Histogram 수정을 사용한 영상 개선

김성영교수
금오공과대학교
컴퓨터공학과

학습 내용

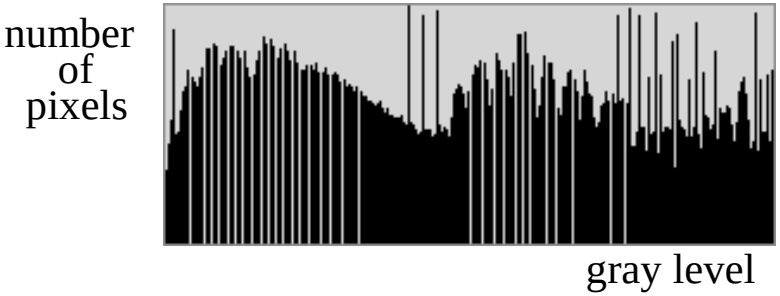
- Histogram
- Histogram modifications

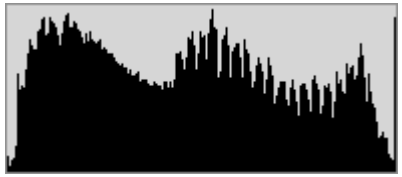
Histogram

- A simple datum that gives **the number of pixels that a given value** in an image

