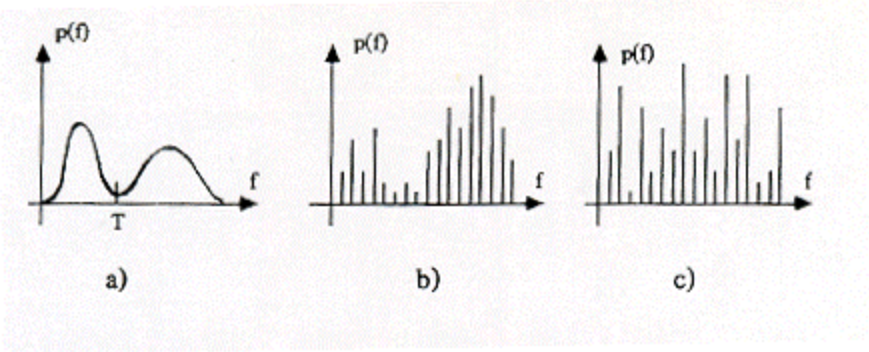
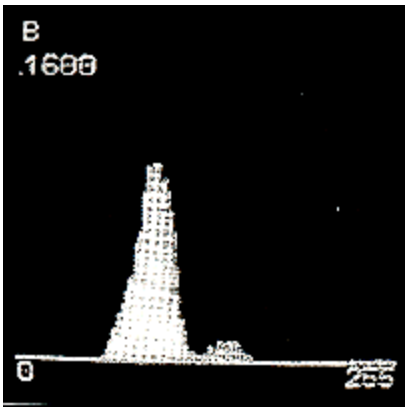
HISTOGRAM THRESHOLDING

The histogram presents the frequency of grayscale values in an image. Some examples are given below.



Global thresholding means we assign to all pixels with values below the threshold a value, which is zero, else we assign a value which is maximal (255 for an 8 bit pixel).

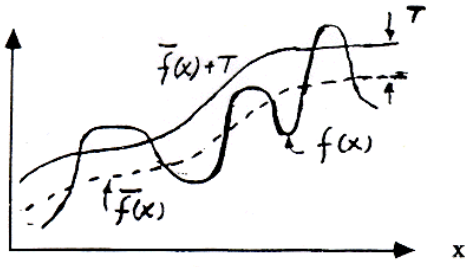
Original image



Histogram

Thresholded image

Local thresholding

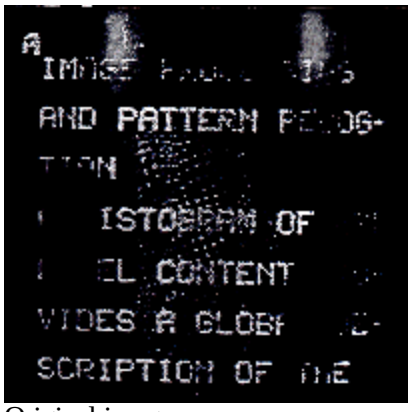


$g(x) = 1$ if $f(x, y) \geq \overline{f}(x, y) + T$

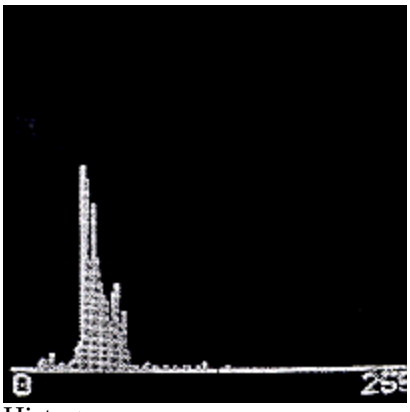
equivalent to:

$\underbrace{f(x, y) - \overline{f}(x, y)}_{\text{Laplace operator + global thresholding}} \geq T$

