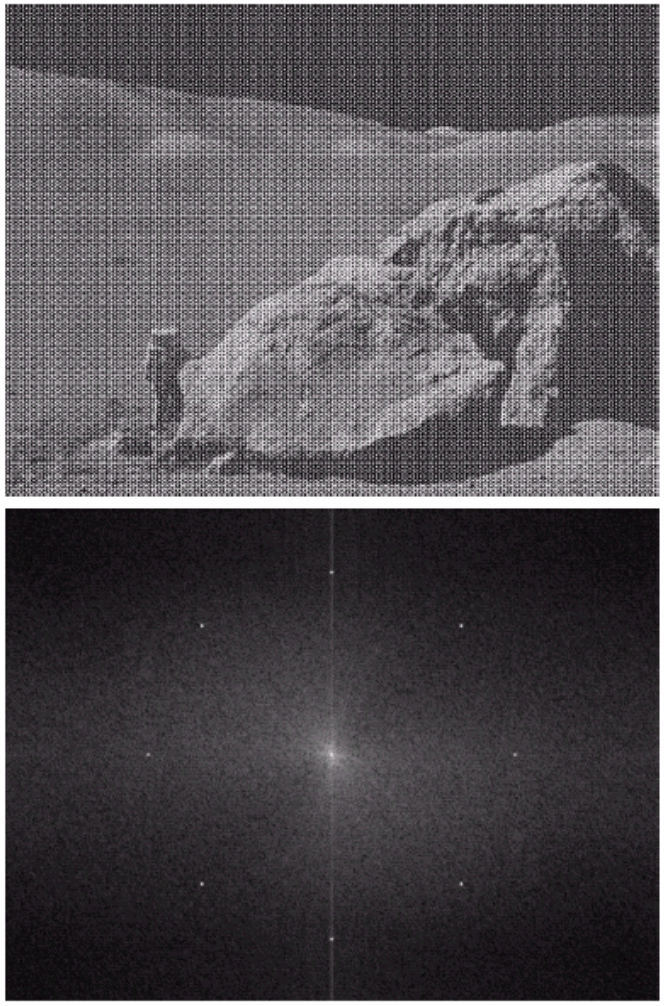
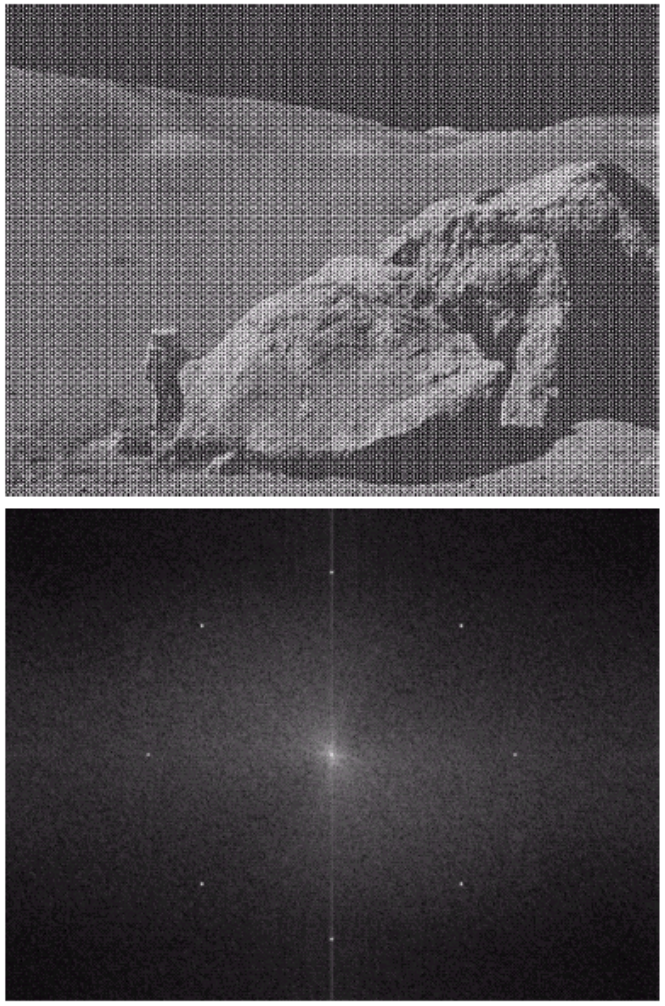


Periodic Noise

- 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



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- Remove periodic noise form an image involves removing a particular range of frequencies from that image

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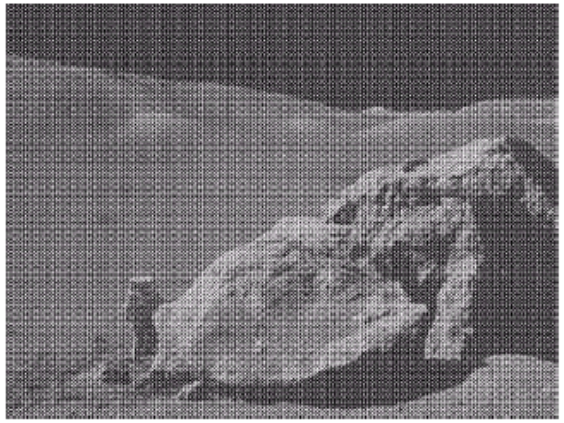
- An ideal band reject filter is given as follows:

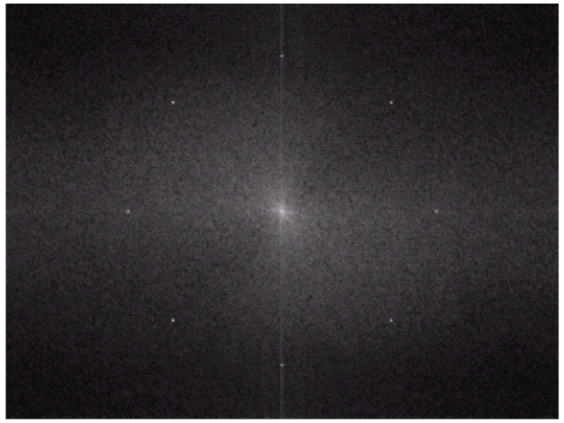
$$H(u,v) = \begin{cases} 1 & if\ D(u,v) < D_0 - \frac{W}{2} \\ 0 & if\ D_0 - \frac{W}{2} \le D(u,v) \le D_0 + \frac{W}{2} \\ 1 & if\ D(u,v) > D_0 + \frac{W}{2} \end{cases}$$

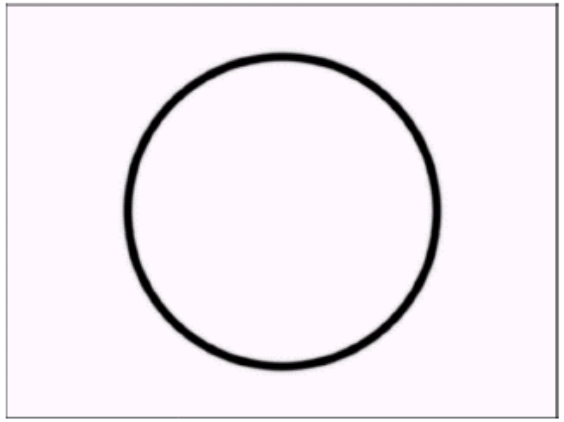
Band Reject Filter Example

Image corrupted by sinusoidal noise



Fourier spectrum of corrupted image





Butterworth band reject filter

Filtered image