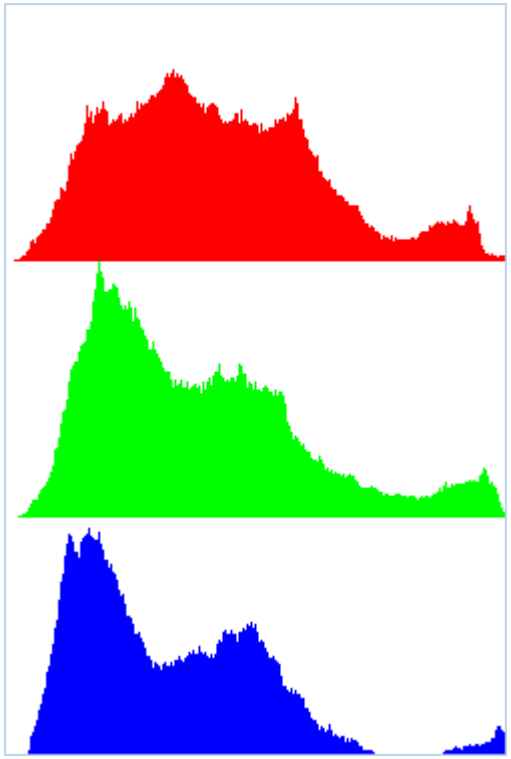
- Ex) a 8bit gray-scale image

Bin	Counts	Prob.
0	163	0.005
1	77	0.003
. . .		
255	1561	0.051

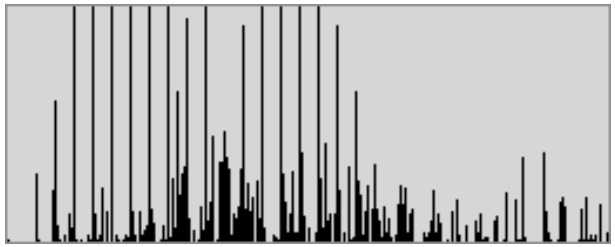




in color images



Color Quantization

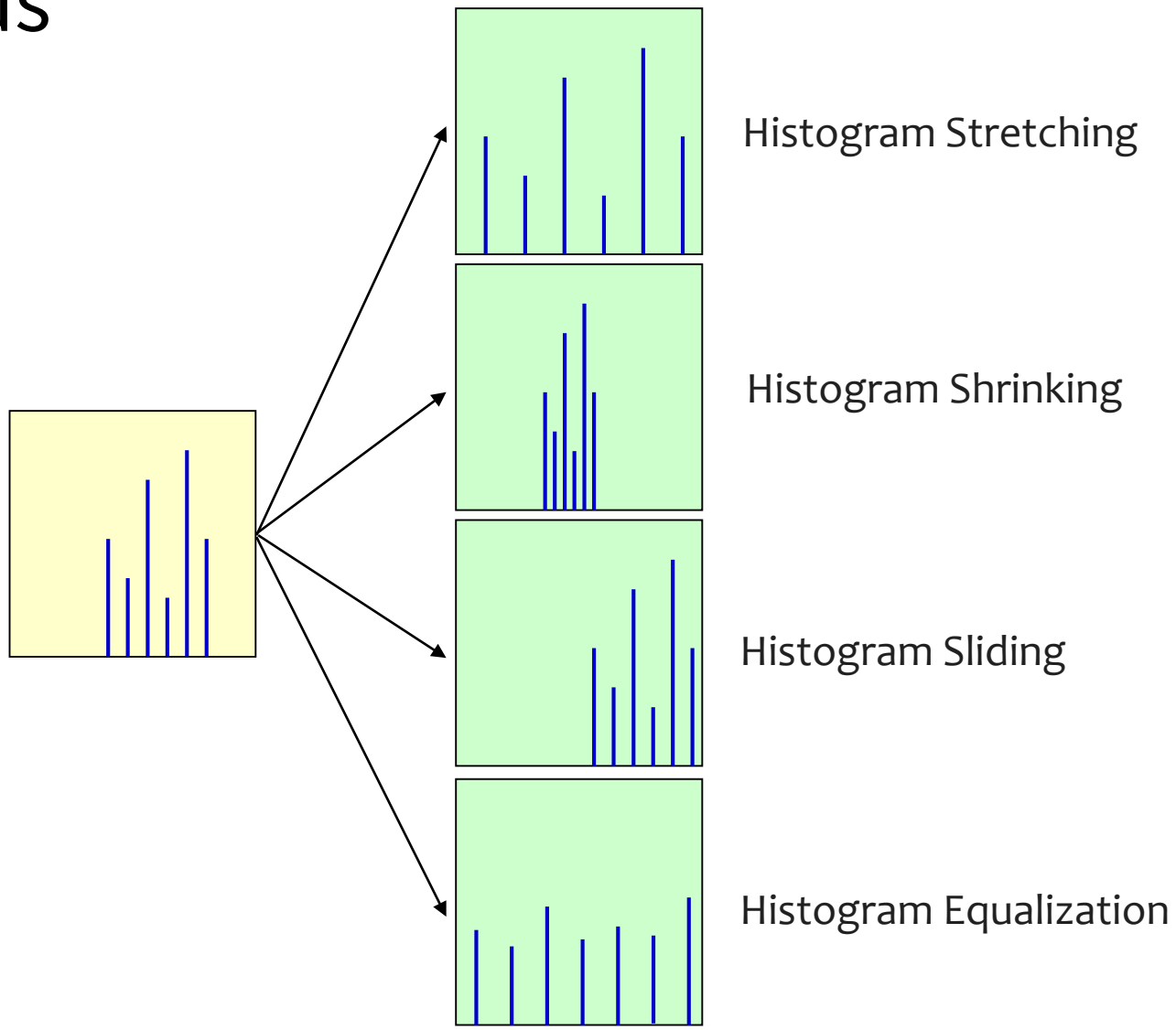


Histogram modifications

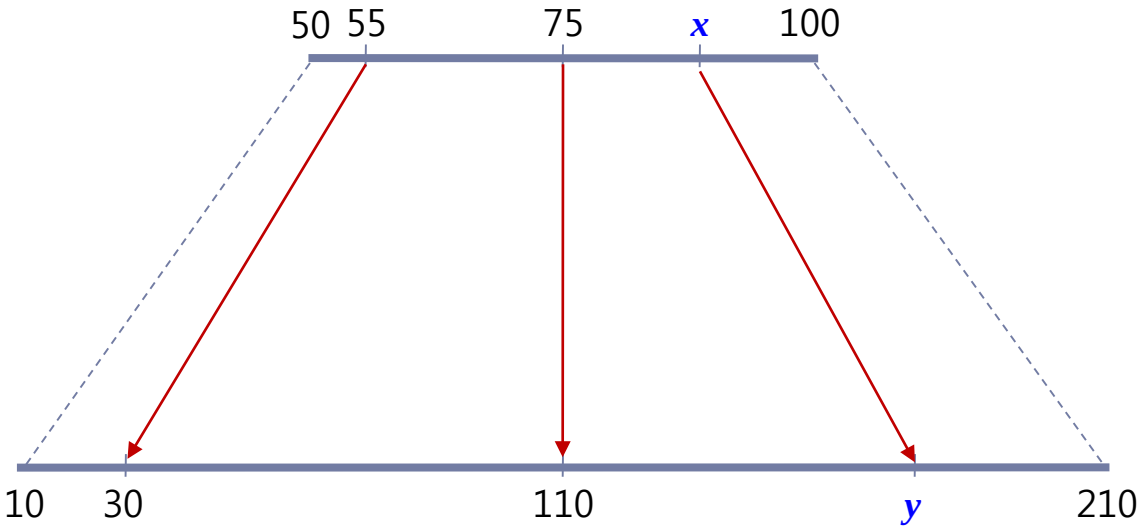
Improving image contrast and brightness based on **histogram**

Focus on the histogram shape and range

fields


Histogram Stretching
Histogram Shrinking
