Image Processing
(Pengolahan Citra)

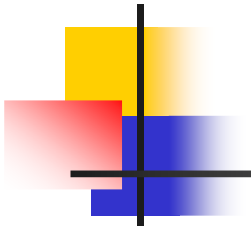
Semester Genap Tahun 2019-2020

Jam 08:00 s.d. 10:30

Pengajar: Mohammad Agung Wibowo, M.Kom.

STT Nurul Fikri

Slides by: Prof. Dr. Aniati Murni Arymurthy (FASILKOM UI)



Session Topics

- Image Enhancement: Frequency Domain
  - Fourier Transform
  - Wavelet Transform
- Image Restoration
- Cloud Elimination in Optical Images

- Color Transformation

Topic 1
Image Enhancement: Domain Frekwensi

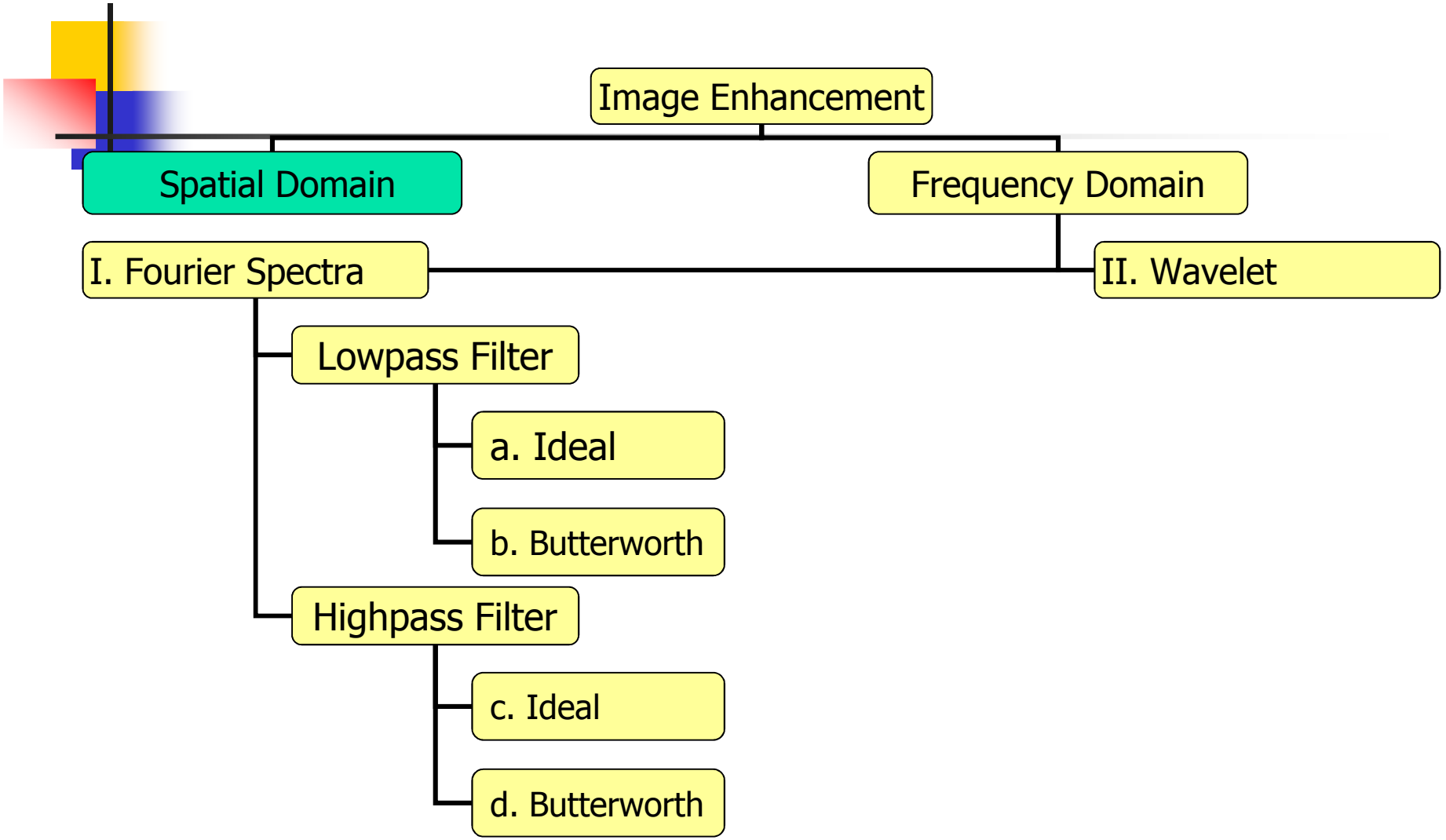
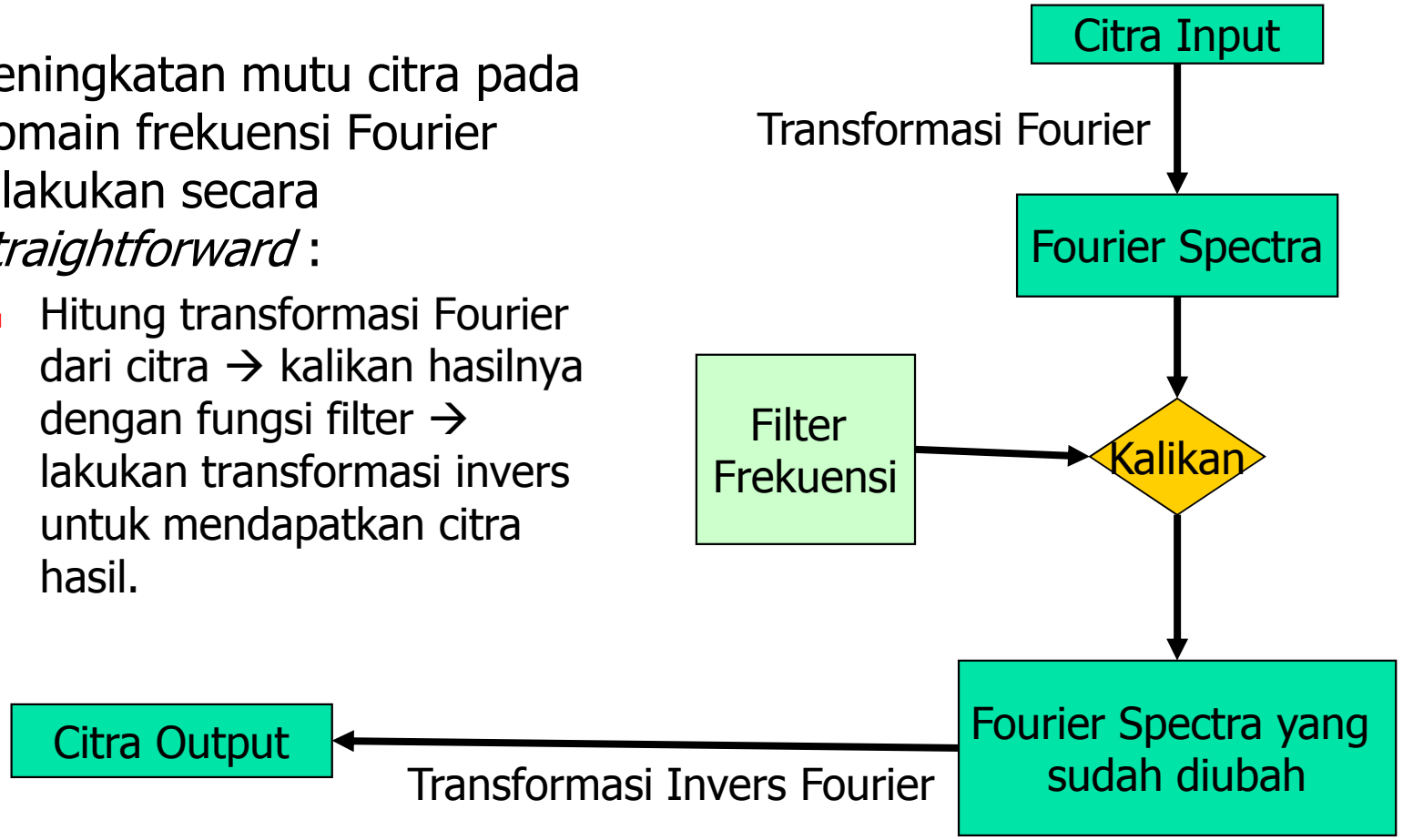
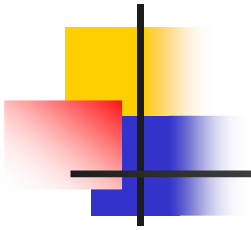


