Image Noise and Filtering (I)

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Noise

- Impulse noise
- Gaussian white noise (thermal noise)
- Texture noise (spatial correlated noise)

Impulse Noise

- **Salt-Pepper Impulsive Noise** — the noise value will be either the **maximum** value or the **minimum** value of the image gray level, each with the equal probability.
- **Uniform Impulsive Noise** — the noise value is an **uniform random variable** between the maximum value and the minimum value of the image gray level.

$$x_{ij} = \begin{cases} o_{ij}; & with \quad probability \quad 1 - p_n \\ n_{ij}; & with \quad probability \quad p_n \end{cases}$$

The only input parameter is p_n.

Impulse Noise Examples

a) 3% Salt-Pepper impulse noise

b) 3% Uniform impulse noise

J = *imnoise*(I, ‘salt & pepper’, 0.03);

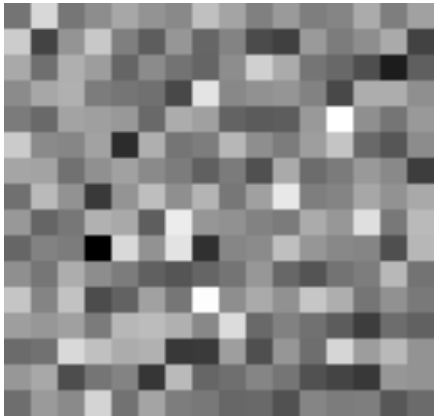
Gaussian Noise Examples

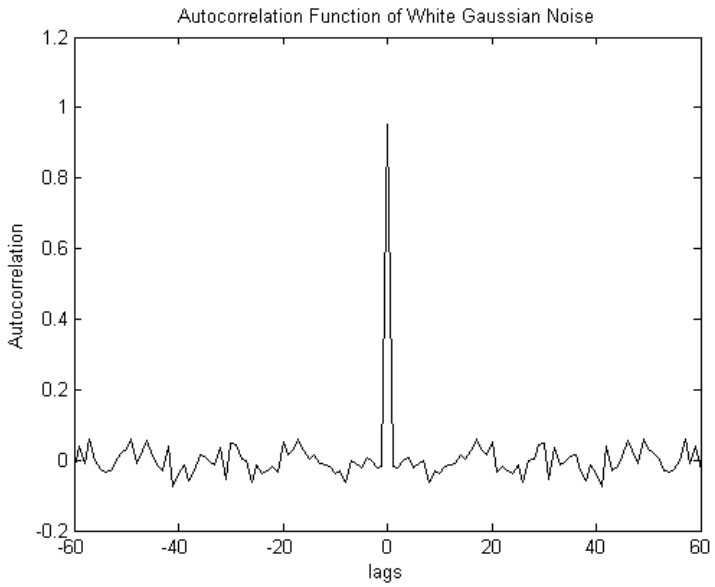
a) Original image

b) Gaussian white noise (mean = 0, std = 10)

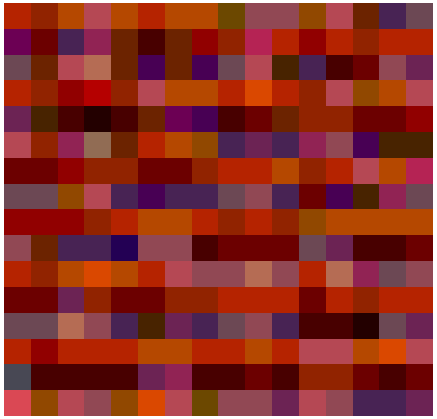
Texture Noise [1]

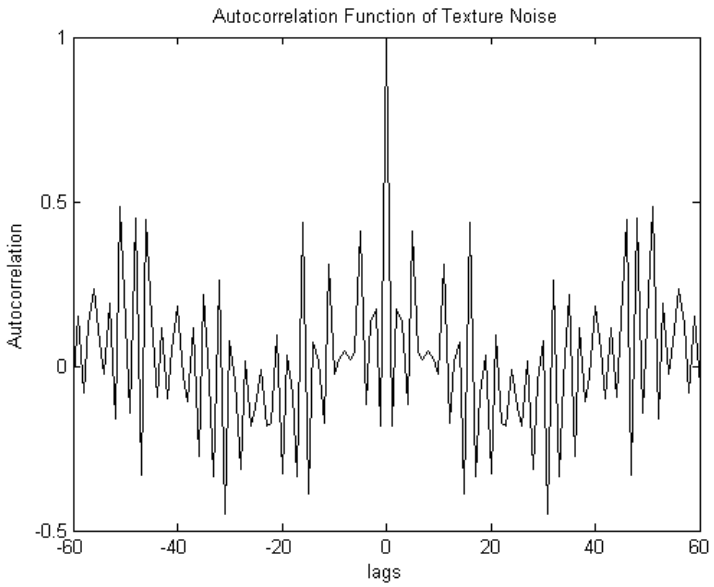
White Gaussian Noise





Color Texture Noise





ISNR (the Improvement in SNR)

- We usually use the ISNR (the Improvement in SNR) to determine the quality of the filtered image.

$$ISNR = 10 \cdot \log_{10} \left\{ \frac{\sum_{i,j} [f(i,j) - y(i,j)]^2}{\sum_{i,j} [f(i,j) - \hat{f}(i,j)]^2} \right\}$$

where $f(i,j)$ and $y(i,j)$ denote the original and the noise image, respectively, and $\hat{f}(i,j)$ denotes the filtered image.

Impulse Noise Examples

a) 3% Salt-Pepper impulse noise

b) 3% Uniform impulse noise

Median Filtering Results

- 3×3 Median filter on the two above image corrupted by impulse noises.

a) Median filtering of 3% Salt-pepper impulse noise

b) Median filtering of 3% Uniform impulse noise

Median Filtering Results (Cont.)

- 3×3 Threshold Median filter on the two above image corrupted by impulse noises (T=35)

a) Median filtering of 3% Salt-pepper impulse noise

b) Median filtering of 3% Uniform impulse noise

References

- [1] X.-Q. Lu and H. Sakaino, “A spatial adaptive filter for smoothing of non-Gaussian texture noise” in Proc. of ICASSP, 2009.
- [2] C. Tomasi and R. Manduchi, “Bilateral filtering for gray and color images,” in Proc. Of the IEEE International Conference on Computer Vision, pp.839-846, 1998

Thank You!

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