CS4243

Computer Vision & Pattern Recognition

AY 2023/24

Lab Session 3

NUS National University of Singapore | School of Computing

Arrangement

- Part 1 – Quick Recap from the Lecture (~15 min)
- Part 2 – Lab Tutorial (~40 min)
- Break (10 min)
- Part 3 – Lab Solution (~40 min)

Lab Materials

- GitHub Repo: https://github.com/ldkong1205/cs4243_lab
- Slides
- Notebook & Solution
- Other Materials (image, media, etc.)

Lesson 3

Image Transforms

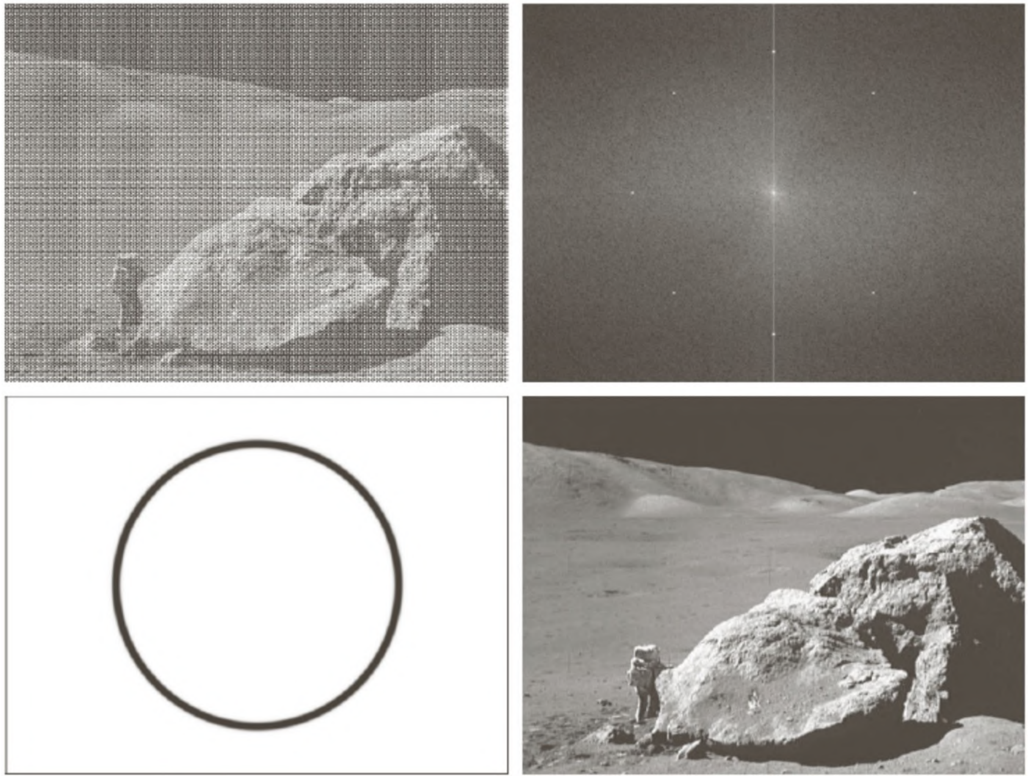


Image Transforms

- Image processing tasks are sometimes best performed in a domain other than the spatial domain, e.g., the Fourier domain.

