

Noise In Images

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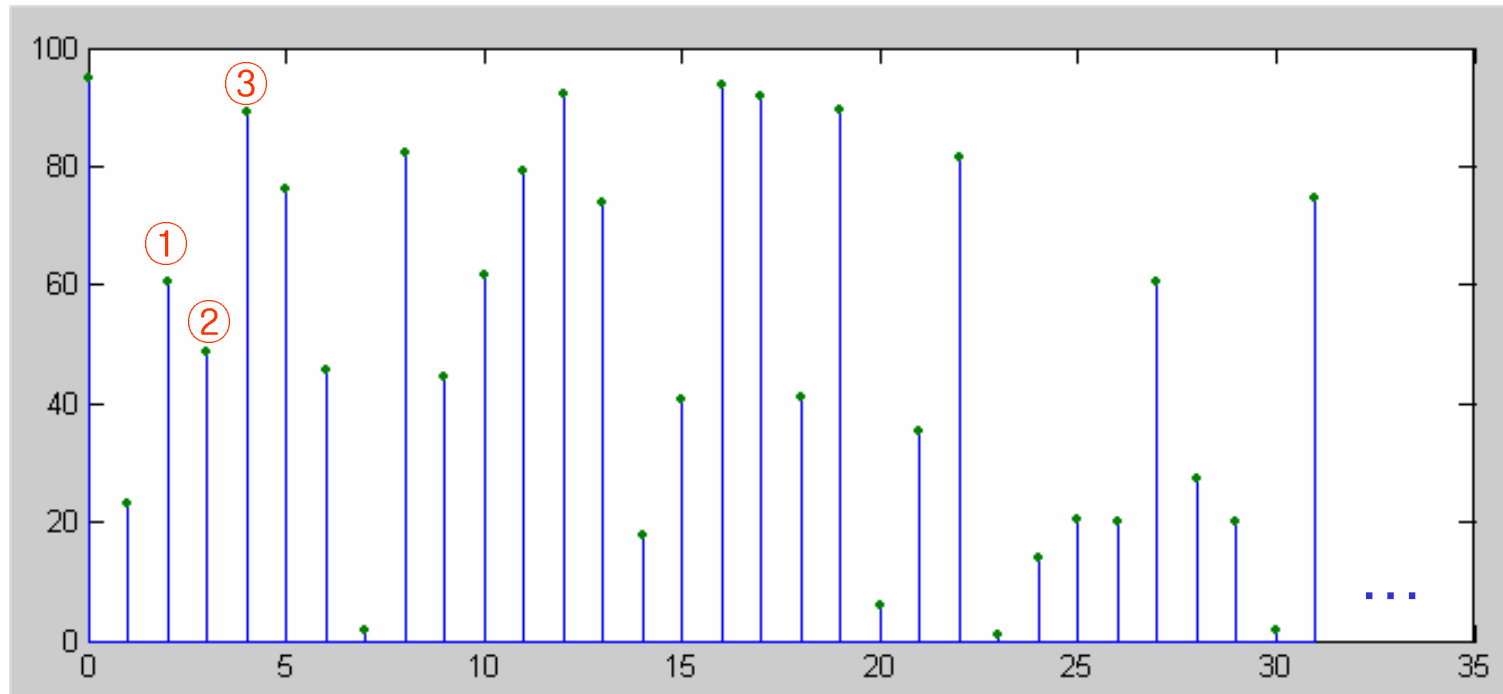
Noise

- Uniform noise
- Gaussian noise
- Impulse noise (salt-and-pepper noise)



What is Noise

- Unwanted signals
- Unable to determine the noise signal values
 - Random variables