Histogram Sliding
Histogram Equalization

Stretching



$$(100-50):(x-50)=(210-10):(y-10)$$

$$(y-10)*(100-50)=(x-50)*(210-10)$$

$$y=\frac{(x-50)*(210-10)}{(100-50)}+10=\frac{(210-10)}{(100-50)}(x-50)+10$$

$$I^{'}(x,y)=\frac{(S_{\max}-S_{\min})}{(I_{\max}-I_{\min})}(I(x,y)-I_{\min})+S_{\min}$$

$$I'(x,y) = \left[\frac{S_{MAX} - S_{MIN}}{I_{MAX} - I_{MIN}}\right][I(x,y) - I_{MIN}] + S_{MIN}$$

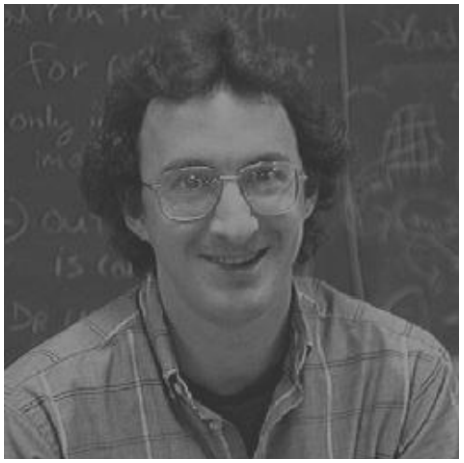
I_{MAX} : largest gray-level value in the image $I(x,y)$

