Module: Computer Vision - Session 2

Computer Vision

Dr. Sunita Dhavale, DIAT

Online Training & Certification Course on Artificial Intelligence & Machine Learning
Defence Institute of Advanced Technology (DU), Pune.

Computer Vision

Dr Sunita Dhavale

Image Transformation

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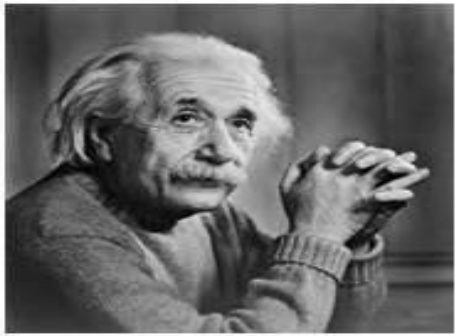
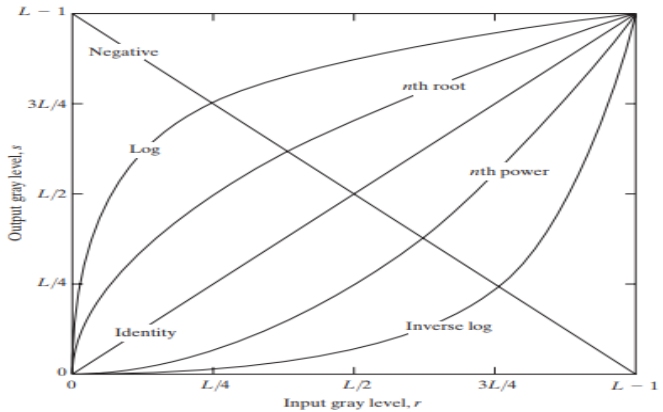
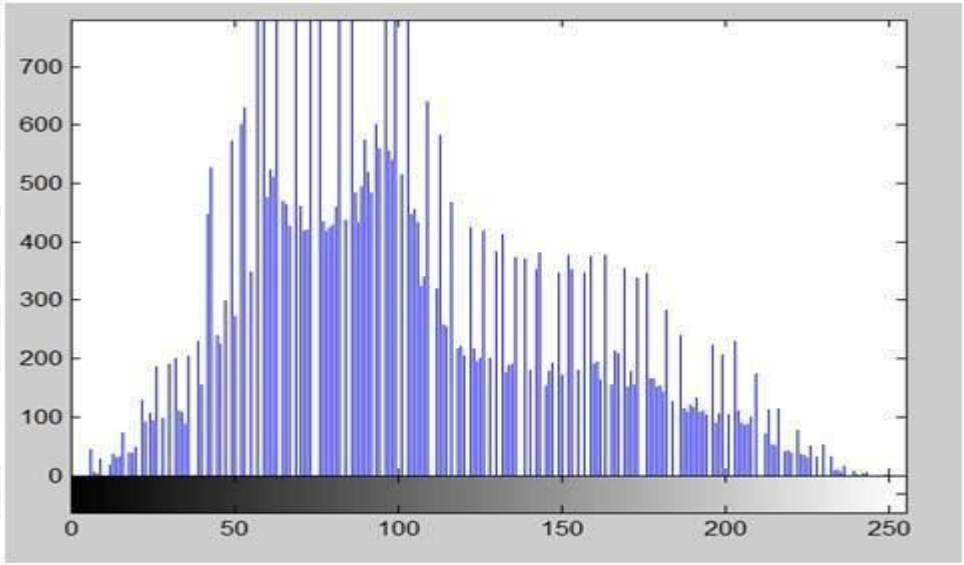
Outline of Presentation

- Image Transformation
- Contrast enhancement
- Histogram Equalization
- Convolution
- Filters
- Noise
- DFT

