Basic thresholding

In this section, we will focus on the simplest thresholding - deciding between two classes using a grayscale image. Basic methods use the histogram of the entire image, i.e. this is **global** thresholding.

A trivial way is to determine the threshold manually (by looking at the histogram). Of course, with overlapping histograms, the task is not so trivial, the threshold can be found by trial and error, or interactively.

If we want to automate the procedure, we can use the following iterative algorithm [1]:

1. Select an initial guess for the global threshold T

2. Let's divide the points of the image (x, y) into two groups G_1, G_2, depending on whether their value is greater than the threshold, i.e. whether $f(x, y,) > T$

3. Let's calculate the average (mean) values for the groups G_1, G_2 and denote them m_1, m_2

4. Let's calculate a new threshold value in the middle between m_1 and m_2 as

$$T = \frac{1}{2}(m_1 + m_2)$$

5. Repeat steps 2 to 4 until the difference between consecutive T values is less than a predefined value

When the image has L brightness levels and dimensions M, N then we calculate m_1, m_2 as:

$$m_1(T) = \frac{1}{P_1(T)} \sum_{i=0}^{T} i p_i$$

$$m_2(T) = \frac{1}{P_2(T)} \sum_{i=T+1}^{L-1} i p_i$$

where

$$P_1(T) = \sum_{i=0}^{T} p_i$$

$$P_2(T) = \sum_{i=T+1}^{L-1} p_i$$

$$p_i = \frac{n_i}{MN}$$

where n_i is the number of points with brightness level i.

References

[1] Gonzalez, R., C., Woods, E., W., Digital Image Processing, Global Edition, 4th edition, Pearson 2018, ISBN 10: 1-292-22304-9