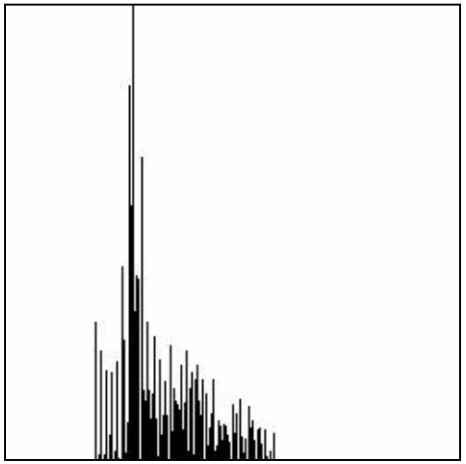
I_{MIN} : smallest gray-level value in $I(x,y)$

S_{MAX} : maximum gray-level values possible
(for an 8-bit image this is 255)

S_{MIN} : minimum gray-level values possible
(for an 8-bit image this is 0)

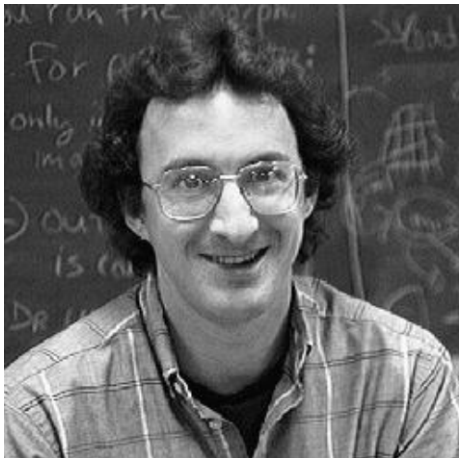
Low-contrast image

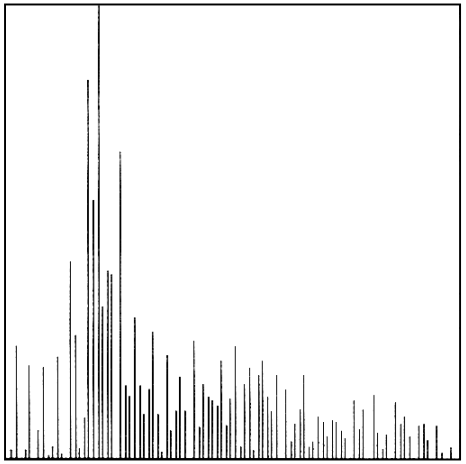




Histogram of low-contrast image

Image after histogram stretching





Histogram of image after stretching

Shrinking

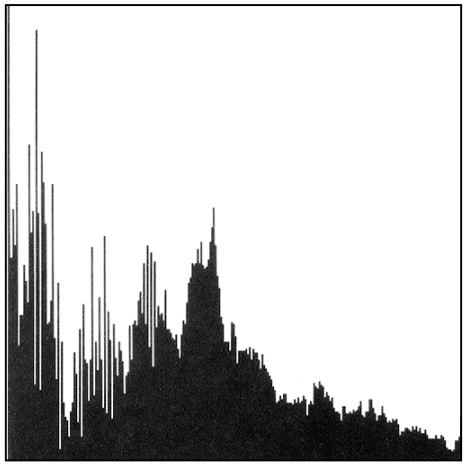
$$I'(x,y) = \left[\frac{S_{MAX} - S_{MIN}}{I_{MAX} - I_{MIN}}\right][I(x,y) - I_{MIN}] + S_{MIN}$$

I_{MAX} : largest gray-level value in the image $I(x,y)$

I_{MIN} : smallest gray-level value in $I(x,y)$

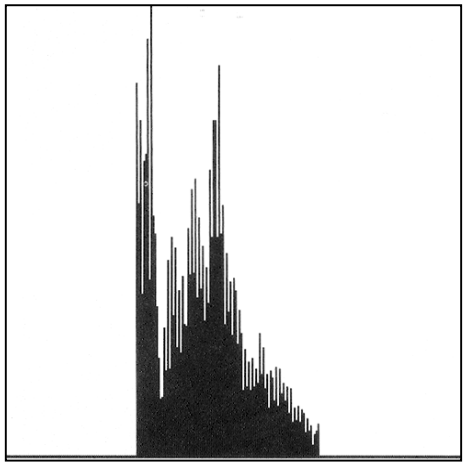
S_{MAX} : maximum desired in the compressed histogram

S_{MIN} : minimum desired in the compressed histogram



Histogram of original image

Image after shrinking to the range [75, 175]