Image Transformation

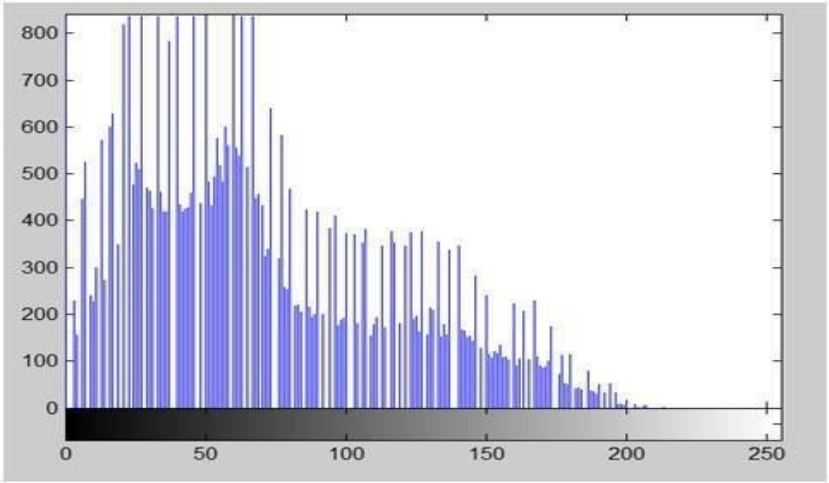


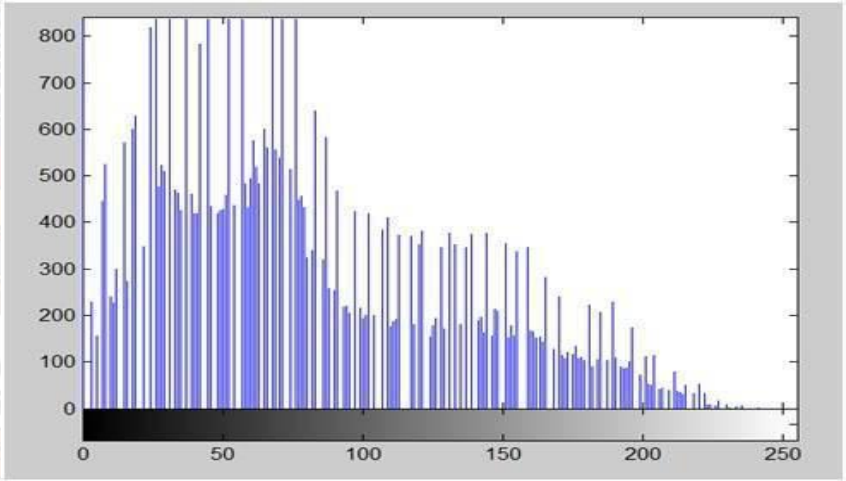




Contrast Enhancement

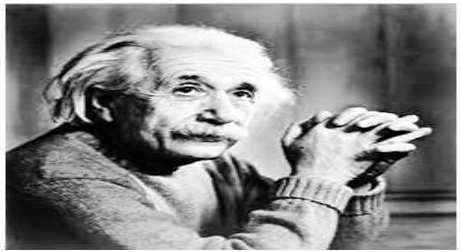
$$g(x,y) = \frac{f(x,y) - fmin}{fmax - fmin} * 2^{bpp}$$



