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No.
Date. / /

Sheet 2

(1) Image Filtering

(1) 128 × 128 using 8 bits ⟹ Size of image = 131072 bits
= 16384 bytes
= 16 KBytes

Gausian Pyramids

128 × 128 $\xrightarrow{\times 8}$ 16 KB
64 × 64 $\xrightarrow{\times 8}$ 4 KB
32 × 32 $\xrightarrow{\times 8}$ 1 KB
16 × 16 $\xrightarrow{\times 8}$ 0.25 KB
8 × 8 $\xrightarrow{\times 8}$ $\frac{1}{16}$ KB

→ $21\frac{5}{16}$ KBytes $\simeq 4/3 \times 16 = 21\frac{1}{3}$ KBytes

Laplacian

128 × 128 $\xrightarrow{\times 4}$ 8 KB
64 × 64 $\xrightarrow{\times 4}$ 2 KB
32 × 32 $\xrightarrow{\times 4}$ $\frac{1}{2}$ KB
16 × 16 $\xrightarrow{\times 4}$ $\frac{1}{8}$ KB
8 × 8 $\xrightarrow{8}$ $\frac{1}{16}$ KB

→ $10\frac{11}{16}$ KB

$\frac{\text{Laplacian}}{\text{Gausian}} = \frac{171}{341} \simeq 50.15\%$ of saving

No.

Date / /

② $BF[I]_p = \frac{1}{W_p} \sum_{q \in S} \underbrace{G_{\sigma_s}(\|p-q\|)}_{BF_S} \underbrace{G_{\sigma_r}(|I_p - I_q|)}_{BF_r} I_q$

$G_\sigma(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-x^2/2\sigma^2}$

$G_{\sigma_S}(x) = \frac{1}{1\sqrt{2\pi}} e^{\frac{-x^2}{2\times 1}} = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$

$G_{\sigma_r}(x) = \frac{1}{20\sqrt{2\pi}} e^{\frac{-x^2}{800}}$

$BF_S = \frac{1}{\sqrt{2\pi}} e^{\frac{-(\|p-q\|)^2}{2}}$, $BF_r = \frac{1}{20\sqrt{2\pi}} e^{\frac{-(|I_p - I_q|)^2}{800}}$

$\|p-q\| = \begin{bmatrix} \sqrt{2} & 1 & \sqrt{2} \\ 1 & 0 & 1 \\ \sqrt{2} & 1 & \sqrt{2} \end{bmatrix}$, $|I_p - I_q| = \begin{bmatrix} 40 & 30 & 40 \\ 40 & 0 & 0 \\ 30 & 10 & 10 \end{bmatrix}$

$BF_S = \begin{bmatrix} 0.147 & 0.242 & 0.147 \\ 0.242 & 0.399 & 0.242 \\ 0.147 & 0.242 & 0.147 \end{bmatrix}$, $BF_r = \begin{bmatrix} 2.7\times10^{-3} & 6.5\times10^{-3} & 2.7\times10^{-3} \\ 2.7\times10^{-3} & 0.02 & 0.02 \\ 6.5\times10^{-3} & 0.018 & 0.018 \end{bmatrix}$

$BF_S \times BF_r = \begin{bmatrix} 2.01\times10^{-3} & 8.44\times10^{-3} & 7.88\times10^{-3} \\ 3.30\times10^{-3} & 0.014 & 0.013 \\ 2.01\times10^{-3} & 8.44\times10^{-3} & 7.88\times10^{-3} \end{bmatrix}$

$W_p = 0.06696$ $BF_p = \begin{bmatrix} 0.03 & 0.126 & 0.12 \\ 0.05 & 0.21 & 0.19 \\ 0.03 & 0.126 & 0.12 \end{bmatrix}$

#

No.
Date. / /

③ Sharpening the image

Hough Transform

① $\rho = x\cos\theta + y\sin\theta$ $\quad \theta \in [0, 360]$

$x \in [1, W]$

Range of $\theta = 0 \rightarrow 360$ $\quad y \in [1, H]$

$\frac{\partial \rho}{\partial x} = \cos\theta$ $\quad U = \frac{\partial \rho}{\partial x} + \frac{\partial \rho}{\partial y} = \cos\theta + \sin\theta$

$\frac{\partial \rho}{\partial y} = \sin\theta$

$U = \cos\theta + \sin\theta$

$\frac{\partial U}{\partial \theta} = -\sin\theta + \cos\theta$

$\sin\theta = \cos\theta$

$\theta = 45$

$\rho = x\cos 45 + y\sin 45$

$\rho = \frac{x}{\sqrt{2}} + \frac{y}{\sqrt{2}} \Rightarrow Max = \frac{1}{\sqrt{2}}[W + H]$

② $p = (7, 10)$, gradient of $p = [0.707, 0.707]^T$

$r = 20$

$a = x + r\cos\theta \rightarrow 0.707$

$b = y + r\sin\theta \rightarrow 0.707$

$a = 7 + 20 \times 0.707 = 21.14$

$b = 10 + 20 \times 0.707 = 24.14$

Center = (21.14, 24.14)

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No.

Date. / /

(3) $y = ax^2 + bx + c$

a) 3D space

b) Cubic Curve

c) a straight line

d) Cubic Curve with an offset

e) $\frac{dy}{dx} = 2ax + b$

we would use the tangents for figuring out the polar coordinates