Image Analysis and Computer Vision
Lecture 5、Image Enhencement in Frequency Domain(I)

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Outline

Sharpening Frequency Domain Filters

- General high-pass frequency domain filters

$$H_{hp}(u,v) = 1 - H_{lp}(u,v)$$

Why? how to prove it?

Sharpening Frequency Domain Filters

高频对应边缘信息，变化剧烈

- Ideal highpass filter

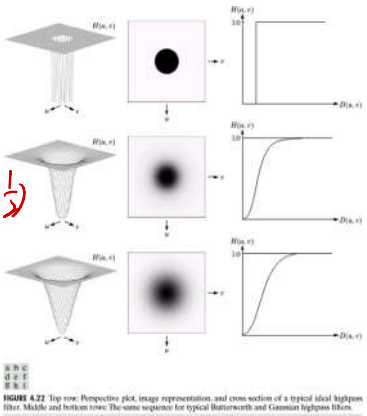
$$H(u,v) = \begin{cases} 0 & if\ D(u,v) \le D_0 \\ 1 & if\ D(u,v) > D_0 \end{cases}$$

- Butterworth highpass filter

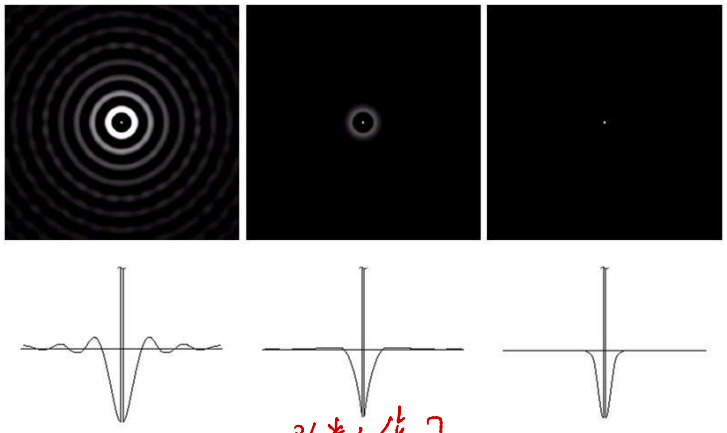
$$H(u,v) = \frac{1}{1 + [D_0/D(u,v)]^{2n}}$$

- Gaussian highpass filter

$$H(u,v) = 1 - e^{-D^2(u,v)/2D_0^2}$$



Highpass Filters Spatial Representations



a b c

FIGURE 4.23 Spatial representations of typical (a) ideal, (b) Butterworth, and (c) Gaussian frequency domain highpass filters, and corresponding gray-level profiles.

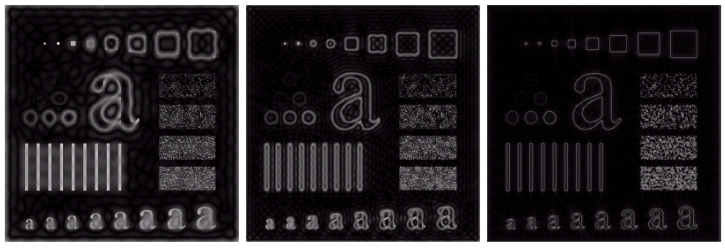
所考点像了

Ideal Highpass Filters

D_0变大，能量变小，定位更准确，（筛选出后的能量更高）但是整体变暗。

- Ideal highpass filter

$$H(u,v) = \begin{cases} 0 & if\ D(u,v) \le D_0 \\ 1 & if\ D(u,v) > D_0 \end{cases}$$



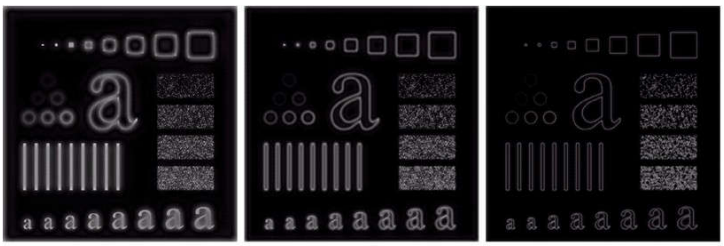
a b c

FIGURE 4.24 Results of ideal highpass filtering the image in Fig. 4.11(a) with $D_0 = 15$, 30, and 80, respectively. Problems with ringing are quite evident in (a) and (b).

Butterworth Highpass Filters

- Butterworth highpass filter

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



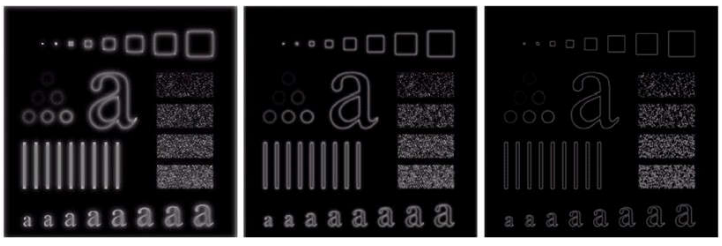
a b c

FIGURE 4.25 Results of highpass filtering the image in Fig. 4.11(a) using a BHPF of order 2 with $D_0 = 15$, 30, and 80, respectively. These results are much smoother than those obtained with an ILPF.

Gaussian Highpass Filters

- Gaussian highpass filter

$$H(u,v) = 1 - e^{-D^2(u,v)/2D_0^2}$$



a b c

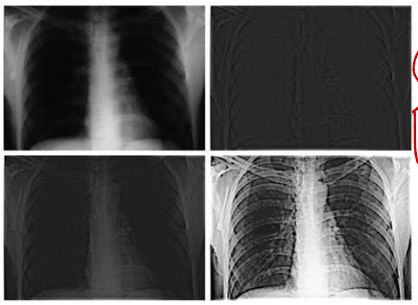
FIGURE 4.26 Results of highpass filtering the image of Fig. 4.11(a) using a GHPF of order 2 with $D_0 = 15$, 30, and 80, respectively. Compare with Figs. 4.24 and 4.25.

Sharpening Frequency Domain Filters

- High-Frequency Emphasis Filtering 高频加强滤波

$$H_{hfe}(u,v) = a + bH_{hp}(u,v)$$

```
>>f=imread('Fig0419(a)(chestXray_original).tif');
>>PQ=paddedsize(size(f));
>>D0=0.05*PQ(1);
>>HBW=hpfilter('btw',PQ(1),PQ(2),D0,2);
>>H=0.5+2*HBW;
>>gbf=dftfilt(f,H);
>>ghf=gscale(gbf);
>>ghe=histeq(ghf,256);
>>imshow(ghe);
```



a b
c d

FIGURE 4.19 High-frequency emphasis filtering. (a) Original image. (b) Highpass filtering result. (c) High-frequency emphasis result. (d) Image (c) after histogram equalization. (Original image courtesy of Dr. Thomas R. Gest, Division of Anatomical Sciences, University of Michigan Medical School.)