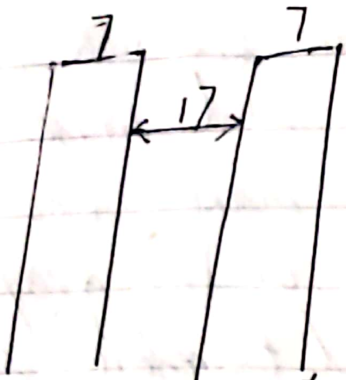
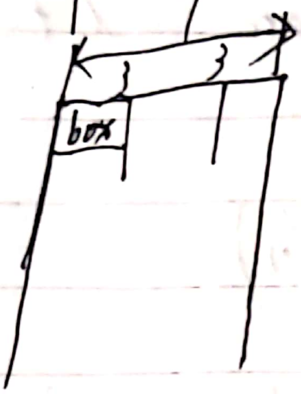
(1) 5.1

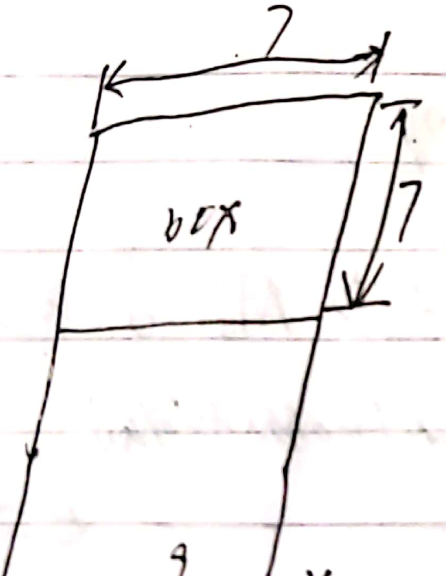


3X3



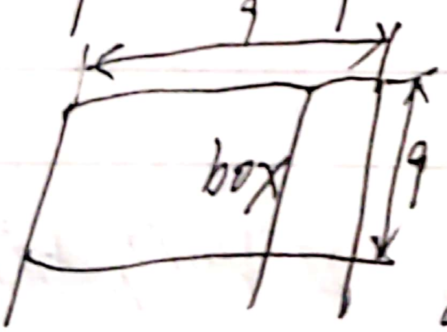
fliter inside the white bar, most of pixels inside the white bar are still completely white without being polluted by black pixels outside.

7X7



Most of the pixels inside the white ~~are~~ bar are influenced by black pixels outside.

9X9



Most of the pixels inside the white bar are more strongly influenced. So the border of the white box will be more blurred.

5.11

$$f(x,y) = \underset{(r,c)\in S_{xy}}{\text{median}} \{g(r,c)\} \qquad (5\text{-}27)$$

Linear smoothing filters. will make the pixels near the boundary have different gray levels and cause blur.

In contrast, median filter makes the pixels near the binary edge either (A) gray scale or (B) grayscale. There will be no intermediate state and therefore will not cause blur

5.15

5.15

$\sin[2\pi\mu_0 x/M + 2\pi v_0 y/N]$

$F(u,v) = \frac{jMN}{2}[\delta(u+u_0, v+v_0) - \delta(u-u_0, v-v_0)]$

$1 \Leftrightarrow MN\delta(u,v)$

$e^{j2\pi(u_0x/M + v_0y/N)} \Leftrightarrow MN\delta(u-u_0, v-v_0)$

$\frac{e^{-j2\pi(u_0x/M + v_0y/N)} - e^{j2\pi(u_0x/M + v_0y/N)}}{2} \Leftrightarrow \frac{MN}{2}[\delta(u+u_0, v+v_0) - \delta(u-u_0, v-u_0)]$

$\theta = \frac{1}{2j}(e^{j\theta} - e^{-j\theta}) \Rightarrow \sin(2\pi\mu_0 x/M + 2\pi v_0 y/N) \Leftrightarrow \frac{jMN}{2}[\delta(u+u_0, v+v_0) - \delta(u-u_0, v-v_0$

(c) $f(x,y) = \delta$

$G(u,v) =$

$g(x,y) = \delta$

5.19

$h(x,y)=\delta(x-a,y-b)$

(a) $H(u,v) \Leftrightarrow$ [illegible] $e^{-j2\pi(ua/M+vb/N)}$

(b) $f(x,y)=K$

$G(u,v)=MNK\delta(u,v)\cdot e^{-j2\pi(ua/M+vb/N)}$

与x, y无关

$=$ [illegible] . $g(x,y)=K$.