Image Enhancement
Spatial Domain
Frequency Domain
I. Fourier Spectra
II. Wavelet
Lowpass Filter
a. Ideal
b. Butterworth
Highpass Filter
c. Ideal
d. Butterworth

Fourier Spectra

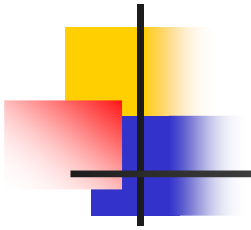
- Peningkatan mutu citra pada domain frekuensi Fourier dilakukan secara *straightforward* :
  - Hitung transformasi Fourier dari citra → kalikan hasilnya dengan fungsi filter → lakukan transformasi invers untuk mendapatkan citra hasil.





Noise: bersifat low frequency
Filter: diperlukan High Pass Filter

- Blurring (informasi low frequency) : informasi komponen frekuensi tinggi hilang
- Sharpening (high pass filter) : meloloskan komponen frekuensi tinggi
- G(u,v) = H(u,v)F(u,v)



Noise: bersifat high frequency
Filter: diperlukan Low Pass Filter

- Jika suatu citra banyak memiliki noise dalam bentuk edge/garis maka nilai komponen Fourier-nya pada frekuensi tinggi akan besar.
- Semakin tinggi frekuensi, semakin besar nilai (u,v) pada citra Fourier → (semakin jauh dari titik origin (0,0))
- Prinsip Low Pass Filter: Blurring (smoothing) dapat dilakukan untuk mengurangi nilai komponen frekuensi tinggi.

Ideal Low Pass Filter (LPF)

- $H(u,v) = 1$ if $D(u,v) \leq D_0$
  $= 0$ if $D(u,v) > D_0$
- D_0 adalah nilai ambang (cutoff frequency locus, nilainya > 0)
- D(u,v) adalah jarak (u,v) terhadap titik origin.
  $D(u,v) = (u^2+v^2)^{1/2}$