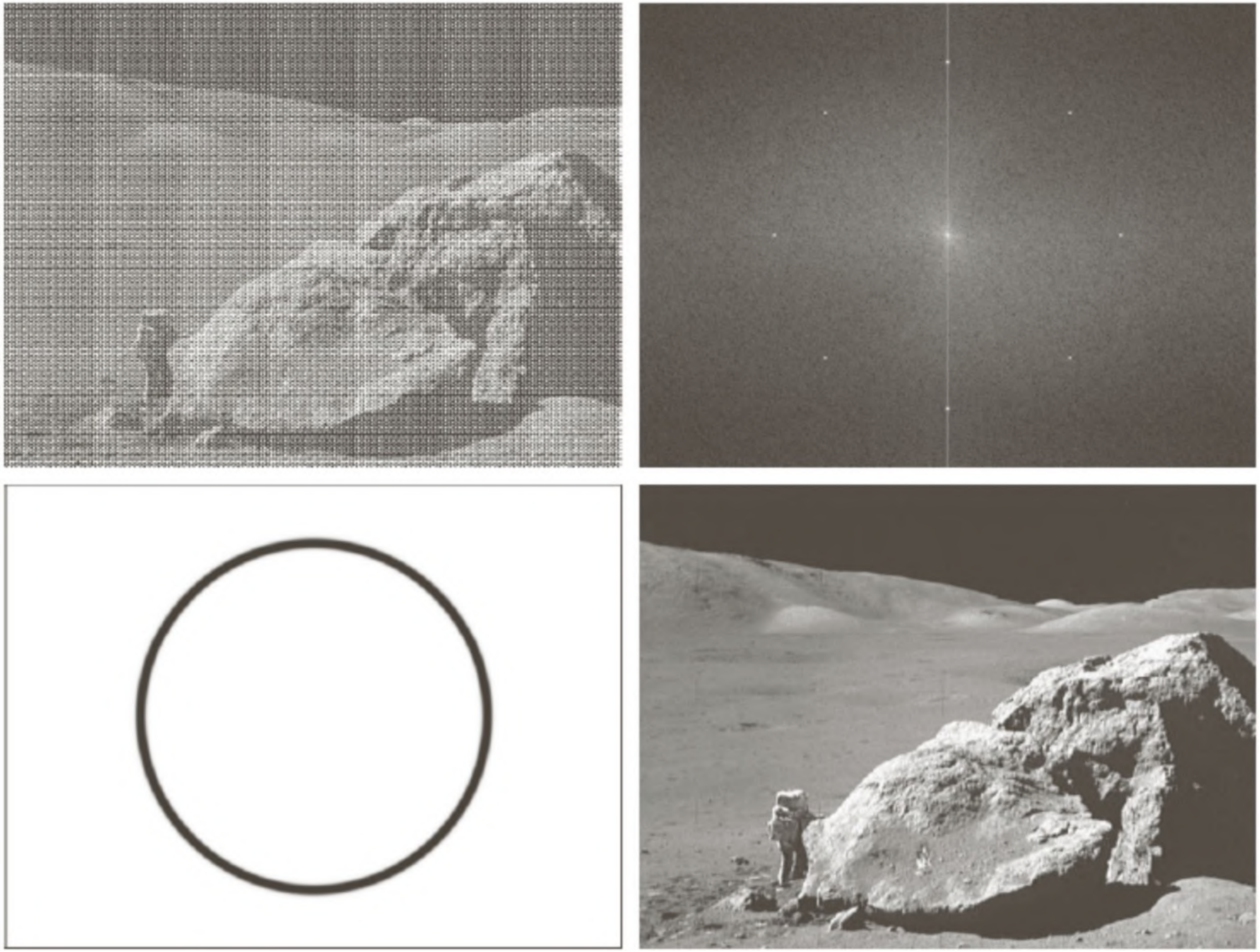
- Key steps:

  1. Transform the image.

  2. Carry the task(s) in the transform domain.

  3. Apply inverse transform to return to the spatial domain.

Periodic-Noise Reduction using FT



Fourier Transform

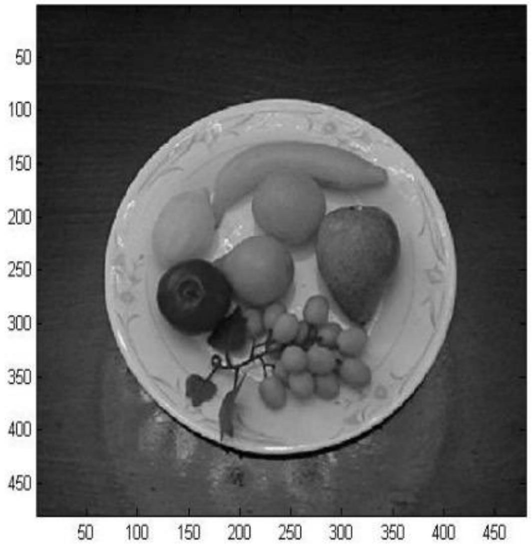
- Continuous Fourier Transform (FT)
- Discrete Fourier Transform (DFT)
- Fast Fourier Transform (FFT)

- A sinusoidal signal / function has got 3 parameters:
    - Amplitude.
    - Frequency.
    - Phase.

