EE621 Computer Vision

Assignment-2

Vusuvandla Khagesh Kumar

170102070, ECE

Q2. $h(x,y) = \exp\left(-\frac{x^2+y^2}{2\sigma^2}\right)$. Expression for Wiener filter?

Given ratio of power spectra of the noise and undegraded signal is a constant

$$W(u,v) = \frac{H^*(u,v)}{|H(u,v)|^2 + P(u,v)}$$

$$P(u,v) = S_\eta(u,v) / S_f(u,v) = \text{constant (Given)}$$

$S_f(u,v) = |H(u,v)|^2$ power spectral density of signal

$S_n(u,v) = |N(u,v)|^2$ power spectral density of noise

$$H(u,v) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} h(x,y)\, e^{-2\pi j(ux+vy)}\, dx\, dy$$

$$= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \exp\left(-\frac{x^2+y^2}{2\sigma^2}\right) \exp\left(-2\pi j(ux+vy)\right) dx\, dy$$

$$= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \exp\left(-\frac{(x+2\pi j u\sigma^2)^2}{2\sigma^2}\right) \exp\left(-\frac{(y+2\pi j v\sigma^2)^2}{2\sigma^2}\right)$$

$$\exp\left(-\frac{1}{2\sigma^2}\left(4\pi^2u^2\sigma^4 + 4\pi^2v^2\sigma^4\right)\right) dx\, dy$$

$$= e^{-2\pi^2\sigma^2(u^2+v^2)} \left(\sqrt{2\pi\sigma^2}\right)\left(\sqrt{2\pi\sigma^2}\right)$$

$$= 2\pi\sigma^2 e^{-2\pi^2\sigma^2(u^2+v^2)}$$

$$\boxed{H(u,v) = 2\pi\sigma^2 e^{-2\pi^2\sigma^2(u^2+v^2)}}$$

$$H^*(u,v) = H(u,v)$$

$\therefore$ Wiener filter expression

$$\boxed{W(u,v) = \frac{2\pi\sigma^2 e^{-2\pi^2\sigma^2(u^2+v^2)}}{4\pi^2\sigma^4 e^{-4\pi^2\sigma^2(u^2+v^2)} + \text{constant}}}$$

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Q3 i) Calculate the Local Binary Pattern (LBP)

ii) " " Local Derivative Pattern (LDP)

For 4 neighbours $\rightarrow (0^\circ, 45^\circ, 90^\circ, 135^\circ)$

Image Patch $\rightarrow$ $$\begin{bmatrix} 2 & 5 & 3 & 5 & 1 \\ 6 & 7 & 9 & 1 & 5 \\ 2 & 3 & 4 & 8 & 2 \\ 3 & 2 & 3 & 2 & 9 \\ 1 & 2 & 3 & 2 & 1 \end{bmatrix}$$

i) Local Binary pattern

$$\begin{bmatrix} 2 & 5 & 3 & 5 & 1 \\ 6 & 7 & 9 & 1 & 5 \\ 2 & 3 & \boxed{4} & 8 & 2 \\ 3 & 2 & 3 & 2 & 9 \\ 1 & 2 & 3 & 2 & 1 \end{bmatrix} \rightarrow Z_0$$

$$\begin{matrix} 1 & 1 & 0 \\ 0 & \boxed{\cdot} & 1 \\ 0 & 0 & 0 \end{matrix}$$

Binary representation $= (11010000)_2$

$= (208)_{10}$

ii) Local Derivative Pattern

$$\left.\begin{aligned} I'_{0^\circ} &= 4-8 = -4 \\ I'_{45^\circ} &= 4-1 = 3 \\ I'_{90^\circ} &= 4-9 = -5 \\ I'_{135^\circ} &= 4-7 = -3 \end{aligned}\right\} \text{First order derivate}$$

$$LDP^2_\alpha(Z_0) = \{ f(I'_\alpha(Z_0), I'_\alpha(Z_1)), f(I'_\alpha(Z_0), I'_\alpha(Z_2)), f(I'_\alpha(Z_0), I'_\alpha(Z_8))\}$$

Second-order Local Derivative Pattern

$$LDP^2(z) = \{LDP_\alpha^2(z) \mid \alpha = 0^\circ, 45^\circ, 90^\circ, 135^\circ\}$$

$$LDP_{0^\circ}^2(z_0) = 01010100$$

$$LDP_{45^\circ}^2(z_0) = 00101111$$

$$LDP_{90^\circ}^2(z_0) = 11010000$$

$$LDP_{135^\circ}(z_0) = 11000110$$

$$LDP^2(z_0) = \underline{01010100}\ \underline{00101111}\ \underline{11010000}\ \underline{11000110}$$