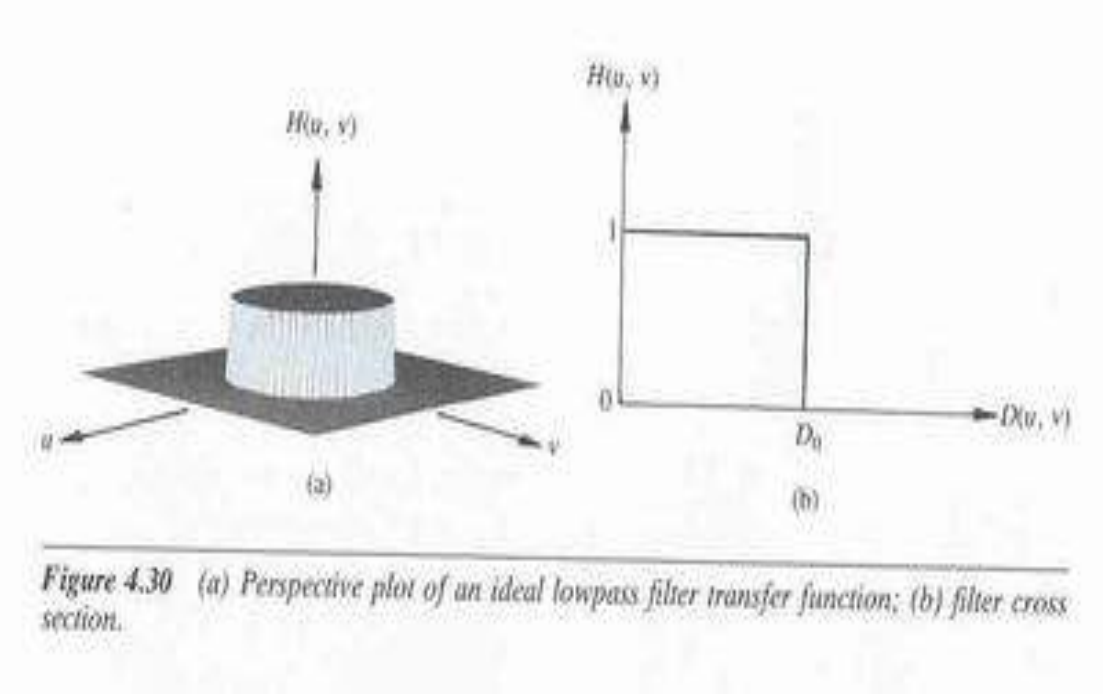
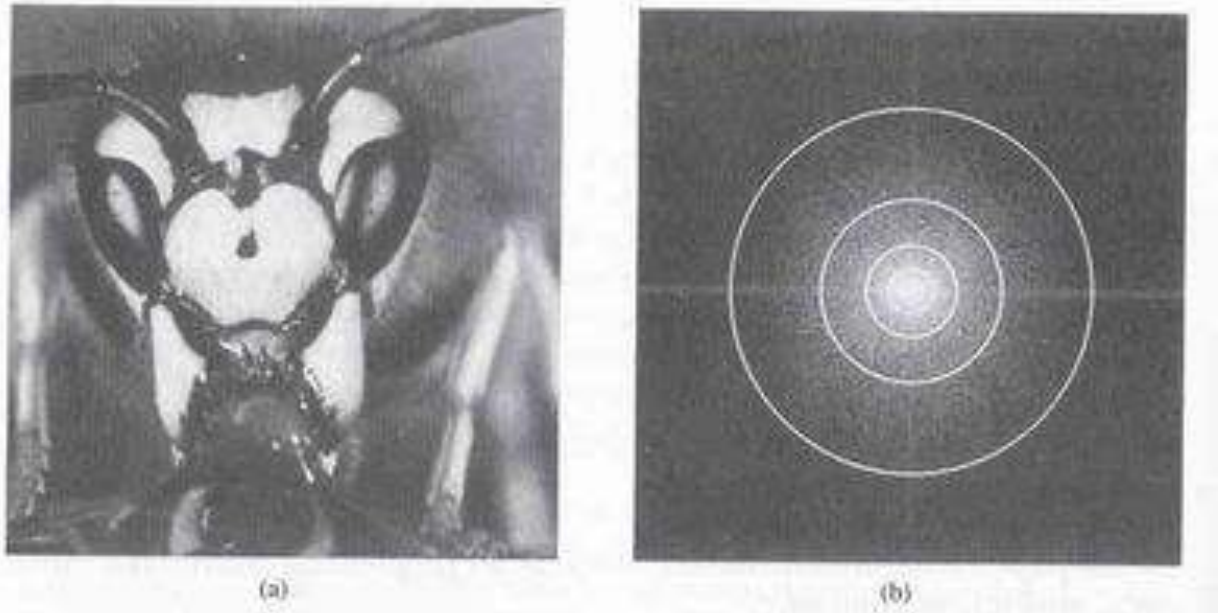


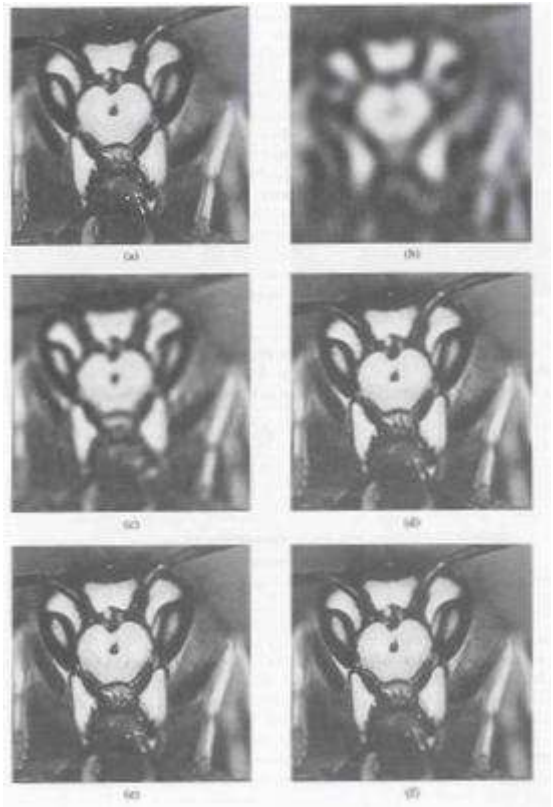
Figure 4.30 (a) Perspective plot of an ideal lowpass filter transfer function; (b) filter cross section.