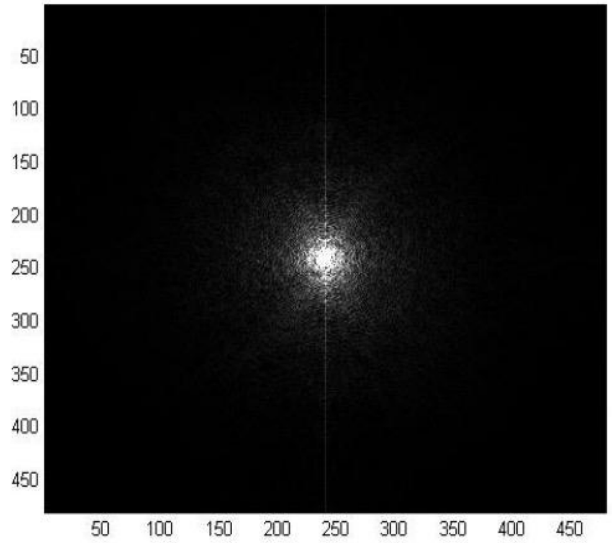
$$x(t) = a.\sin(\omega t + \varphi)$$

$$x[n] = a.\sin(\omega n + \varphi)$$

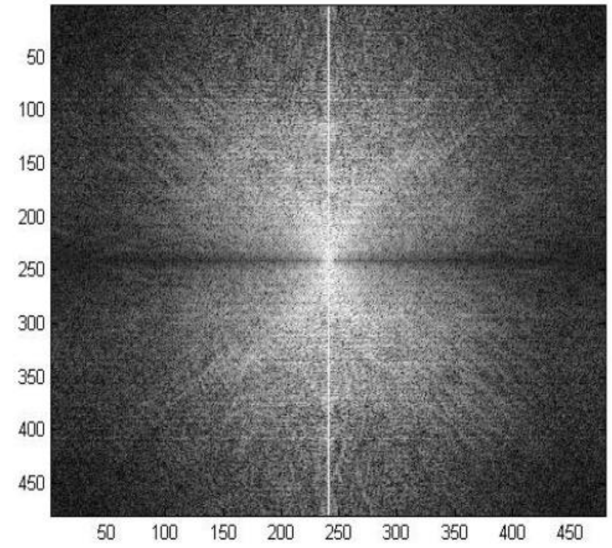
Example: Discrete Fourier Transform



Gray-Level
Image



DFT
(Fourier Spectrum)