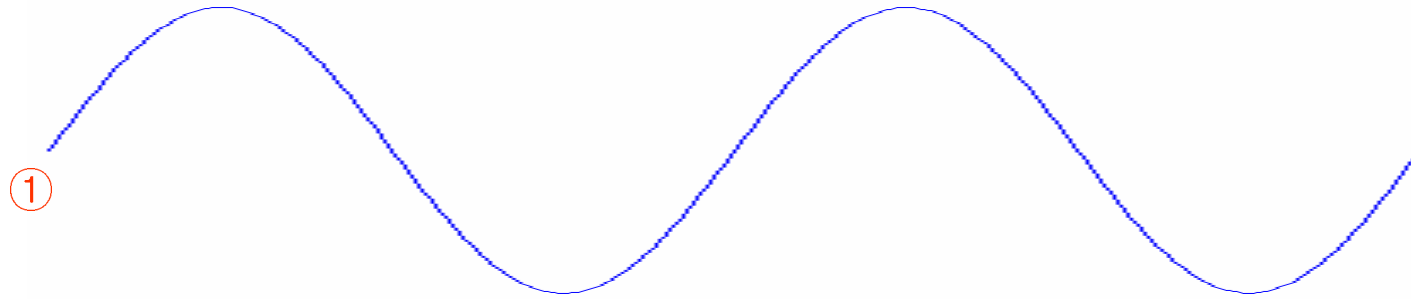


Characteristics of Noise

- Operational characteristics
 - Additive, Multiplicative
- Spectrum characteristics
 - White or Colored
- Statistical characteristics
 - Uniform, Gaussian, Impulse (Bipolar)

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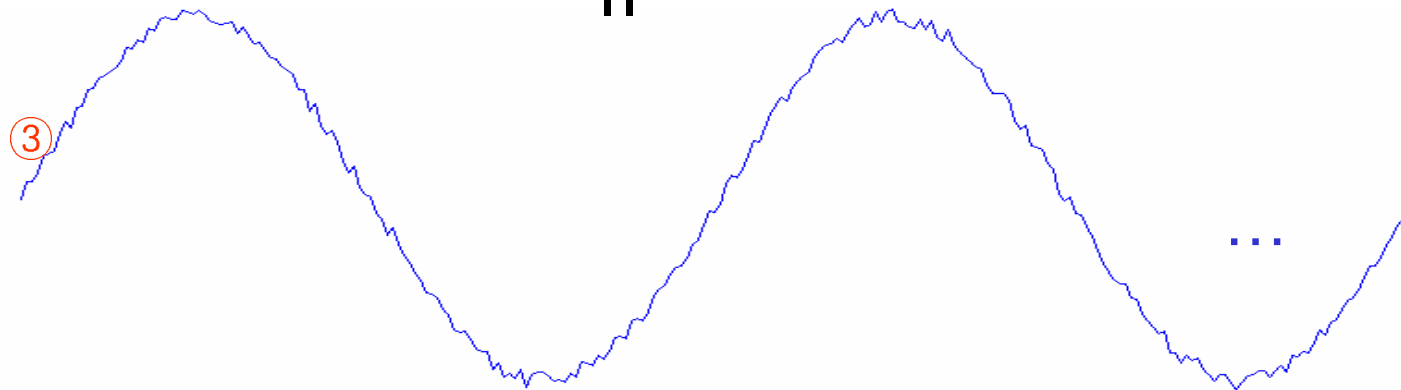
Additive Noise