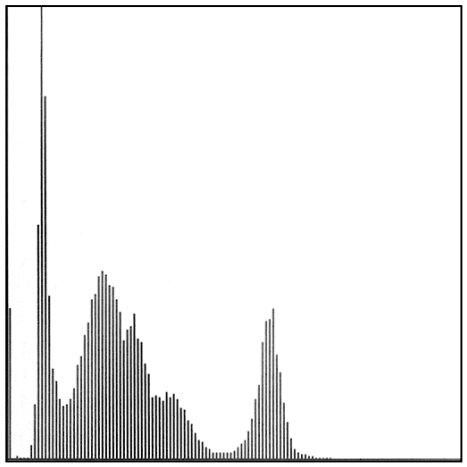
Histogram of shrinked image

Sliding

$$S(x, y) = I(x, y) + offset$$

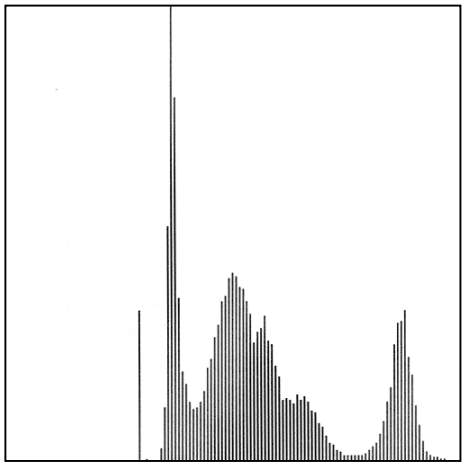
offset : amount to slide the histogram

Original image



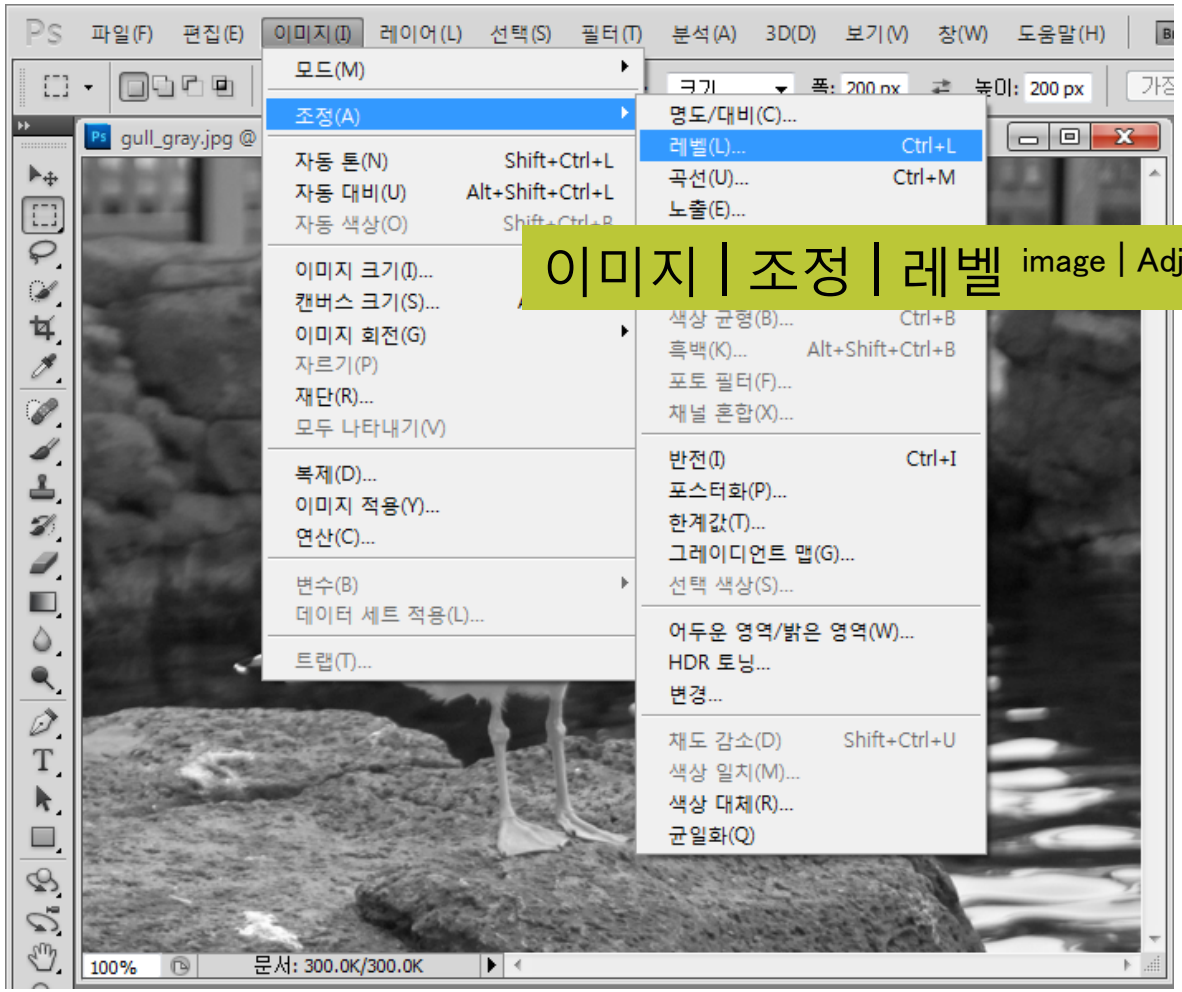
Histogram of original image

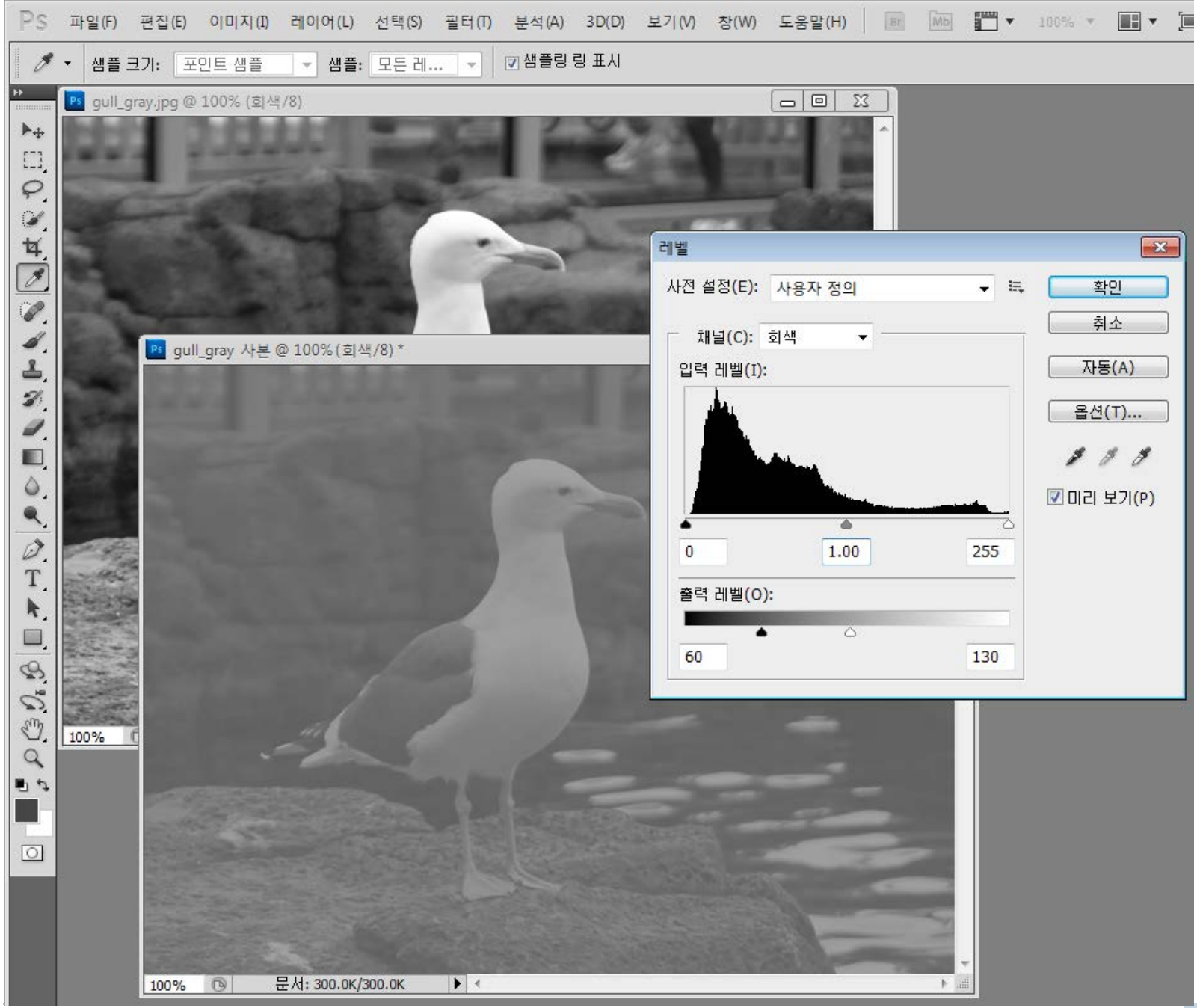
positive-value histogram sliding

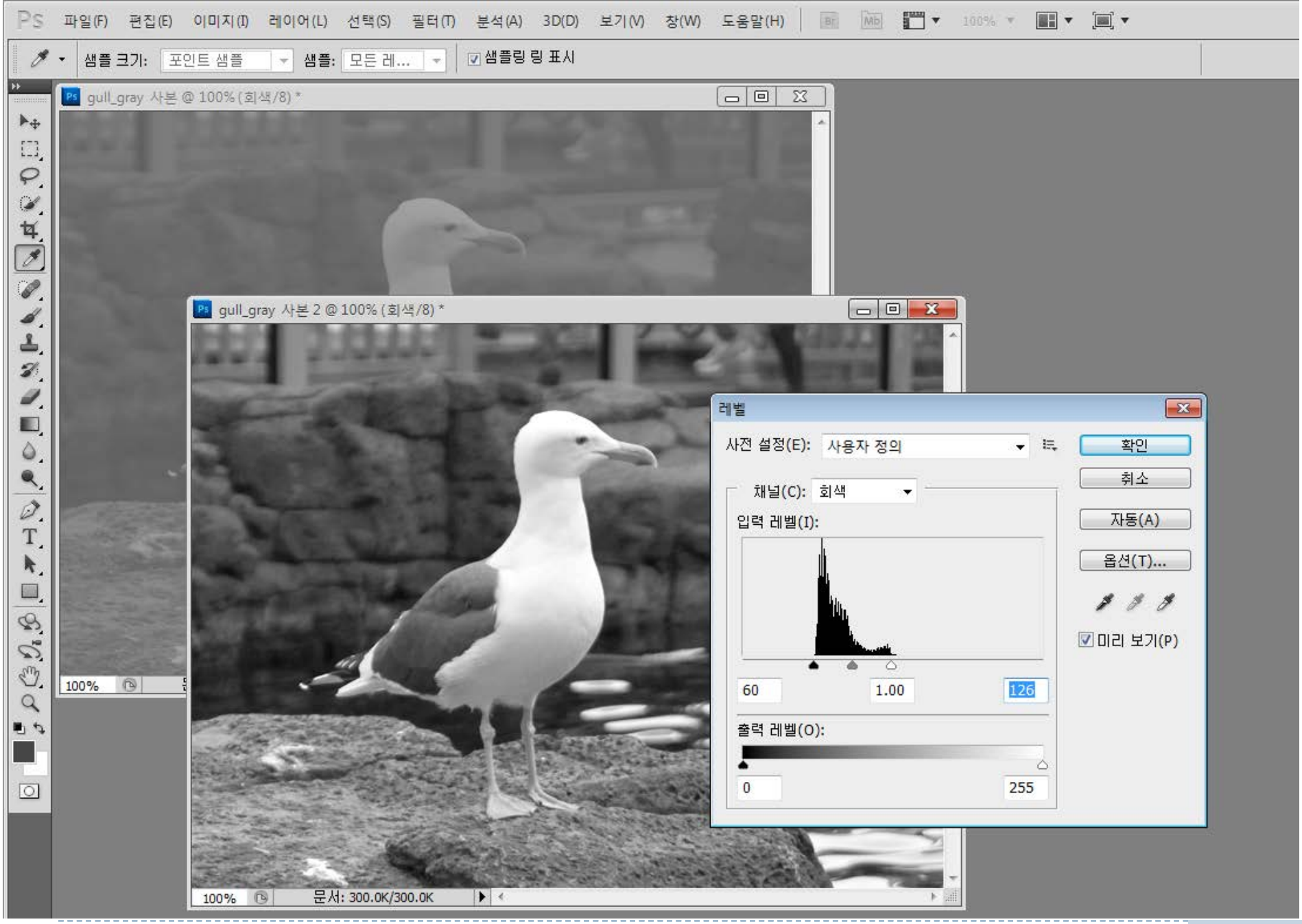


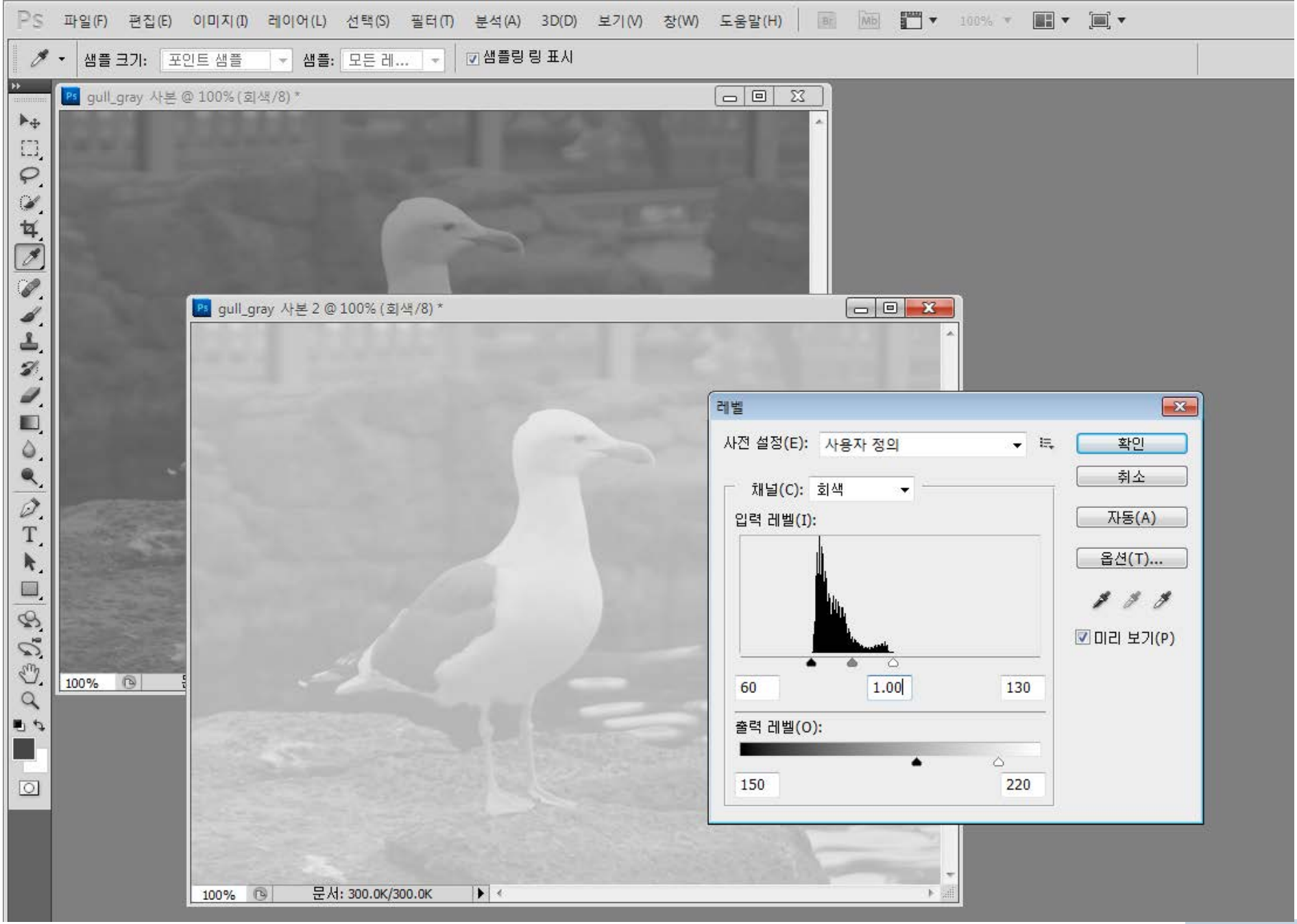
Histogram of image after sliding