Contoh ideal low pass filtering



(a) (b)

Figure 4.31 *(a) 512 × 512 image and (b) its Fourier spectrum. The superimposed circles, which have radii equal to 8, 18, 43, 78, and 152, enclose 90, 93, 95, 99, and 99.5 percent of the image power, respectively.*



Butterworth Low Pass Filter

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

$n = orde$

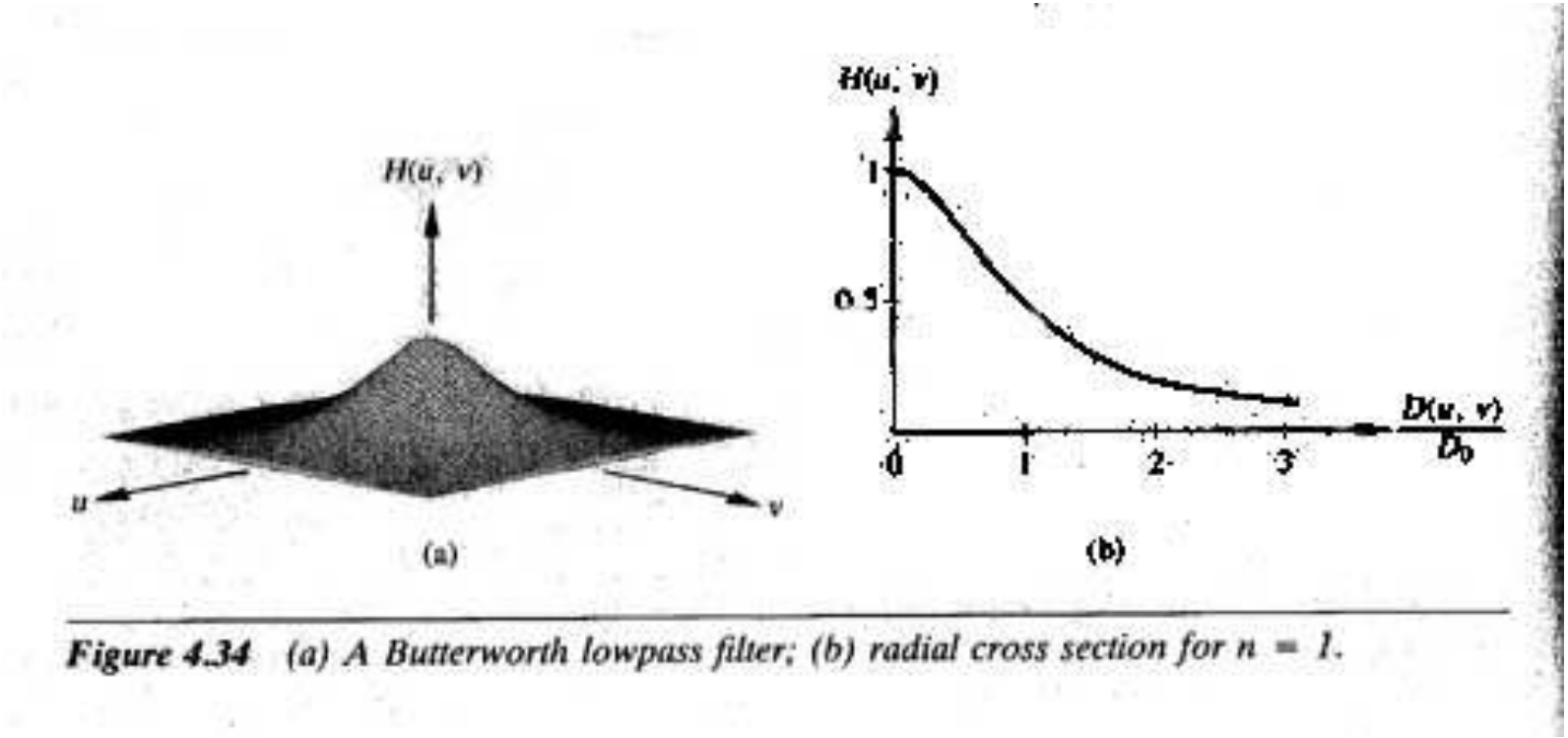
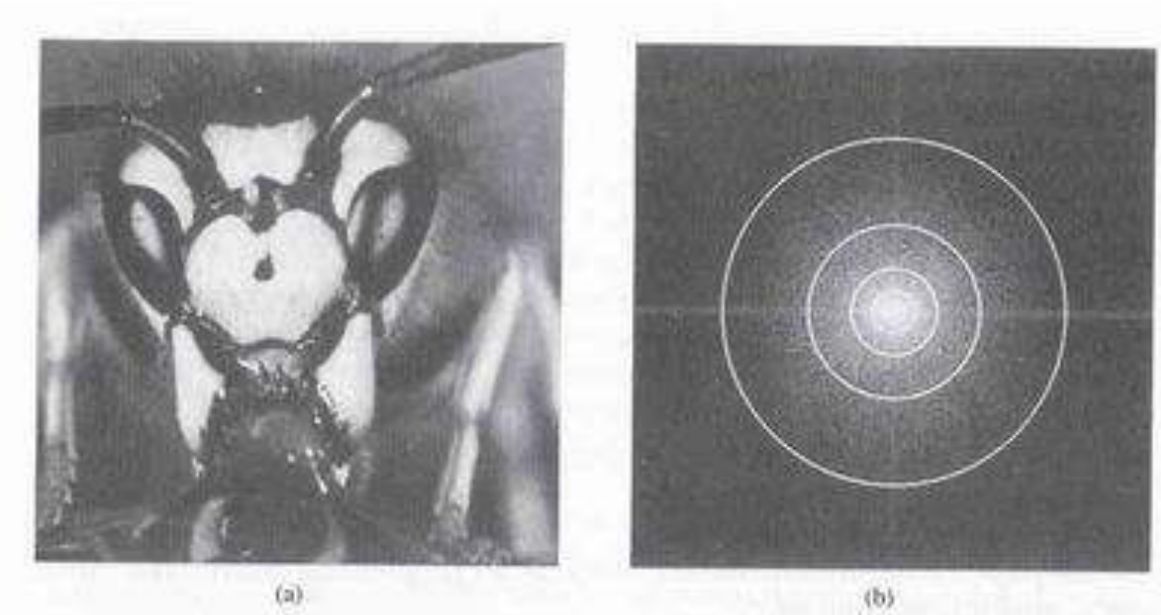


