Computer Vision-IT813

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September 7, 2021

Concept of Histogram.

Contrast

Contrast can be simply explained as the difference between maximum and minimum pixel intensity in an image.

For example.

Consider the final image1 in brightness.

The matrix of this image is:

100	100	100	100	100
100	100	100	100	100
100	100	100	100	100
100	100	100	100	100
100	100	100	100	100

The maximum value in this matrix is 100.

The minimum value in this matrix is 100.

Contrast = maximum pixel intensity(subtracted by) minimum pixel intensity

= 100 (subtracted by) 100

= 0

0 means that this image has 0 contrast.

Transformation

Transformation is a function. A function that maps one set to another set after performing some operations.

Digital Image Processing system

We have already seen in the introductory tutorials that in digital image processing, we will develop a system that whose input would be an image and output would be an image too. And the system would perform some processing on the input image and gives its output as an processed image. It is shown below.

Image transformation.

Consider this equation

$G(x,y) = T\{ f(x,y) \}$

In this equation,

F(x,y) = input image on which transformation function has to be applied.

G(x,y) = the output image or processed image.

T is the transformation function.

This relation between input image and the processed output image can also be represented as.

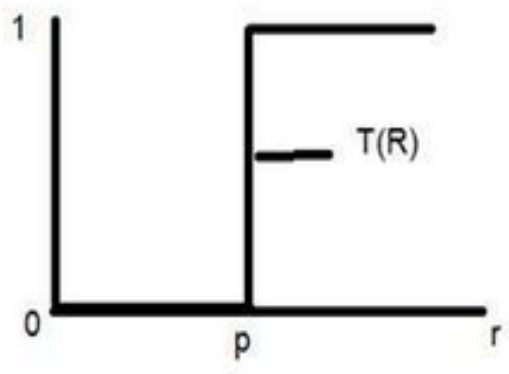
$s = T(r)$

where r is actually the pixel value or gray level intensity of f(x,y) at any point. And s is the pixel value or gray level intensity of g(x,y) at any point.

The basic gray level transformation has been discussed in our tutorial of basic gray level transformations.

Examples

Consider this transformation function.



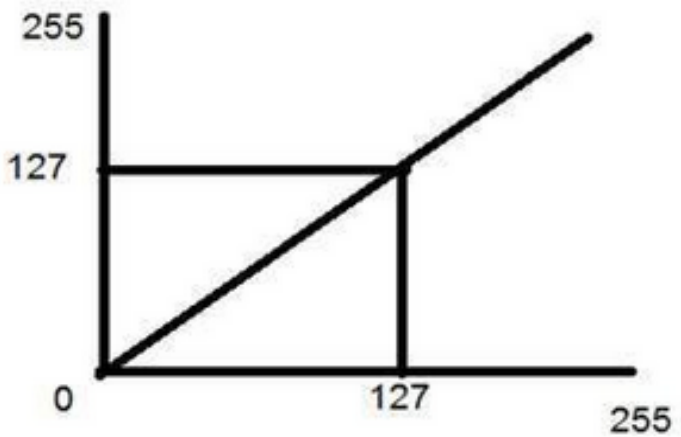
Lets take the point r to be 256, and the point p to be 127. Consider this image to be a one bpp image. That means we have only two levels of intensities that are 0 and 1. So in this case the transformation shown by the graph can be explained as.

All the pixel intensity values that are below 127 (point p) are 0, means black. And all the pixel intensity values that are greater then 127, are 1, that means white. But at the exact point of 127, there is a sudden change in transmission, so we cannot tell that at that exact point, the value would be 0 or 1.

Mathematically this transformation function can be denoted as:

$$g(x,y) = \begin{cases} 0 & f(x,y) < 127 \\ 1 & f(x,y) > 127 \end{cases}$$

Consider another transformation like this



Now if you will look at this particular graph, you will see a straight transition line between input image and output image.

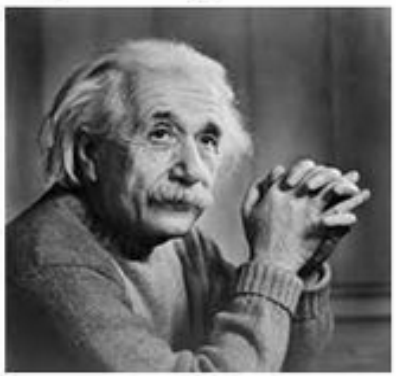
It shows that for each pixel or intensity value of input image, there is a same intensity value of output image. That means the output image is exact replica of the input image.