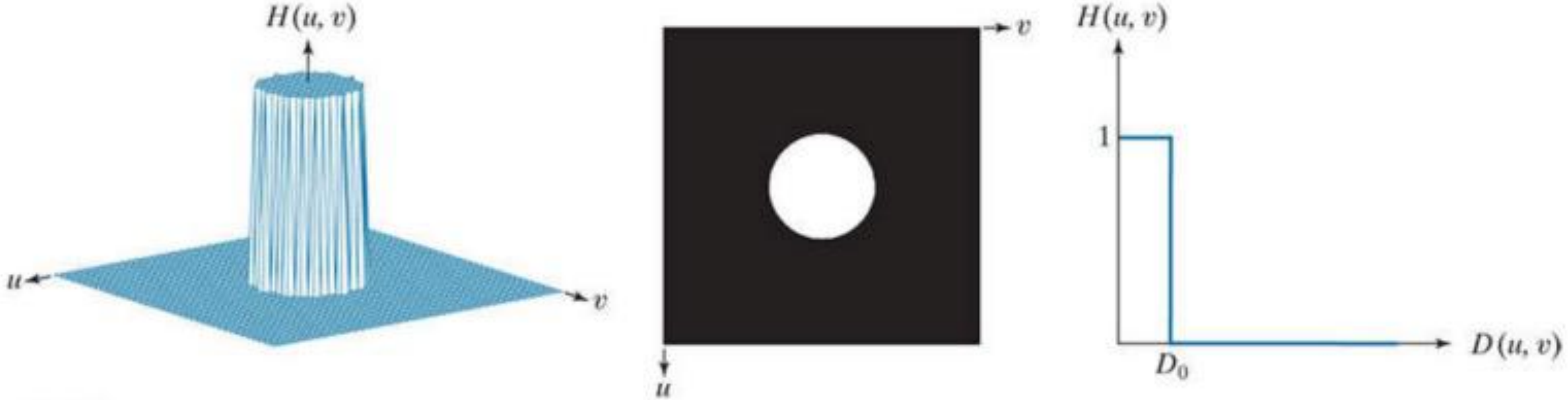
Logarithmic-Scaled
Spectrum

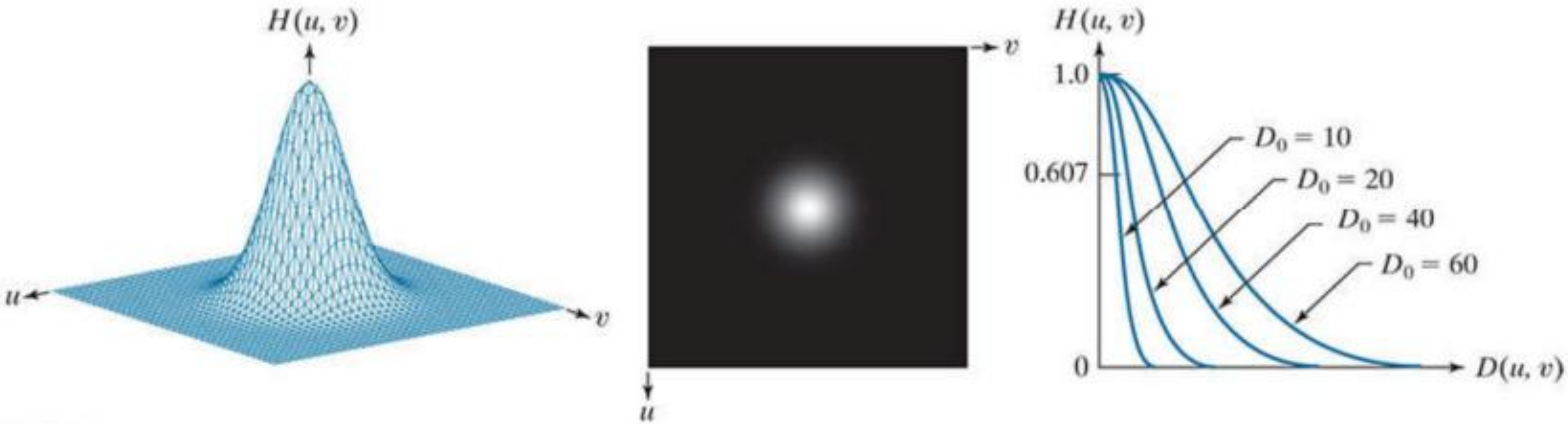
Frequency Domain Filters

Ideal	Gaussian	Butterworth
$H(u,v) = \begin{cases} 1 & \text{if } D(u,v) \le D_0 \\ 0 & \text{if } D(u,v) > D_0 \end{cases}$	$H(u,v) = e^{-D^2(u,v)/2D_0^2}$	$H(u,v) = \frac{1}{1+[D(u,v)/D_0]^{2n}}$

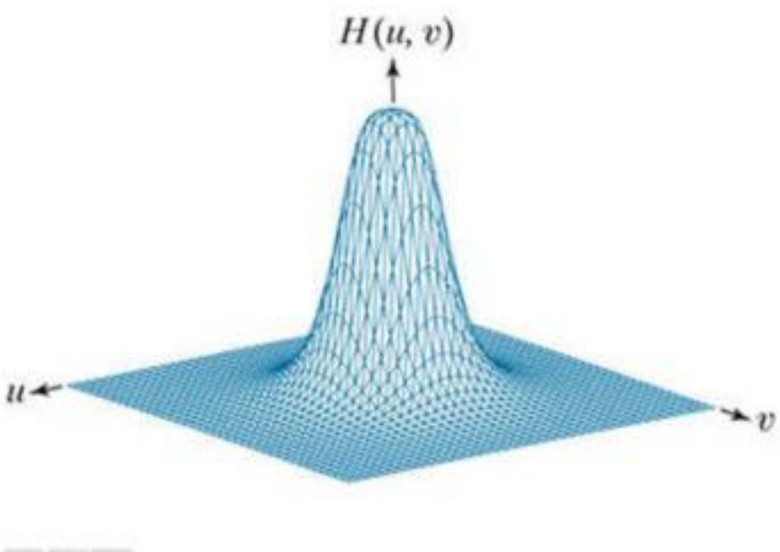
- Filter matrix size = image size = Fourier Transformed matrix size
- D_0 = filter bandwidth or coordination of the cut-off point
- Cut-off point: Where the magnitude of the filter reaches 0.5
- D = distance to the frequency axes origin in the <u,v> page
- Corresponding high pass filter (HPF) obtains by 1 - LPF

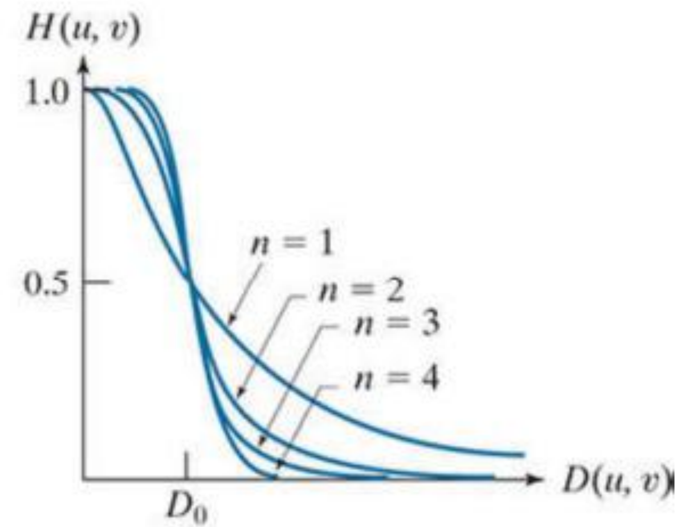
Ideal and Gaussian LPFs





Butterworth LPF





$$H(u,v) = \frac{1}{1 + [D(u,v)/D_0]^{2n}}$$

Lab Session 3

Filtering in Fourier Domain

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