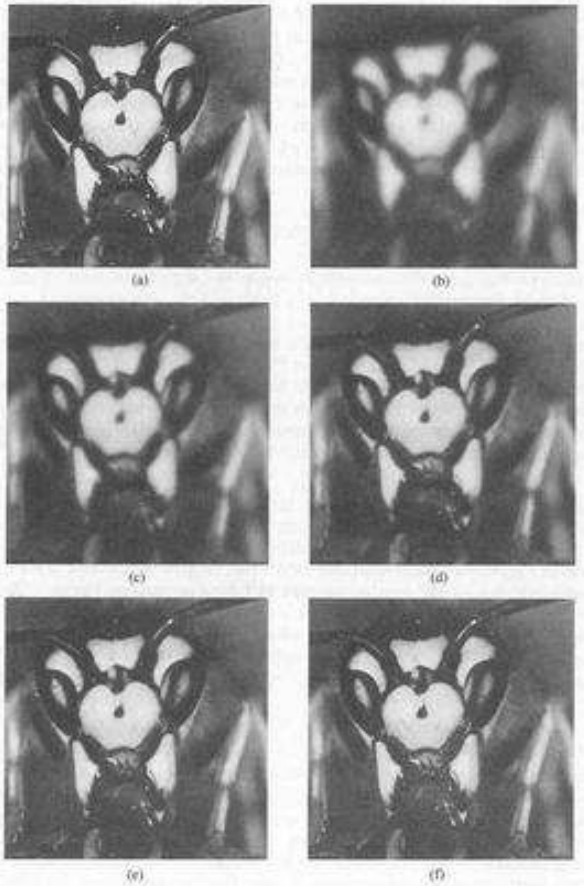
Figure 4.34 *(a) A Butterworth lowpass filter; (b) radial cross section for n = 1.*