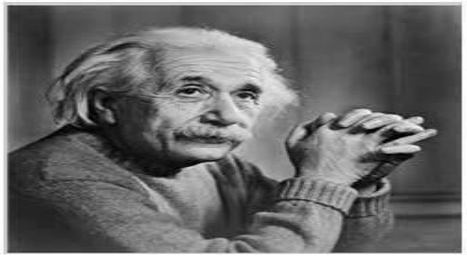


Histogram Equalization

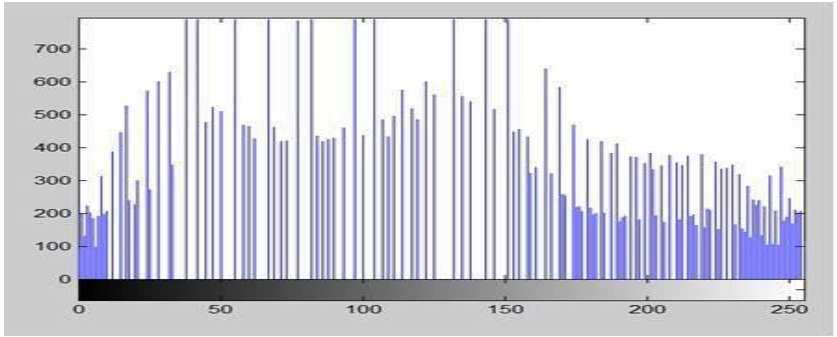
New Image



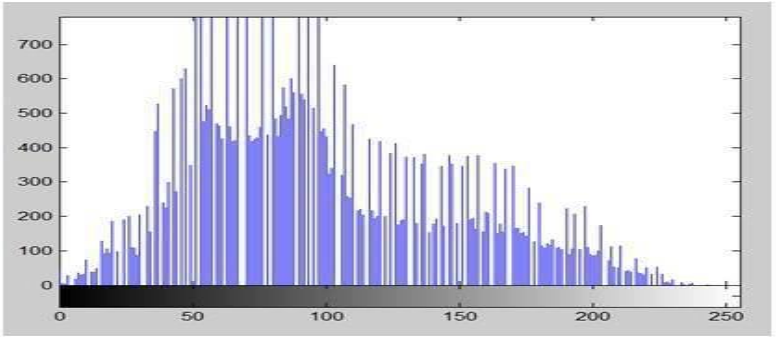
Old image



New Histogram



Old Histogram



Convolution/Spatial/Time domain Filtering

- g(x,y) = h(x,y) * f(x,y) = f(x,y) * h(x,y)
- convolution operator (*)

Example of convolution

1	2	3	3	2	1	9	8	7	2	4	6
4	5	6	6	5	4	6	5	4	8	10	12
7	8	9	9	8	7	3	2	1	14	16	18
Original mask			Flipping the mask horizontally			Flipping the mask vertically			Original Image		

Types of Filters

- linear/spatial domain filters or frequency domain filters
- Box/Mean/average filter,
- Weighted average filter
- Gaussian filter.

Noise

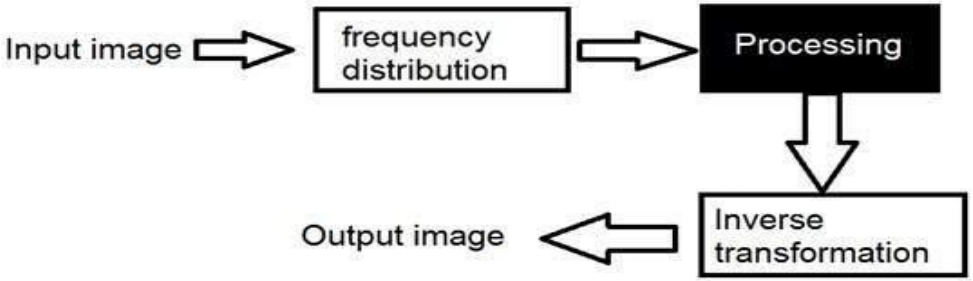
- Speckle/random noise
- Transient frequency spike
- Jitter and judder line noise
- Motion blur
- Gaussian noise
- Impulse noise
- Salt and pepper noise
- common measure of noise is the signal to noise ratio
- additive noise model
- multiplicative noise model

$$S/N ratio = \Sigma_{(i,j)} f^2(i,j) \Big/ \Sigma_{(i,j)} v^2(i,j)$$

$$f(i,j) = g(i,j) + v(i,j)$$

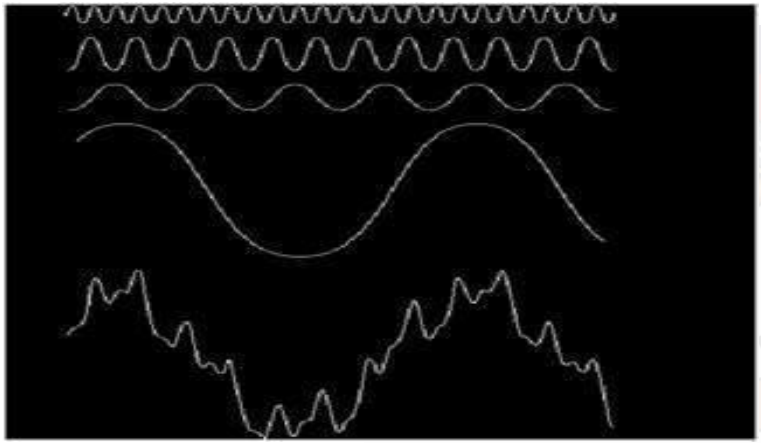
$$f(i,j) = g(i,j) + g(i,j).v(i,j)$$

Frequency domain analysis



$$F(u, v) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f(x, y) e^{-j2\pi(ux+vy)} \, dx \, d$$

$$f(x, y) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} F(u, v) e^{j2\pi(ux+vy)} \, du \, dv.$$



