

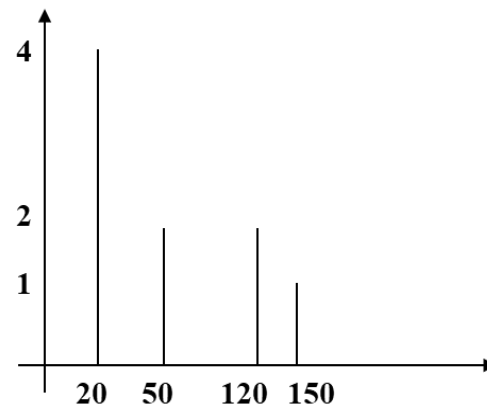
Histogram Equalization

Sung Soo Hwang

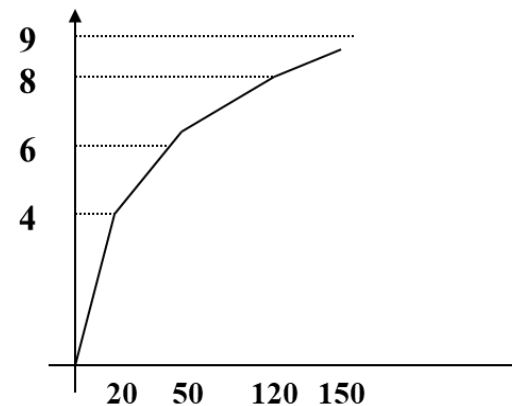
Introduction

- Definition of a histogram
 - Histogram of an image with intensity levels in the range $[0, L-1]$
 - $h(r_k) = n_k$
 - r_k : k^{th} intensity value
 - n_k : the number of pixels with intensity r_k
 - The number of bin is L in this case

20	20	50
20	20	50
120	120	150



Histogram



Cumulative histogram

Introduction

- Histogram normalization
 - By dividing each of its components by the total number of pixels
 - It can be considered as a probability function

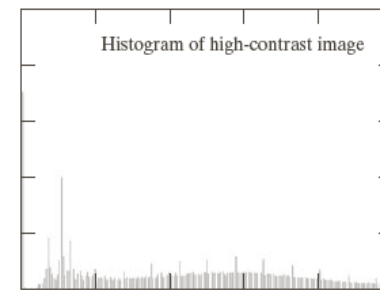
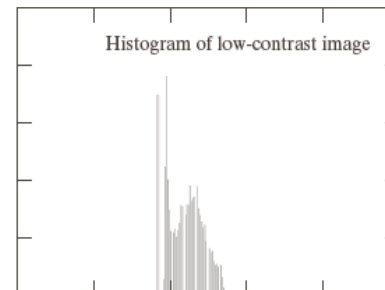
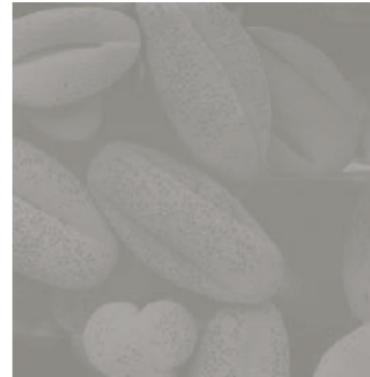
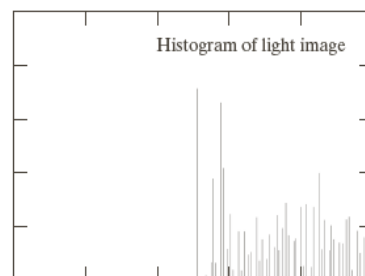
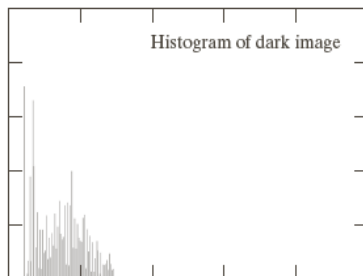
Introduction

- Let's make a histogram!
- Intensity level is 16 [0, 15]
- Number of bins: 4
 - 1st bin[0-3]:28/30
 - 2nd bin[4-7]:1/30
 - 3rd bin[8-11]:1/30
 - 4th bin[12-15]:0/30

0	0	0	0	0
0	0	1	1	1
1	1	1	1	1
2	2	2	2	2
2	3	3	3	3
3	3	3	7	10

Histogram equalization

- Histogram equalization
 - A method which adjust contrast of an image
 - Contrast: The difference in brightness or color that makes an object distinguishable

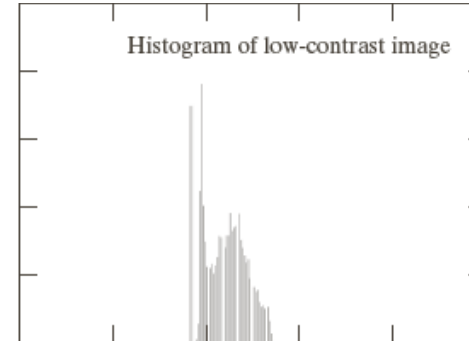
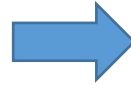


