



Histogram equalization works by first creating a histogram of the gray levels in the image, then using the histogram to create a map which maps each value of these levels to a new value, and finally, using this map to create the new image.

We will implement histogram equalization on  $M \times N$  gray scale images, each represented as a `unsigned char` array of length  $M \times N$ , with values in the range  $[0, 255]$ , where 0 means black, and 255 means white.

We perform histogram equalization as follows:

1. Create a histogram  $h$ : an array of length 256.  $h[v]$  is the number of pixels which have the value  $v$ .
2. Create the cumulative distribution function ( $CDF$ ) from the histogram.  

$$CDF[v] = h[0] + h[1] + \dots + h[v]$$
3. Calculation  $CDF_{min} = \min\{x \in CDF \mid x \neq 0\}$
4. Create a map  $m$  from old gray level to new gray level.  $m[v]$  is the new value of pixels which originally had the value  $v$ .  
 $m$  is computed as follows:

$$m(v) = \text{floor}\left(255 \times \frac{cdf(v) - cdf_{min}}{M \times N - cdf_{min}}\right)$$

5. Compute the new image:  

$$\text{new}[i] = m[\text{original}[i]]$$

for each pixel  $i$ .