Discrete Fourier transform

$$F(u,v) = \frac{1}{MN}\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)e^{-j2\pi(ux/M+vy/N)}$$

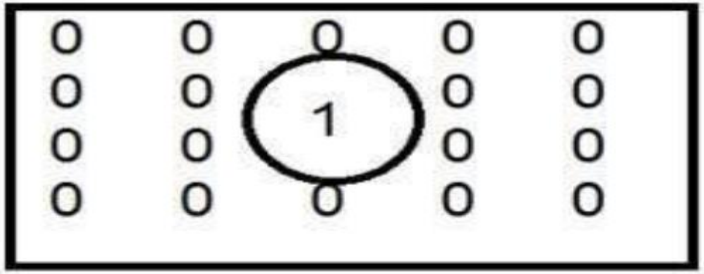
$$f(x,y) = \sum_{u=0}^{M-1}\sum_{v=0}^{N-1} F(u,v)e^{j2\pi(ux/M+vy/N)}$$

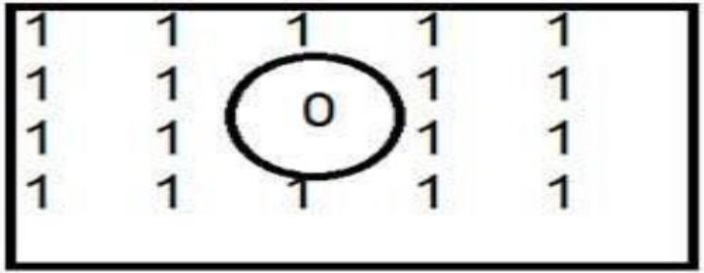
$$G(u,v) = F(u,v) \times H(u,v)$$

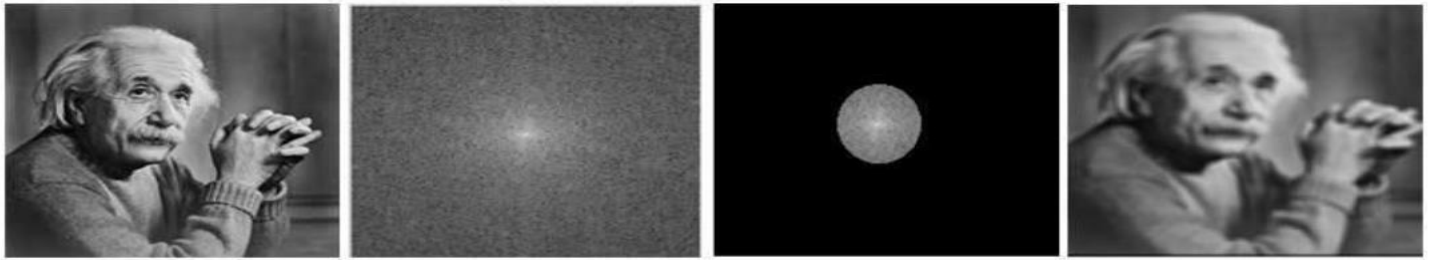
Ideal high pass filter, Ideal low pass filter, Gaussian high pass filter, Gaussian low pass filter

Filtering an image in frequency domain

Ideal low pass and Ideal High pass filters







Sample image, Image in frequency domain, Applying LPF filter over this image, Resultant Image

Python

- Histogram Equalization
- Gaussian Filter
- DFT

Reference Material

- 1. E. R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press, 2012.
- 2. R. Szeliski, “Computer Vision: Algorithms and Applications”, Springer 2011.
- 3. Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 2012.
- 4. Mark Nixon and Alberto S. Aquado, “Feature Extraction & Image Processing for Computer Vision”, Third Edition, Academic Press, 2012.
- 5. Sunita Dhavale, “Advanced Image-Based Spam Detection and Filtering Techniques”, Book Published by CyberTech: An Imprint of MKP Technologies, Hershey, PA, USA IGI Global, March 2017, ISBN13: 9781683180135|ISBN10: 1683180135|EISBN13: 9781683180142|DOI: 10.4018/978-1-68318-013-5.
- Gonzalez and R. Woods Digital Image Processing, Addison-Wesley Publishing Company, 1992, p 442.

<<Epilogue>>

- We will meet in next scheduled lecture.
- Implement algorithms using python.
- Feel free to ask your questions.
- Email: sunitadhavale@diat.ac.in

Thank You!