Histogram equalization

- Histogram equalization



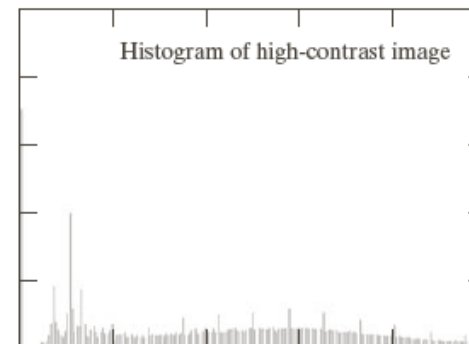
1. Histogram
computation



3. Apply the mapping
function to an input
image



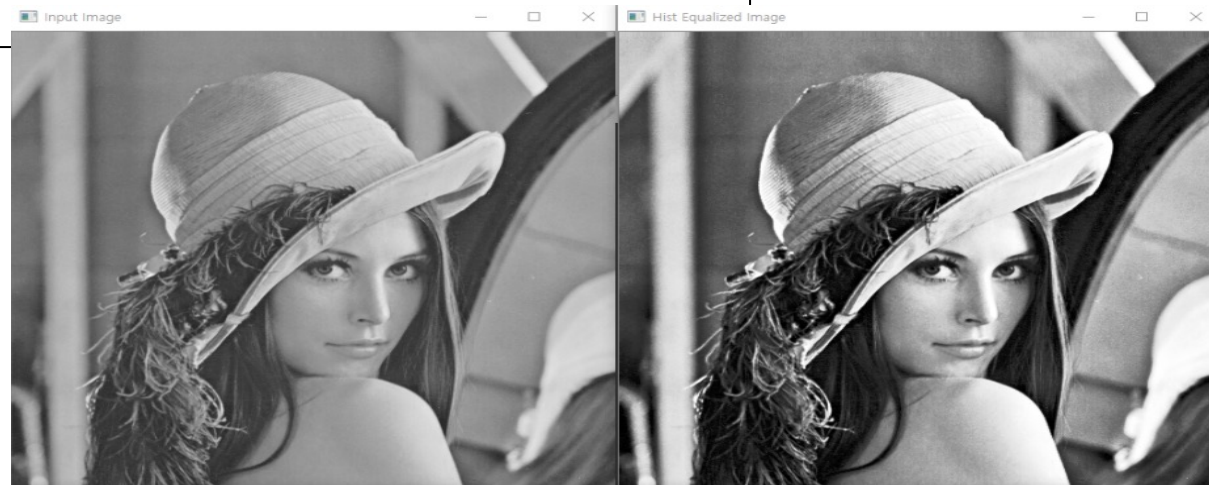
2. Find mapping function
which distributes pixel
values uniformly



Histogram equalization

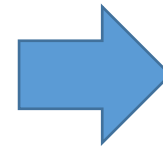
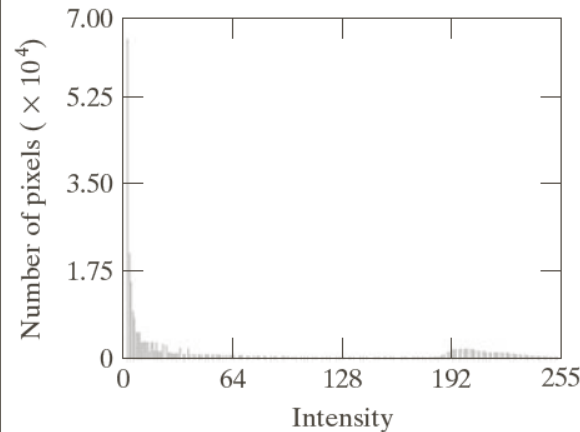
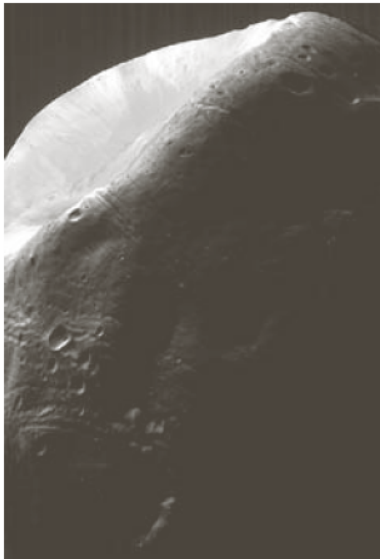
- Example code

```
int main() {  
    Mat image;  
    Mat hist_equalized_image;  
  
    image = imread("lena.png", 0);  
    if (!image.data) exit(1); //Check image  
  
    equalizeHist(image, hist_equalized_image); //histogram equalization  
  
    imshow("Input Image", image);  
    imshow("Hist Equalized Image", hist_equalized_image);  
  
    waitKey(0);  
    return 0;  
}
```



Histogram equalization

- Does histogram equalization provide an enhanced image?
 - Not always, especially when a certain range of data is dominant



Washed out
appearance