Global versus local thresholding – an example

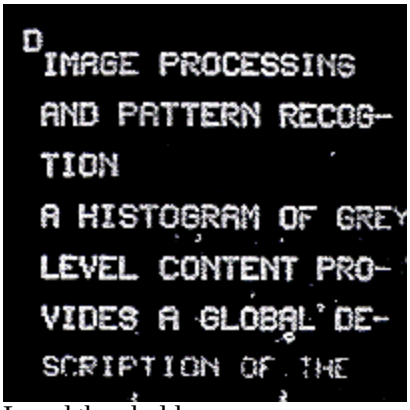


Original image



Histogram

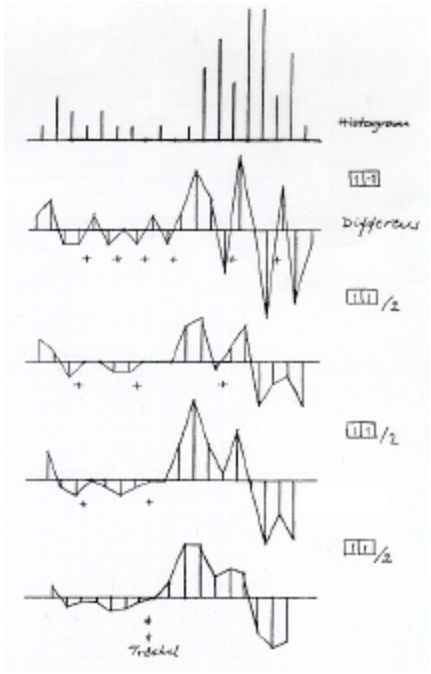
Global threshold



Local threshold

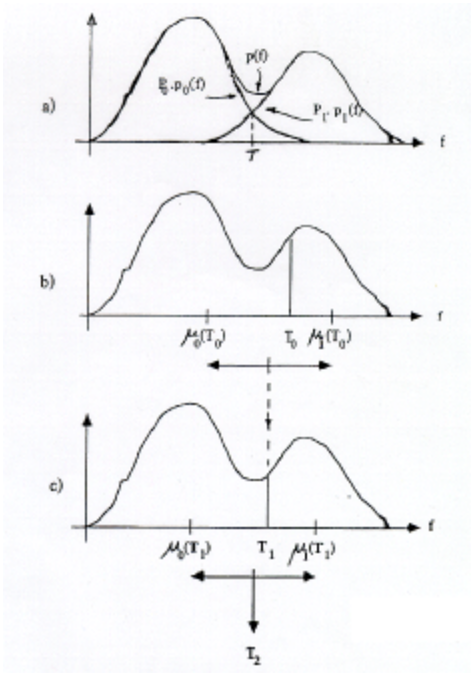
Histogram smoothing

If the histogram is clearly bimodal, it is easy to find an appropriate threshold value. If the histogram contains multiple minima we can apply an algorithm for smoothing the histogram until it only contains only one minimum, which then becomes our threshold value. The algorithm runs in several steps. First, apply a derivative filter to the histogram. Then, repeatedly smooth until you are left with one minimum. The algorithm is outlined below.



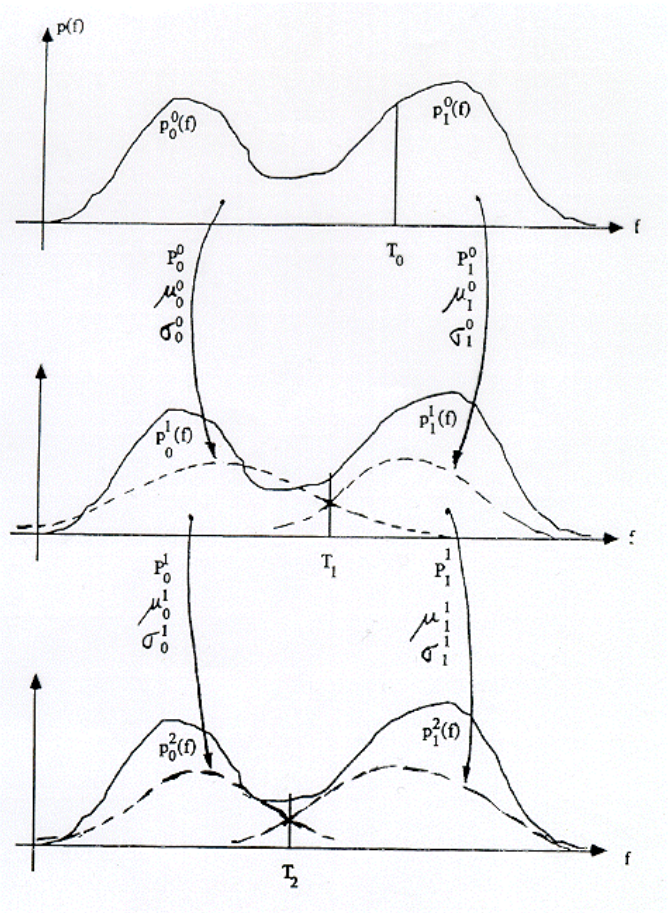
Midpoint method

The midpoint method finds an appropriate threshold value in an iterative fashion. First, apply a reasonable initial threshold value. Then, compute the mean of the pixel values below and above this threshold, respectively. Finally, compute the mean of the two means and use this value as the new threshold value. Continue until the difference between two consecutive threshold values is smaller than a preset minimum. The algorithm is outlined below.



Minimum error method

The minimum error method is similar to the midpoint method but mostly gives a more precise result. First, apply a reasonable initial threshold value. Then, fit a Gaussian to the pixel values below and above this threshold, respectively. Then proceed as for the midpoint method. The algorithm is outlined below.



The high-pass masking method

First, apply a Laplacian filter to the input image f(x). Then, apply a threshold value to the output image g(x). A new histogram, $Hist_g$

, is computed from the pixels whose absolute values are higher than the threshold value, t , i.e. the thresholded g(x) is used as a mask applied to f(x). The masked pixels hopefully create a bimodal histogram from which the final threshold value T can be computed. The algorithm is outlined below.