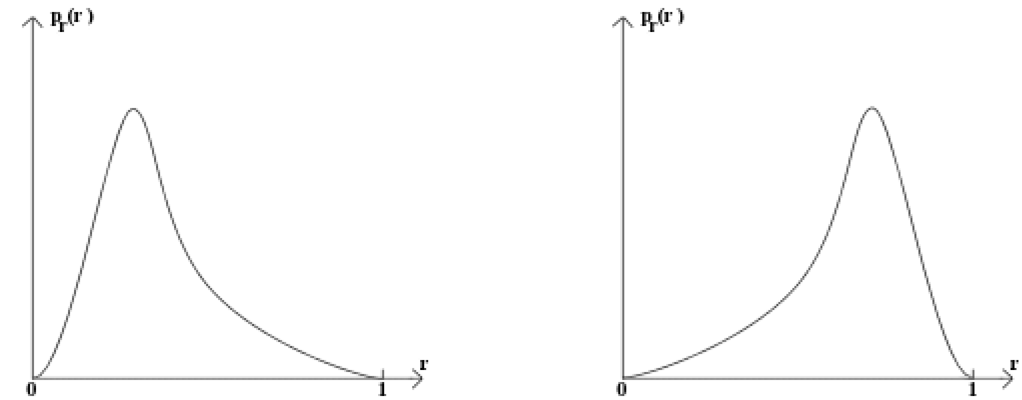
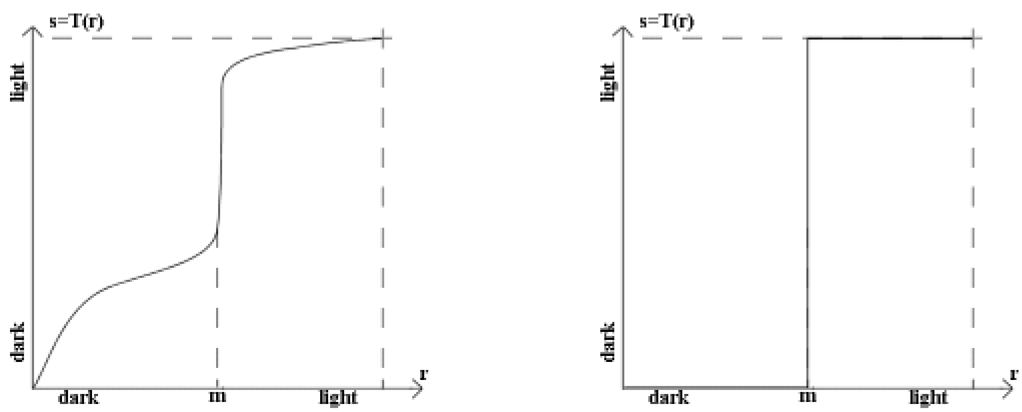
HISTOGRAM TRANSFORMATION

Histogram examples



Histogram Stretching



Histogram Equalization

Let the variable r represent the gray level. For any r in the interval [0,1] (with r=0 representing black, and r=1 representing white), consider the transformation:

$$s=T(r) \qquad (1)$$

It is assumed that T satisfies the conditions:

a) T(r) is single valued and monotonically increasing in the interval $0 \le r \le 1$
b) $0 \le T(r) \le 1$ for $0 \le r \le 1$

Condition a) preserves the order from black to white, whereas condition b) guaranties a mapping that is consistent with the allowed range of pixel values. Let the original and transformed gray levels be considered random quantities in the interval [0,1] with probability density functions $p_r(r)$ and $p_s(s)$, respectively. Then,

$$p_s(s) = \left[p_r(r) \frac{dr}{ds} \right] \quad (2)$$

Consider the transformation function

$$s = T(r) = \int_0^r p_r(w)dw \quad 0 \le r \le 1 \qquad (3)$$

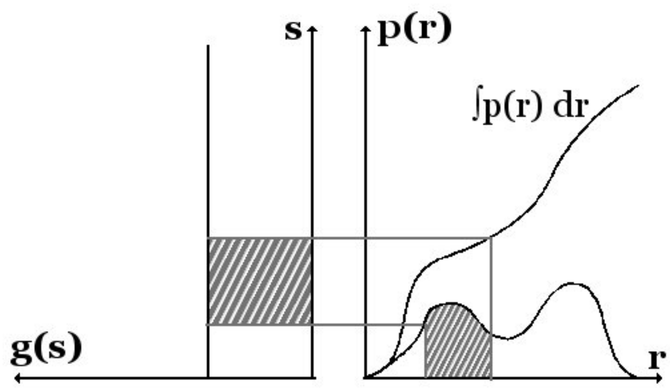
From (3) we get: $$\frac{ds}{dr} = p_r(r) \qquad (4)$$

Substituting in (2) gives:

$$p_s(s) = \left[p_r(r) \frac{1}{p_r(r)} \right] = 1 \qquad 0 \le s \le 1 \qquad (5)$$

Equalization

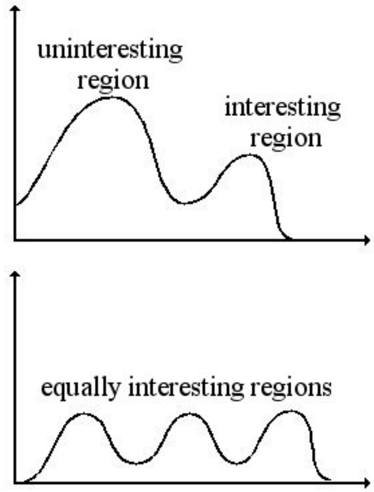
s=T(r), where
r=old grayscale
s=new grayscale
T=transformation



Equalization: chose $T(r) = \int_0^r p_r(w)dw$

•keeps the order between the values. A dark area will remain dark.
•increases contrast between pixels with similar gray levels.

When should you use it? If the histogram is clearly divided into one uninteresting and one interesting region the technique may work well. If the histogram contains a number of equally interesting regions the technique may fail.


uninteresting
region
interesting
region
equally interesting regions