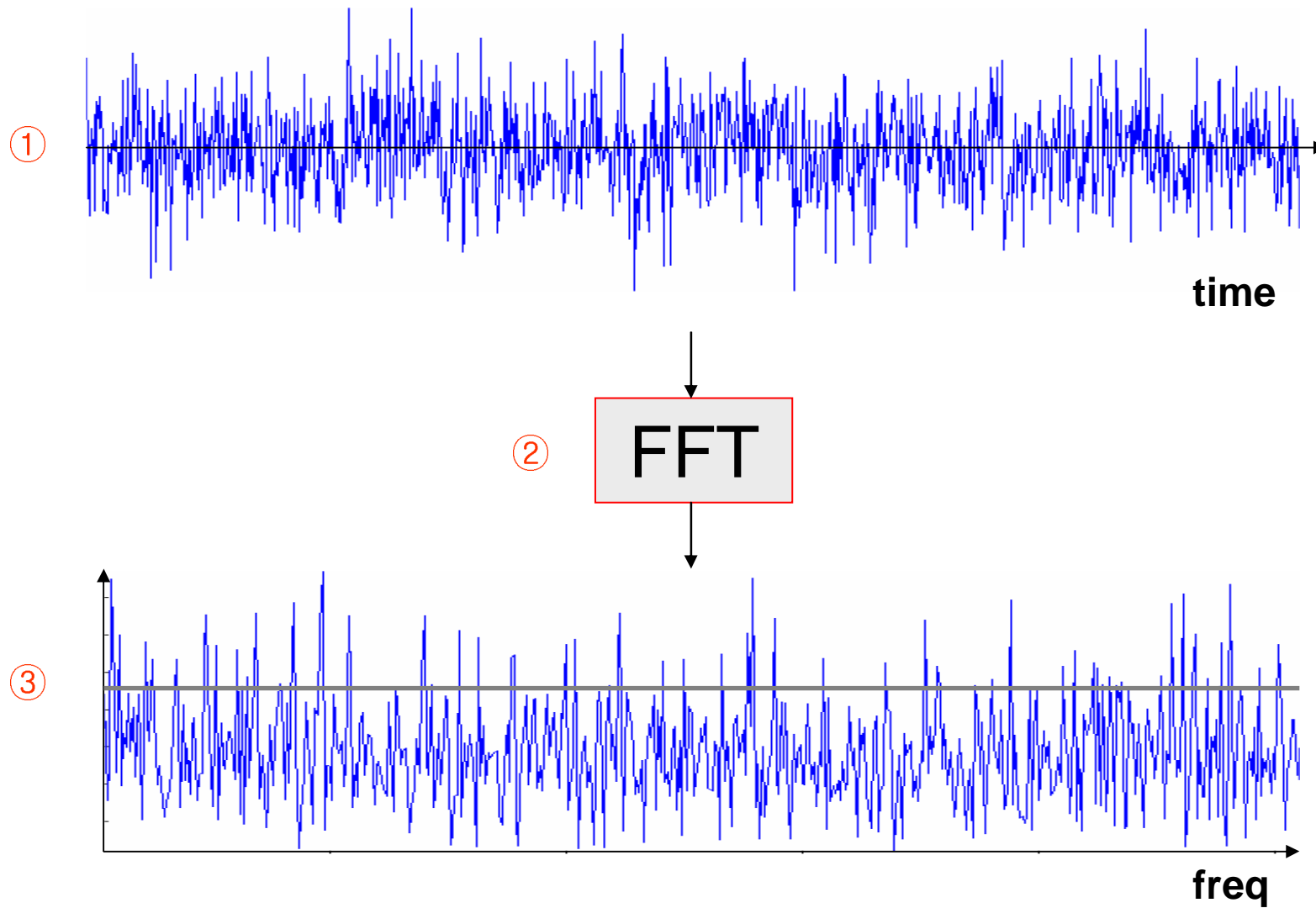
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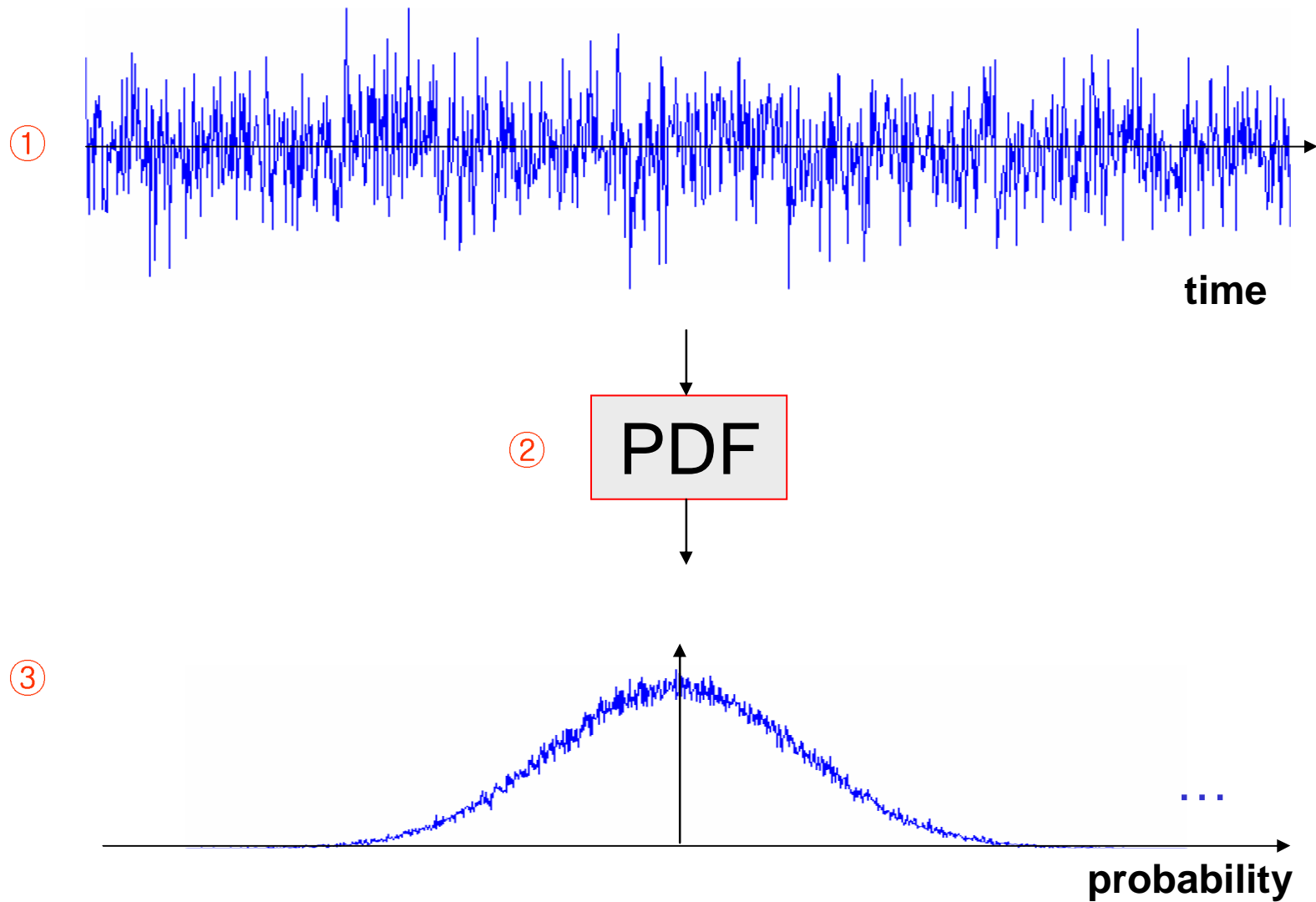
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Frequency Response of Noise