Contoh Butterworth low pass filter



(a) (b)

Figure 4.31 *(a) 512 × 512 image and (b) its Fourier spectrum. The superimposed circles, which have radii equal to 8, 18, 43, 78, and 152, enclose 90, 93, 95, 99, and 99.5 percent of the image power, respectively.*



(a) (b) (c) (d) (e) (f)

Figure 4.35 *(a) Original image; (b)–(f) results of Butterworth lowpass filtering with the cutoff point set at the radii shown in Fig. 4.31(b).*

Masih lebih tajam kontrasnya

Ideal High Pass Filter

- $H(u,v) = 0$ if $D(u,v) \leq D_0$
  $= 1$ if $D(u,v) > D_0$

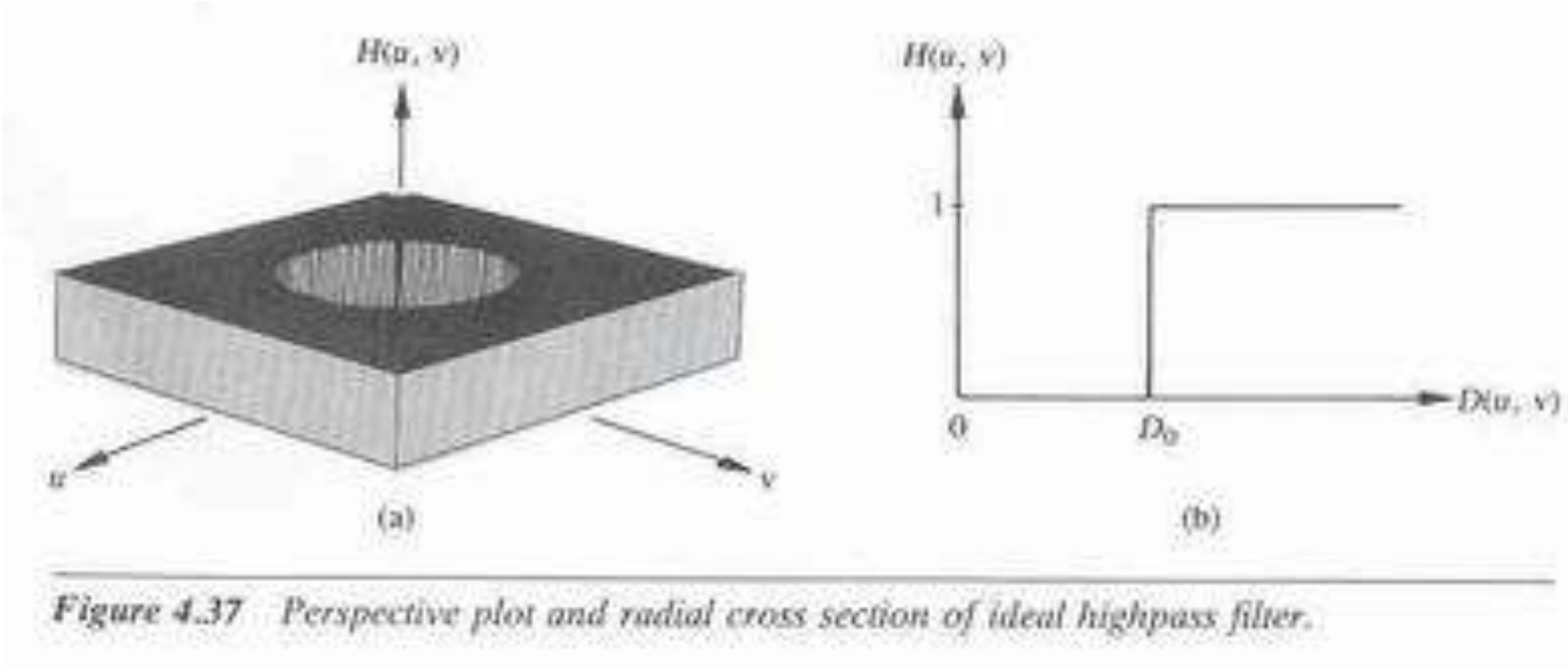


Figure 4.37 Perspective plot and radial cross section of ideal highpass filter.