It can be mathematically represented as:

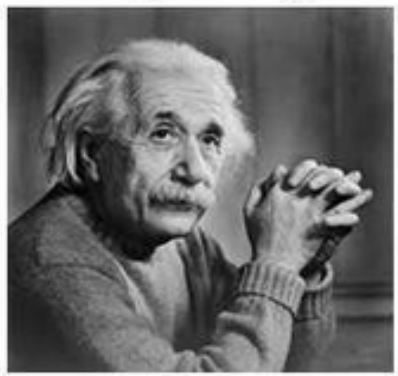
$g(x,y) = f(x,y)$

the input and output image would be in this case are shown below.

Input image



Output image



Histogram

Histogram is nothing but a graph that shows frequency of occurrence of data. Histograms has many use in image processing, out of which we are going to discuss one user here which is called histogram sliding.

Histogram sliding

In histogram sliding, we just simply shift a complete histogram rightwards or leftwards. Due to shifting or sliding of histogram towards right or left, a clear change can be seen in the image.In this tutorial we are going to use histogram sliding for manipulating brightness.

The term i-e: Brightness has been discussed in our tutorial of introduction to brightness and contrast. But we are going to briefly define here.

Brightness

Brightness is a relative term. Brightness can be defined as intensity of light emit by a particular light source.

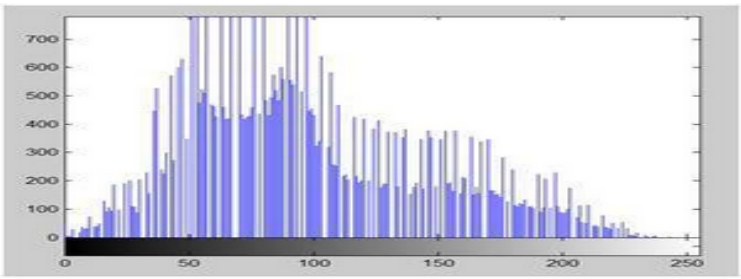
Contrast

Contrast can be defined as the difference between maximum and minimum pixel intensity in an image.

Sliding Histograms

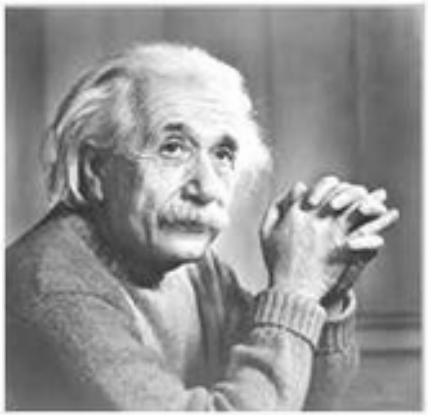
Increasing brightness using histogram sliding

Histogram of this image has been shown below.

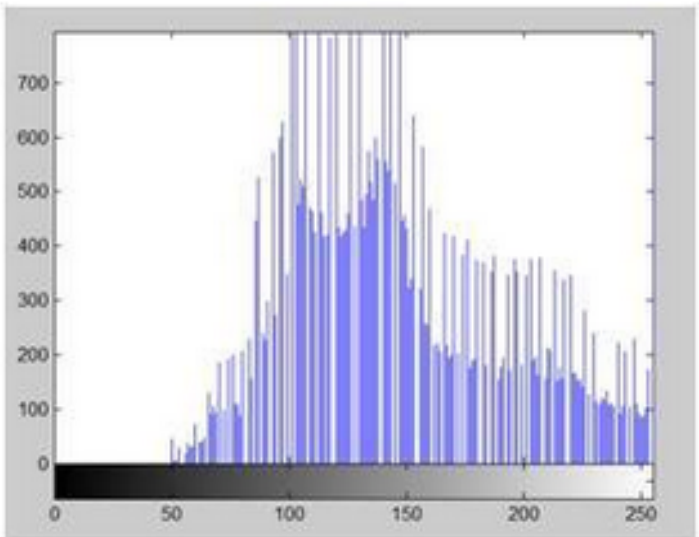


Here what we got after adding 50 to each pixel intensity.

The image has been shown below.

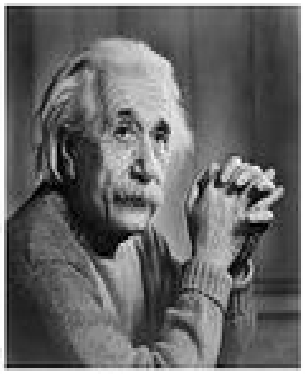


And its histogram has been shown below.

