Maximum Entropy Thresholding

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Single Threshold

Let \( h(i) \) be value of a normalized histogram. Typically \( i \) takes integer values from 0 to 255. We assume that \( h(i) \) is normalized, that is:

\[
\sum_{i=0}^{i_{max}} h(i) = 1
\]  

(1)

Entropy of white pixels:

\[
H_B(t) = -\sum_{i=0}^{t} \frac{h(i)}{\sum_{j=0}^{i} h(j)} \log \frac{h(i)}{\sum_{j=0}^{i} h(j)}
\]

(2)

Entropy of black pixels:

\[
H_W(t) = -\sum_{i=t+1}^{i_{max}} \frac{h(i)}{\sum_{j=t+1}^{i} h(j)} \log \frac{h(i)}{\sum_{j=t+1}^{i} h(j)}
\]

(3)

Optimal threshold can be selected by maximizing the entropy of black and white pixels:

\[
T = \text{Arg Max}_{t=0,...,i_{max}} H_B(t) + H_W(t)
\]

(4)

Multiple Threshold

Assume that we want to find optimal \( n \) thresholds, the Equation (4) can be generalized from one threshold to \( n \) threshold as follows:

\[
\{ T_1,...,T_n \} = \text{Arg Max}_{t_1<...<t_n} H(-1,t_1) + H(t_1,t_2) + ... + H(t_n,i_{max})
\]

(5)

Where

\[
H(t_k,t_{k+1}) = -\sum_{i=t_{k+1}}^{i_{max}} \frac{h(i)}{\sum_{j=t_{k+1}}^{i} h(j)} \log \frac{h(i)}{\sum_{j=t_{k+1}}^{i} h(j)}
\]

(6)

References