Butterworth High Pass Filter

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

$$n = orde$$

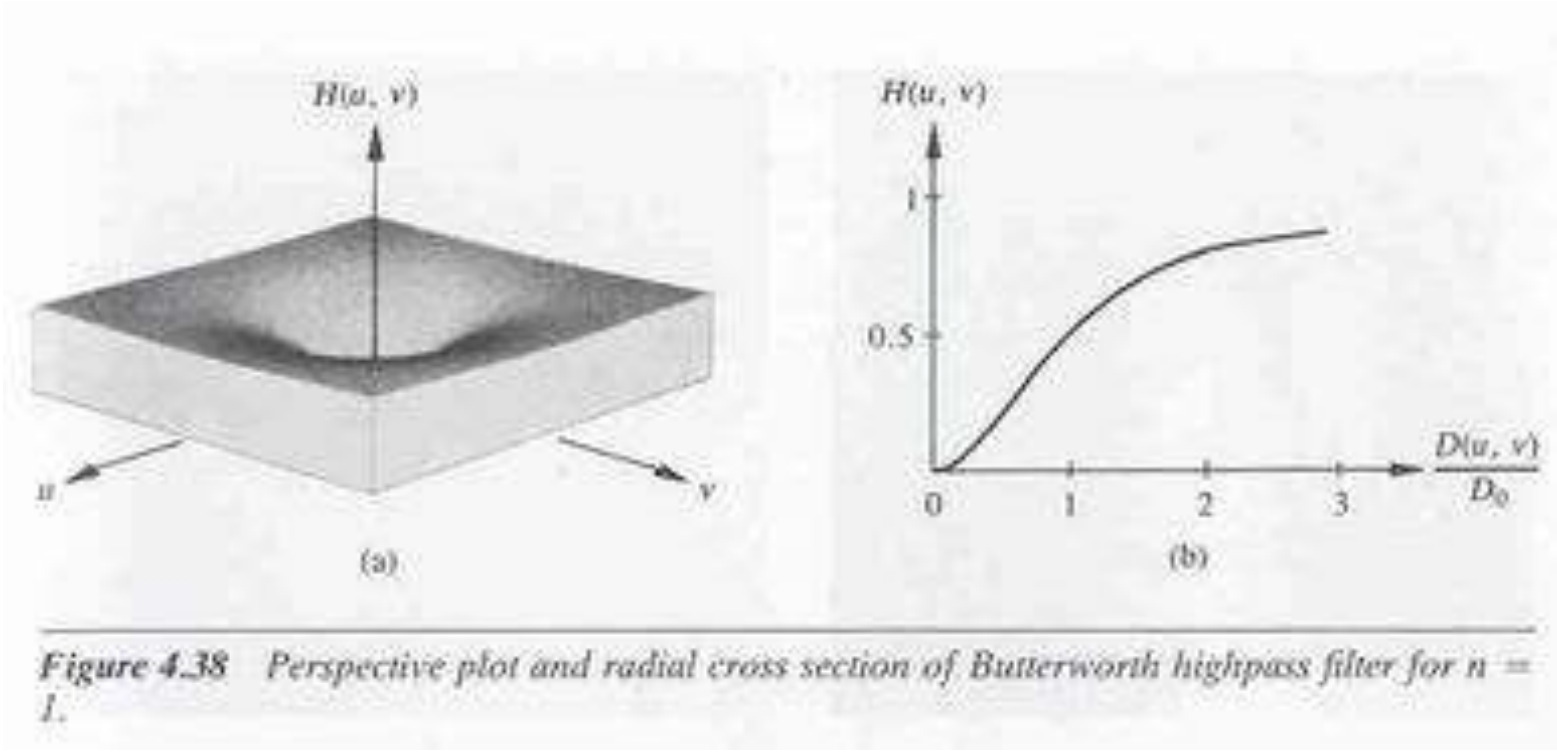


Figure 4.38 Perspective plot and radial cross section of Butterworth highpass filter for n = 1.

Topic 2:
Wavelet Transform
(sudah dibahas pada diskusi wavelet transform)

The End