Using Photoshop

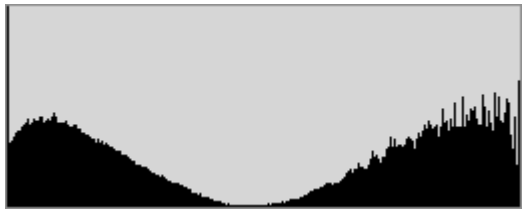



파일(F) 편집(E) 이미지(I) 레이어(L) 선택(S) 필터(T) 분석(A) 3D(D) 보기(V) 창(W) 도움말(H)
샘플 크기: 포인트 샘플
샘플: 모든 레...
샘플링 링 표시
gull_gray.jpg @ 100% (회색/8)
gull_gray 사본 @ 100% (회색/8) *
레벨
사전 설정(E): 사용자 정의
확인
취소
채널(C): 회색
자동(A)
입력 레벨(I):
옵션(T)...
0
1.00
255
출력 레벨(O):
60
130
미리 보기(P)
100%
문서: 300.0K/300.0K

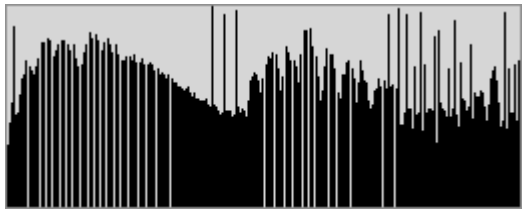

파일(F) 편집(E) 이미지(I) 레이어(L) 선택(S) 필터(T) 분석(A) 3D(D) 보기(V) 창(W) 도움말(H)
샘플 크기: 포인트 샘플
샘플: 모든 레...
샘플링 링 표시
gull_gray 사본 @ 100% (회색/8) *
gull_gray 사본 2 @ 100% (회색/8) *
100%
문서: 300.0K/300.0K
레벨
사전 설정(E): 사용자 정의
확인
취소
채널(C): 회색
자동(A)
입력 레벨(I):
옵션(T)...
60
1.00
126
미리 보기(P)
출력 레벨(O):
0
255


파일(F) 편집(E) 이미지(I) 레이어(L) 선택(S) 필터(T) 분석(A) 3D(D) 보기(V) 창(W) 도움말(H)
샘플 크기: 포인트 샘플
샘플: 모든 레...
샘플링 링 표시
gull_gray 사본 @ 100% (회색/8) *
gull_gray 사본 2 @ 100% (회색/8) *
100%
문서: 300.0K/300.0K
레벨
사전 설정(E): 사용자 정의
확인
취소
채널(C): 회색
자동(A)
입력 레벨(I):
옵션(T)...
60
1.00
130
미리 보기(P)
출력 레벨(O):
150
220

