

Notation

$p(i, j)$ - (i, j) th entry in a normalized gray-tone spatial-dependence matrix, $= P(i, j)/R$

$p_x(i)$ - i th entry in the marginal-probability matrix obtained by summing the rows of $p(i, j)$, $= \sum_{j=1}^{N_g} p(i, j)$

N_g - number of distinct gray levels in the quantized image

$$p_y(j) = \sum_{i=1}^{N_g} p(i, j)$$

$$p_{x+y}(k) = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i, j), \quad k = 2, 3, \dots, 2N_g; \quad i + j = k$$

$$p_{x-y}(k) = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i, j), \quad k = 0, 1, \dots, N_g - 1; \quad |i - j| = k$$

1 Textural features

1) Angular second moment

$$f_1 = \sum_i \sum_j p(i, j)^2$$

2) Contrast:

$$f_2 = \sum_{n=0}^{N_g-1} n^2 \left(\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i, j) \right)$$

3) Correlation:

$$f_3 = \frac{\sum_i \sum_j (ij) p(i, j) - \mu_x \mu_y}{\sigma_x \sigma_y}$$

4) Sum of squares: variance:

$$f_4 = \sum_i \sum_j (i - \mu)^2 p(i, j)$$

5) Inverse difference moment:

$$f_5 = \sum_i \sum_j \frac{1}{1 + (i - j)^2} p(i, j)$$

6) Sum of average:

$$f_6 = \sum_{i=2}^{2N_g} i p_{x+y}(i)$$

7) Sum variance:

$$f_7 = \sum_{i=2}^{2N_g} (i - f_8)^2 p_{x+y}(i)$$

Sum entropy:

$$f_8 = - \sum_{i=2}^{2N_g} p_{x+y}(i) \log(p_{x+y}(i))$$

9) Entropy:

$$f_9 = - \sum_i \sum_j p(i, j) \log(p(i, j))$$

10) Difference variance:

$$f_{10} = \text{variance of } p_{x-y}$$

11) Difference entropy:

$$f_{11} = - \sum_{i=0}^{N_g-1} p_{x-y}(i) \log(p_{x-y}(i))$$

12), 13) Information measures of correlation:

$$f_{12} = \frac{HXY - HXY1}{\max\{HX, HY\}}$$

$$f_{13} = \sqrt{(1 - \exp - 2(HXY2 - HXY))}$$

$$HX = - \sum_i \sum_j p(i, j) \log(p(i, j))$$

$$HXY1 = - \sum_i \sum_j p(i, j) \log(p_x(i) p_y(j))$$

$$HXY2 = - \sum_i \sum_j p_x(i) p_y(j) \log(p_x(i) p_y(j))$$

Maximal correlation coefficient:

$$f_{14} = \sqrt{\text{Second largest eigenvalue of } Q}$$

$$Q(i, j) = \sum_k \frac{p(i, k) p(j, k)}{p_x(i) p_y(k)}$$