1 First- and second-order features

We present in Tables A.1 and A.2 the formal definition of first- and second-order features. The content of such tables adopt the following notation:

- X is a set of N_p pixel in a ROI;
- $S(i)$ is the first order histogram of the ROI using N_g discrete intensity levels, equally spaced from 0 with a defined width of 0.1;
- $s(i) = \frac{S(i)}{N_p}$ is the normalized first order histogram;
- V_{pixel} is the volume of a pixel in mm;
- X_{10} is the 10^{th} percentile of X;
- X_{90} is the 90^{th} percentile of X;
- X_{10-90} is the image array with gray levels in between, or equal to the 10^{th} and 90^{th} percentile of X;
- $\overline{X}$ is the mean value of the image array;
- $P(i, j)$ co-occurence matrix with a defined distance (δ= 1) and angle (θ=0);
- $p(i, j) = \frac{P(i,j)}{\sum P(i,j)}$ is the normalized co-occurence matrix;
- $p_x(i) = \sum_{j=1}^{N_g} P(i, j)$ and $p_y(i) = \sum_{i=1}^{N_g} P(i, j)$ are the marginal probabilities per row and per column, respectively;
- μ_x and μ_y are the mean grey level intensities, defined as Joined Average, of p_x and p_y respectively. If $P(i, j)$ is symmetrical $p_x = p_y$;
- σ_x and σ_y are the standard deviations of p_x and p_y respectively;
- $p_{x+y}(k) = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i, j)$, where $i + j = k$, and $k = 2, 3, .., 2N_g$;
- $p_{x-y}(k) = \sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i, j)$, where $|i - j| = k$, and $k = 0, 1, .., N_g - 1$;
- HX, HY and HXY are the entropy of p_x, p_y and $p(i, j)$, respectively.
- $HXY1 = -\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i, j) \cdot \log[p_x(i)p_y(j)]$ is an auxiliary quantity;
- $HXY2 = -\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p_x(i)p_y(j) \cdot \log[p_x(i)p_y(j)]$ is an auxiliary quantity;
- DA is the Difference Average used to obtain the Difference Variance;

Feature	**Definition**
Energy	$\sum_{i=0}^{N_p} X(i)^2$
Entropy	$-\sum_{i=1}^{N_g} s(i) \cdot \log[s(i)]$, for $s(i) > 0$
Minimum	$min(X)$
Maximum	$max(X)$
Mean	$\frac{1}{N_p} \sum_{i=1}^{N_p} X(i)$
Median	median grey level intensity
Interquartile Range	$X_{75} - X_{25}$
Range	$max(X) - min(X)$
Mean Absolute Deviation	$\frac{1}{N_p} \cdot \sum_{i=1}^{N_p} \lvert X(i) - \overline{X} \rvert$
Robust Mean Absolute Deviation	$\frac{1}{N_{10-90}} \cdot \sum_{i=1}^{N_{10-90}} \lvert X_{10-90}(i) - \overline{X}_{10-90} \rvert$
Root Mean Squared	$\sqrt{(\frac{1}{N_p} \cdot \sum_{i=1}^{N_p} X(i)^2)}$
Skewness	$\frac{\frac{1}{N_p} \cdot \sum_{i=1}^{N_p} (X(i) - \overline{X})^3}{(\sqrt{\frac{1}{N_p} \cdot \sum_{i=1}^{N_p} (X(i) - \overline{X})^2})^3}$
Kurtosis	$\frac{\frac{1}{N_p} \cdot \sum_{i=1}^{N_p} (X(i) - \overline{X})^4}{(\frac{1}{N_p} \cdot \sum_{i=1}^{N_p} (X(i) - \overline{X})^2)^2}$
Variance	$\frac{1}{N_p} \cdot \sum_{i=1}^{N_p} (X(i) - \overline{X})^2$
Uniformity	$\sum_{i=1}^{N_g} s(i)^2$

Table A.1: Definition of the first-order statistical measures.

Feature	**Definition**
Sum Squares	$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (i - \mu_x)^2 \cdot p(i,j)$
Sum Entropy	$\sum_{k=2}^{2N_g} p_{x+y}(k) \cdot \log[p_{x+y}(k)]$, for $p_{x+y}(k) > 0$
Sum Average	$\sum_{k=2}^{2N_g} p_{x+y}(k)k$
Maximum Probability	$\max(p(i,j))$
Joint Entropy	$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j) \log[p(i,j)]$, for $p(i,j) > 0$
Joint Energy	$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (p(i,j))^2$
Joint Average	$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j)i$
Inverse Variance	$\sum_{k=0}^{N_g-1} \frac{p_{x-y}(k)}{k^2}$
IDN (Inverse Difference Normalized)	$\sum_{k=0}^{N_g-1} \frac{p_{x-y}(k)}{1+(\frac{k}{N_g})}$
IDM (Inverse Difference Moment)	$\sum_{k=0}^{N_g-1} \frac{p_{x-y}(k)}{1+k^2}$
ID (Inverse Difference)	$\sum_{k=0}^{N_g-1} \frac{p_{x-y}(k)}{1+k}$
Difference Variance	$\sum_{k=0}^{N_g-1} (k - DA)^2 \cdot p_{x-y}(k)$
Difference Entropy	$\sum_{k=0}^{N_g-1} k \cdot p_{x-y}(k) \log[p_{x-y}(k)]$, for $p_{x-y}(k) > 0$
Difference Average	$\sum_{k=0}^{N_g-1} k \cdot p_{x-y}(k)$
Correlation	$\frac{\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j) \cdot i \cdot j - \mu_x \mu_y}{\sigma_x(i)\sigma_y(j)}$
Contrast	$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (i - j)^2 \cdot p(i,j)$
Cluster Tendency	$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (i + j - \mu_x - \mu_y)^2 \cdot p(i,j)$
Cluster Shade	$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (i + j - \mu_x - \mu_y)^3 \cdot p(i,j)$
Cluster Prominence	$\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} (i + j - \mu_x - \mu_y)^4 \cdot p(i,j)$

Table A.2: Definition of the second-order statistical measures.