Intelligente Sehsysteme - Übungsblatt 5

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4 Haralicksche Texturmaße

$$p = (x, y)$$

$$d = \Delta(\sin\alpha, \cos\alpha)$$

$$\delta_D(I) = \begin{cases} 1 & x = 0 \\ 0 & x \neq 0 \end{cases}$$

$$P_{\alpha,\Delta}(I_1, I_2) = \frac{1}{N} \sum_{p \in R} \delta_D(I(p) - I_1) \cdot \delta_D(I(p+d) - I_2)$$

$$S = \sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} P_{\alpha,\Delta}(I_1, I_2)$$

$$p_{\alpha,\Delta}(I_1, I_2) = \frac{1}{S} P_{\alpha,\Delta}(I_1, I_2)$$

Energie/Uniformität $\displaystyle \sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p^2_{\alpha,\Delta}(I_1, I_2)$

Kontrast $\displaystyle \sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} (I_1 - I_2)^2 \cdot p_{\alpha,\Delta}(I_1, I_2)$

Entropie $\displaystyle -\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p_{\alpha,\Delta}(I_1, I_2) \cdot \log_2\left(p_{\alpha,\Delta}(I_1, I_2)\right)$

Homogenität/inverse Differenz $\displaystyle \sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} \frac{p_{\alpha,\Delta}(I_1, I_2)}{1 + |I_1 - I_2|}$

Für Werte, die nicht angegben werden, gilt: $P_{\alpha,\Delta}(I_1, I_2) = p_{\alpha,\Delta}(I_1, I_2) = 0$

I
$$R = \begin{pmatrix} 0\,0\,0\,0 \\ 0\,0\,0\,0 \\ 0\,0\,0\,0 \\ 0\,0\,0\,0 \end{pmatrix}$$

$$P_{0^\circ,1}(0,0) = \frac{3}{4}$$

$$S = \frac{3}{4}$$

$$p_{0^\circ,1}(0,0) = 1$$

Energie/Uniformität
$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p^2_{0^\circ,1}(I_1, I_2) = 1^2 = 1$$

Kontrast
$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} (I_1 - I_2)^2 \cdot p_{0^\circ,1}(I_1, I_2) = 0 \cdot 1 = 0$$

Entropie
$$-\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p_{0^\circ,1}(I_1, I_2) \cdot \log_2 \left(p_{0^\circ,1}(I_1, I_2)\right) = 0 \cdot \log_2 1 = 0$$

Homogenität/inverse Differenz
$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} \frac{p_{0^\circ,1}(I_1, I_2)}{1 + |I_1 - I_2|} = \frac{1}{1+0} = 1$$

Die Lösungen für $\alpha = 0^\circ$ und $\alpha = 90^\circ$ sind identisch.

II $$R = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 3 & 3 & 3 & 3 \\ 3 & 3 & 3 & 3 \end{pmatrix}$$

$$P_{0^\circ,1}(0,0) = P_{0^\circ,1}(0,3) = P_{0^\circ,1}(3,3) = \frac{1}{4}$$

$$S = \frac{3}{4}$$

$$p_{0^\circ,1}(0,0) = p_{0^\circ,1}(0,3) = p_{0^\circ,1}(3,3) = \frac{1}{3}$$

Energie/Uniformität

$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p_{0^\circ,1}^2(I_1, I_2) = 3 \cdot \left(\frac{1}{3}\right)^2 = \frac{1}{3}$$

Kontrast

$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} (I_1 - I_2)^2 \cdot p_{0^\circ,1}(I_1, I_2) = 0 \cdot \frac{1}{3} + 3^2 \cdot \frac{1}{3} + 0 \cdot \frac{1}{3} = 3$$

Entropie

$$-\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p_{0^\circ,1}(I_1, I_2) \cdot \log_2 \left(p_{0^\circ,1}(I_1, I_2)\right) = -\left(3 \cdot \frac{1}{3} \cdot \log_2 \left(\frac{1}{3}\right)\right) \approx 1.58$$