[illegible]

(c) $f(x,y)=\delta(x,y)$

$G(u,v)=$ [illegible] $e^{-j2\pi(ua/M+vb/N)}$

$g(x,y)=\delta(x-a,y-b)$

5.21 $f(x,y)=\delta(x-a)$ $\quad f(\alpha,\beta)=\delta(\alpha-a)$

$$g(x,y)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(\alpha,\beta)\,h(x-\alpha, y-\beta)\,d\alpha\, d\beta$$

$$=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \delta(\alpha-a)\, e^{-[(x-\alpha)^2+(y-\beta)^2]}\,d\alpha\, d\beta$$

$$=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \delta(\alpha-a)\, e^{-(x-\alpha)^2}\, e^{-(y-\beta)^2}\,d\alpha\, d\beta$$

$$=\int_{-\infty}^{\infty} \delta(\alpha-a)\, e^{-(x-\alpha)^2}\int_{-\infty}^{\infty} e^{-(y-\beta)^2}\,d\beta$$

$$= e^{-[(x-a)^2]}\int_{-\infty}^{\infty} e^{-[y-\beta]^2}\,d\beta$$

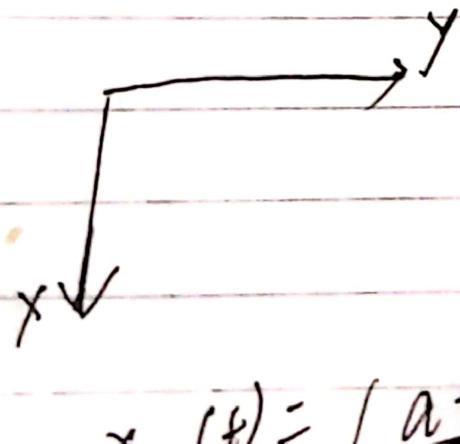
$$\sigma^2=\frac{1}{2}$$

$$\int_{-\infty}^{\infty} e^{-(y-\beta)^2}\,d\beta=\int_{-\infty}^{\infty}\sqrt{2\pi(1/2)}\left[\frac{1}{\sqrt{2\pi\times\frac{1}{2}}}\, e^{-\frac{1}{2}\left[\frac{(\beta-y)^2}{\frac{1}{2}}\right]}\right]d\beta$$

$$=\sqrt{\pi}\cdot 1$$

$$g(x,y)=\sqrt{\pi}\, e^{-[(x-a)^2]}$$

5.25.



$$x_0(t)=\begin{cases}\dfrac{at}{T_1} & 0<t\le t_1\\ a & t_1<t\le t_1+t_2\end{cases}$$

$$y_0(t)=\begin{cases}0 & 0\le t\le T_1\\ \frac{b(t-T_1)}{T_2} & T_1\le t\le T_1+T_2\end{cases}$$

$$H(u,v)=\int_0^{T_1} e^{-j2\pi[u\frac{at}{T_1}]}dt+\int_{T_1}^{T_1+T_2} e^{-j2\pi[v\frac{b(t-T_1)}{T_2}+ua]}dt$$

$$=\frac{T_1(1-e^{-j2\pi au})}{2\pi auj}+e^{-j2\pi ua}\int_{T_1}^{T_1+T_2} e^{-j2\pi vb\frac{t-T_1}{T_2}}dt$$

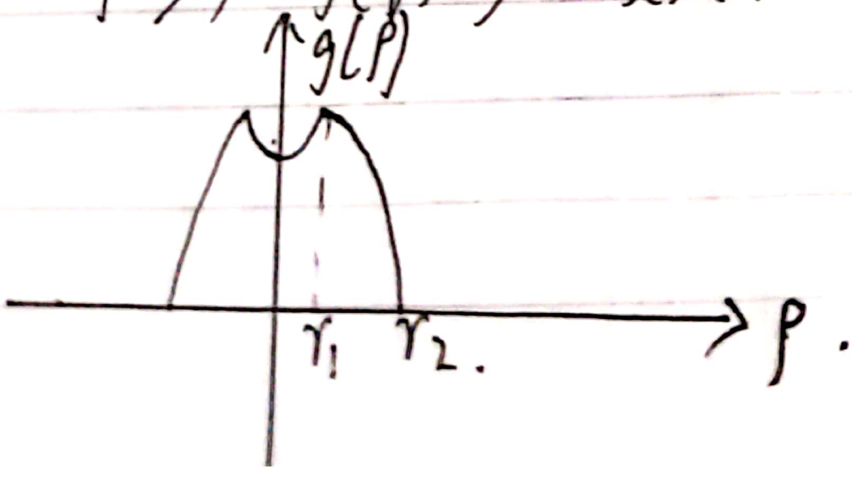
$$=\frac{T_1(1-e^{-j2\pi au})}{2\pi aju}+e^{-j2\pi ua}\int_0^{T_2} e^{-j2\pi vb\frac{z}{T_2}}dz$$

$$=\frac{T_1(1-e^{-j2\pi au})}{2\pi aju}+e^{-j2\pi ua}\frac{T_2(1-e^{-j2\pi bv})}{2\pi bvj}$$

$$g(x,y)=\mathfrak{F}^{-1}[H(u,v)F(u,v)]$$
$$F(u,v)=\mathfrak{F}[f(x,y)]$$

5.42 white 255, black 0.

$\rho\uparrow$, $g(\rho,\theta)$ 先变大再变小



r_1 是中间黑圆半径

r_2 是白环半径.