Equalization

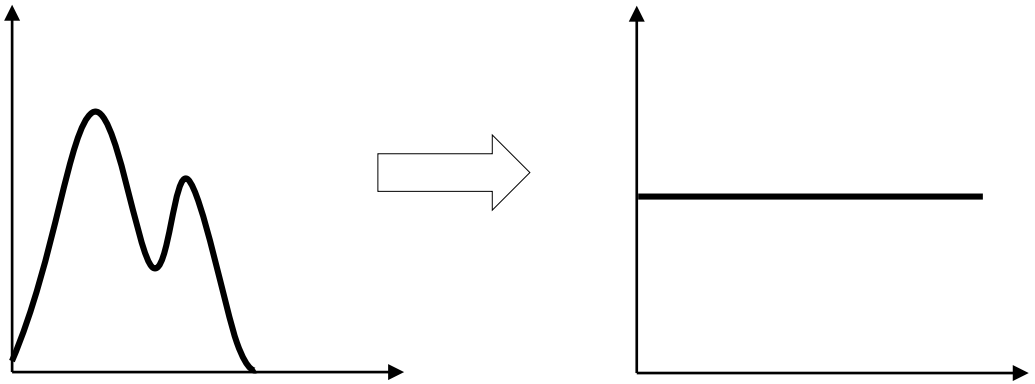


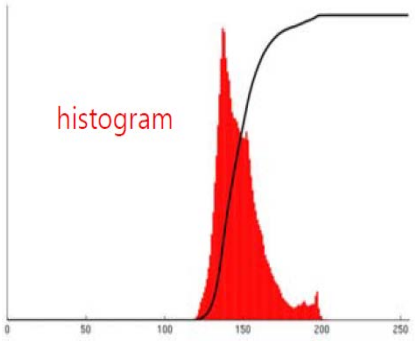
높은 contrast

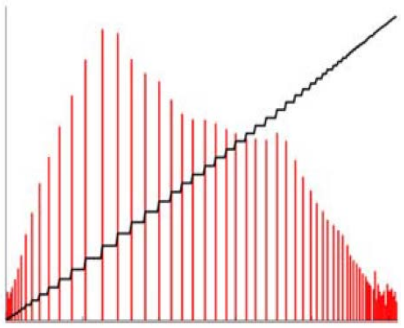


좋은 contrast

균일하지 않은 gray level의 분포를 재분배하여 발생 빈도를 균등하게 분포하도록 만드는 과정







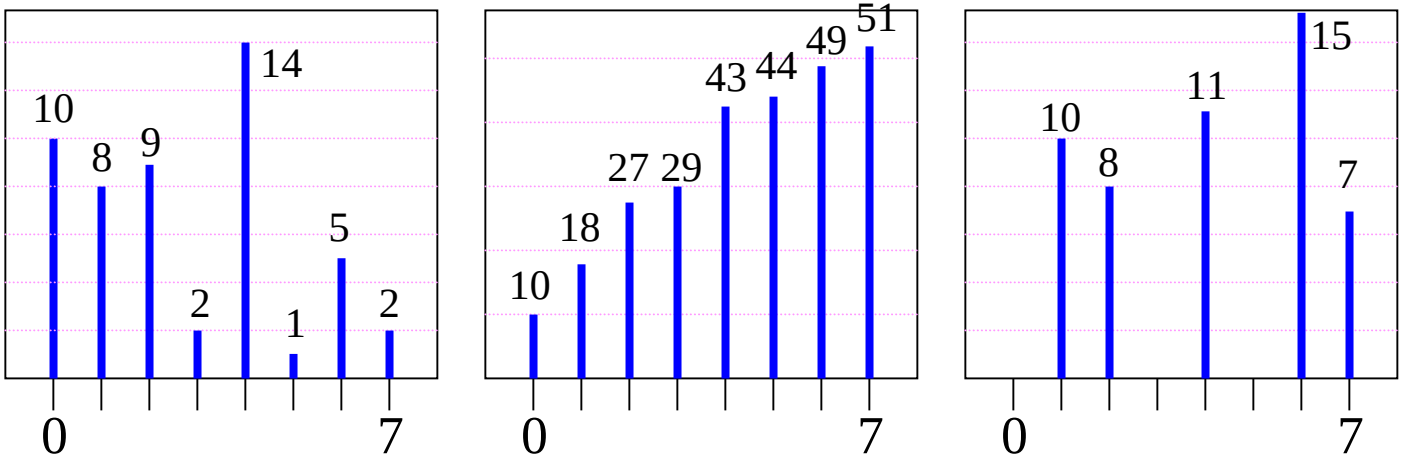
algorithm

① 입력 영상의 히스토그램의 값을 누적시켜 히스토그램 누적 합 계산

② 히스토그램의 누적 합을 전체 픽셀의 개수로 나누어 값을 정규화함

③ 정규화된 값에 최대 gray level 값을 곱한 후 반올림을 수행

④ 입력 영상의 각 gray level에 대해 변환 값으로 대응시킴



히스토그램 누적값 균일화 결과

$$\frac{(10,18,27,29,43,44,49,51)}{51}\times 7$$

$$\approx (1.37,2.47,3.71,3.98,5.90,6.04,6.73,7.00)$$

$$\approx (1,2,4,4,6,6,7,7)$$

4	5	3	6	7
4	2	2	4	6
0	2	2	5	7
0	0	2	3	5
0	1	2	4	4

픽셀값	개수	누적값	균일화	반올림
0	10	10	1.37	1
1	8	18	2.47	2
2	9	27	3.71	4
3	2	29	3.98	4
4	14	43	5.90	6
5	1	44	6.04	6
6	5	49	6.73	7
7	2	51	7.00	7

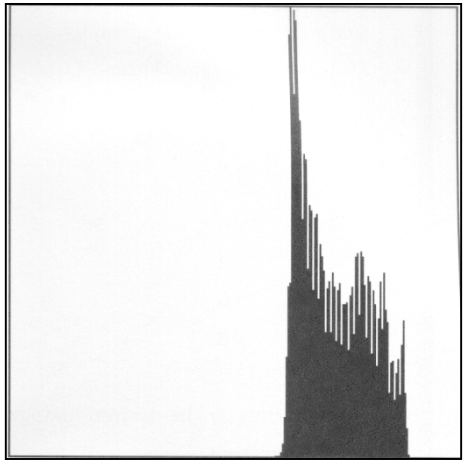
6	6	4	7	7
6	4	4	6	7
1	4	4	6	7
1	1	4	4	6
1	2	4	6	6

$\frac{10}{51} * 7 = 1.37$ $\frac{43}{51} * 7 = 5.90$

균일화를 위한 공식

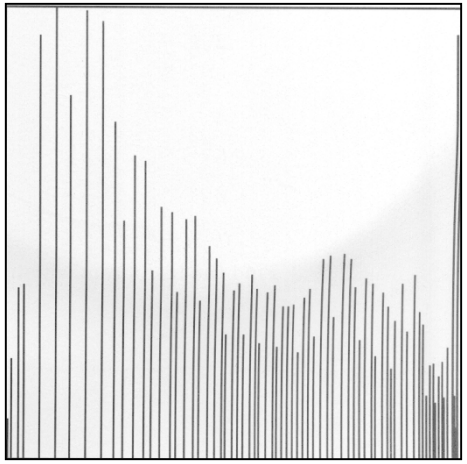
$$Normalization = \frac{\text{누적값}}{\text{전체 픽셀의 수}} \text{ X maximum\_gray\_level}$$

Original light image



Histogram of original image

Light image after histogram equalization



Histogram of equalized image

요약

- Histogram
  - A simple datum that gives the number of pixels that a given value in an image
- Histogram modifications
  - Improving image contrast and brightness by changing shape and range of histogram
  - Histogram Stretching, Histogram Shrinking, Histogram Sliding, Histogram Equalization

Reference

- R. Gonzalez, R. Woods, **Digital Image Processing (2nd Edition),** Prentice Hall, 2002
- Scott E Umbaugh, **Computer Imaging**, CRC Press, 2005