Homogenität/inverse Differenz

$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} \frac{p_{0^\circ,1}(I_1, I_2)}{1 + |I_1 - I_2|} = \frac{\frac{1}{3}}{1+0} + \frac{\frac{1}{3}}{1+3} + \frac{\frac{1}{3}}{1+0} = \frac{3}{4}$$

$$P_{90^\circ,1}(0,0) = P_{90^\circ,1}(3,3) = \frac{3}{8}$$

$$S = \frac{3}{4}$$

$$p_{90^\circ,1}(0,0) = p_{90^\circ,1}(3,3) = \frac{1}{2}$$

Energie/Uniformität

$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p^2_{90^\circ,1}(I_1,I_2) = 2 \cdot \left(\frac{1}{2}\right)^2 = \frac{1}{2}$$

Kontrast

$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} (I_1 - I_2)^2 \cdot p_{90^\circ,1}(I_1,I_2) = 0 \cdot \frac{1}{2} + 0 \cdot \frac{1}{2} = 0$$

Entropie

$$-\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p_{90^\circ,1}(I_1,I_2) \cdot \log_2\left(p_{90^\circ,1}(I_1,I_2)\right) = -\left(2 \cdot \frac{1}{2} \cdot \log_2\left(\frac{1}{2}\right)\right) = 1$$

Homogenität/inverse Differenz

$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} \frac{p_{90^\circ,1}(I_1,I_2)}{1 + |I_1 - I_2|} = \frac{\frac{1}{2}}{1+0} + \frac{\frac{1}{2}}{1+0} = 1$$

III $$R = \begin{pmatrix} 3\,3\,3\,3 \\ 3\,0\,0\,3 \\ 3\,0\,0\,3 \\ 3\,3\,3\,3 \end{pmatrix}$$

$$P_{0^\circ,1}(0,0) = P_{0^\circ,1}(0,3) = P_{0^\circ,1}(3,0) = \frac{1}{8}$$

$$P_{0^\circ,1}(3,3) = \frac{1}{4}$$

$$S = \frac{5}{8}$$

$$p_{0^\circ,1}(0,0) = p_{0^\circ,1}(0,3) = p_{0^\circ,1}(3,0) = \frac{1}{5}$$

$$p_{0^\circ,1}(3,3) = \frac{2}{5}$$

Energie/Uniformität

$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p^2_{0^\circ,1}(I_1, I_2) = 3 \cdot \left(\frac{1}{5}\right)^2 + \left(\frac{2}{5}\right)^2 = \frac{7}{25}$$

Kontrast

$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} (I_1 - I_2)^2 \cdot p_{0^\circ,1}(I_1, I_2) = 3^2 \cdot \frac{1}{5} + 0 \cdot \frac{1}{5} + 3^2 \cdot \frac{1}{5} + 0 \cdot \frac{2}{5} = \frac{18}{5} = 3.6$$

Entropie

$$-\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} p_{0^\circ,1}(I_1, I_2) \cdot \log_2\left(p_{0^\circ,1}(I_1, I_2)\right)$$

$$= -\left(3 \cdot \frac{1}{5} \cdot \log_2\left(\frac{1}{5}\right) + \frac{2}{5} \cdot \log_2\left(\frac{2}{5}\right)\right) \approx 1.92$$

Homogenität/inverse Differenz

$$\sum_{I_1=0}^{I_{max}} \sum_{I_2=0}^{I_{max}} \frac{p_{0^\circ,1}(I_1, I_2)}{1 + |I_1 - I_2|} = \frac{\frac{1}{5}}{1+0} + \frac{\frac{1}{5}}{1+3} + \frac{\frac{1}{5}}{1+0} + \frac{\frac{2}{5}}{1+0} = 1$$

Die Lösungen für $\alpha = 0^\circ$ und $\alpha = 90^\circ$ sind identisch.