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:

$$\sum_{i=0}^{i_{max}} h(i) = 1 \tag{1}$$

Entropy of white pixels:

$$H_B(t) = -\sum_{i=0}^{t} \frac{h(i)}{\sum_{j=0}^{t} h(j)} \log \frac{h(i)}{\sum_{j=0}^{t} h(j)} \tag{2}$$

Entropy of black pixels:

$$H_W(t) = -\sum_{i=t+1}^{i_{max}} \frac{h(i)}{\sum_{j=t+1}^{i_{max}} h(j)} \log \frac{h(i)}{\sum_{j=t+1}^{i_{max}} h(j)} \tag{3}$$

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

$$T = \underset{t=0 \ldots i_{max}}{Arg\,Max}\, H_B(t) + H_W(t) \tag{4}$$

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:

$$\{T_{1,} \ldots, T_n\} = \underset{t_1 < \ldots < t_n}{Arg\,Max}\, H(-1, t_1) + H(t_{1,} t_2) + \ldots + H(t_n, i_{max}) \tag{5}$$

Where

$$H(t_k, t_{k+1}) = -\sum_{i=t_k+1}^{t_{k+1}} \frac{h(i)}{\sum_{j=t_k+1}^{t_{k+1}} h(j)} \log \frac{h(i)}{\sum_{j=t_k+1}^{t_{k+1}} h(j)} \tag{6}$$

References

1. J.N. Kapur, P.K. Sahoo and A.K.C. Wong, "A New Method for Gray-Level Picture Thresholding Using the Entropy of the Histogram", *CVGIP*, (29), pp.273-285 , 1985.