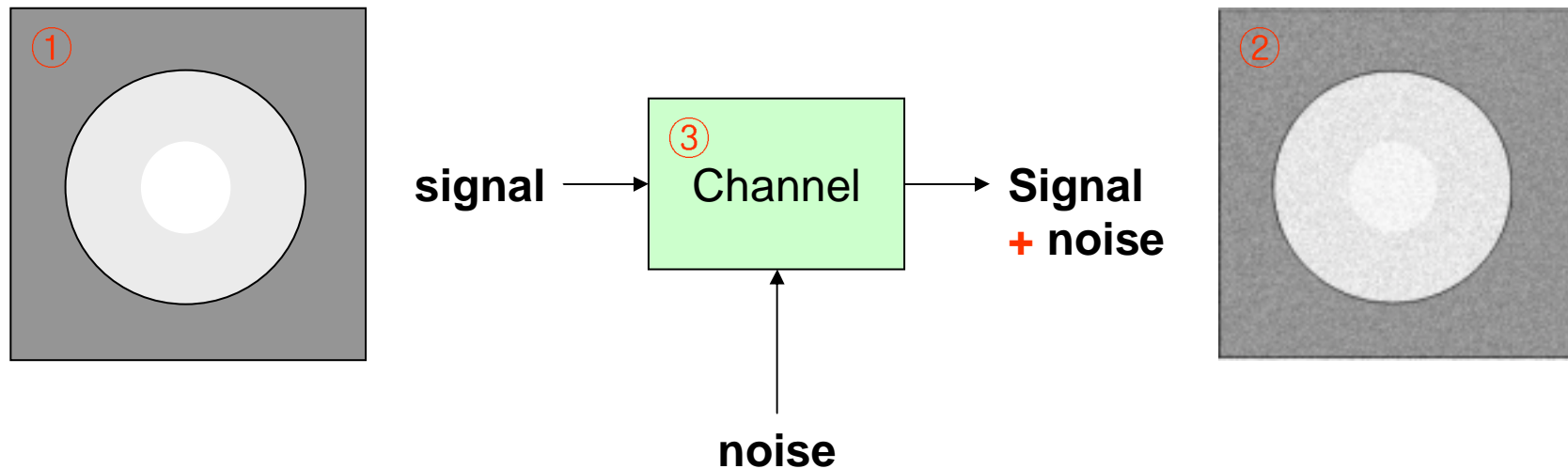


Histogram of Noise



The AWGN Channel

AWGN = Additive White Gaussian Noise



If noise is **white** and **Gaussian**

Measurements of Noise

- Signal-To-Noise Ratio

① $\text{SNR}[\text{dB}] = 10 \log_{10} (P_{\text{signal}} / P_{\text{noise}})$

$$P = \frac{1}{N} \sum_{i=0}^{N-1} x^2[i]$$

- Peak Signal-To-Noise Ratio

② $\text{PSNR}[\text{dB}] = 10 \log_{10} (255^2 / P_{\text{noise}})$

$$P = \frac{1}{N} \sum_{i=0}^{N-1} x^2[i]$$

Measurements of Noise

Original



PSNR = 34dB

PSNR = 28dB



PSNR = 18dB

Summary

- Noise and its characteristics
- AWGN channel
- Noise measurement
 - SNR
 - PSNR