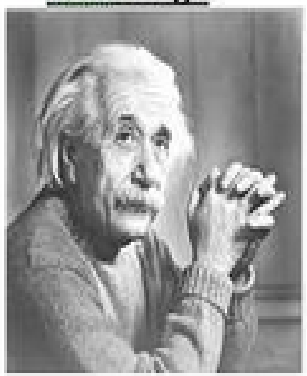


Lets compare these two images and their histograms to see that what change have to got.

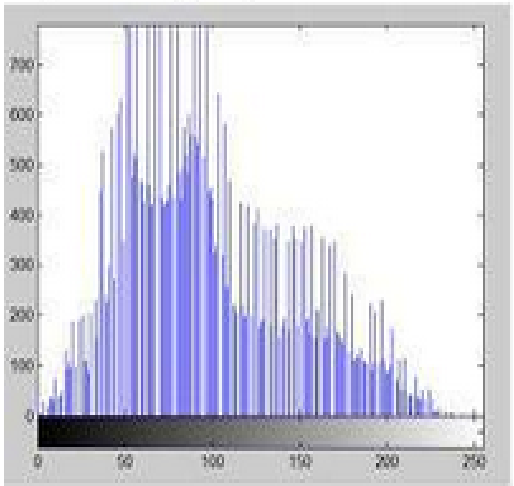
Old image



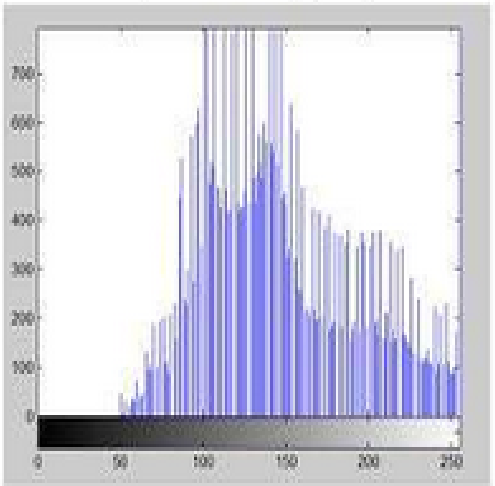
New image



Old histogram



New Histogram

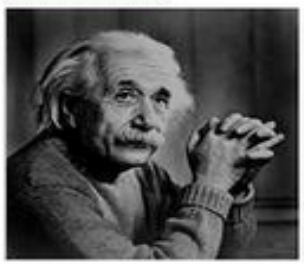


Decreasing brightness using histogram sliding

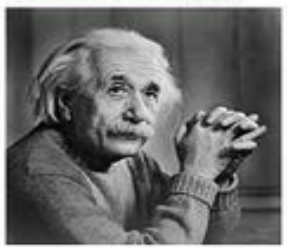
Now if we were to decrease brightness of this new image to such an extent that the old image look brighter, we got to subtract some value from all the matrix of the new image. The value which we are going to subtract is 80. Because we already add 50 to the original image and we got a new brighter image, now if we want to make it darker, we have to subtract at least more than 50 from it.

And this what we got after subtracting 80 from the new image.

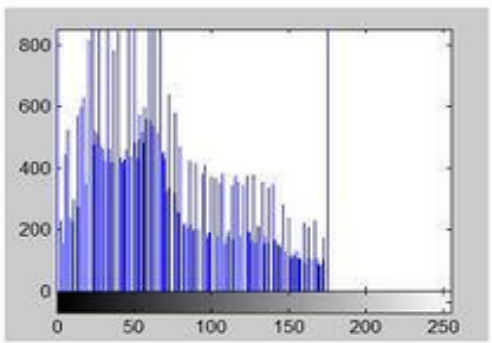
New image.



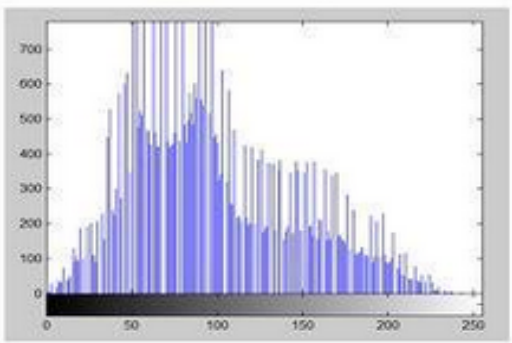
Original image.



New Histogram.



Original Histogram.



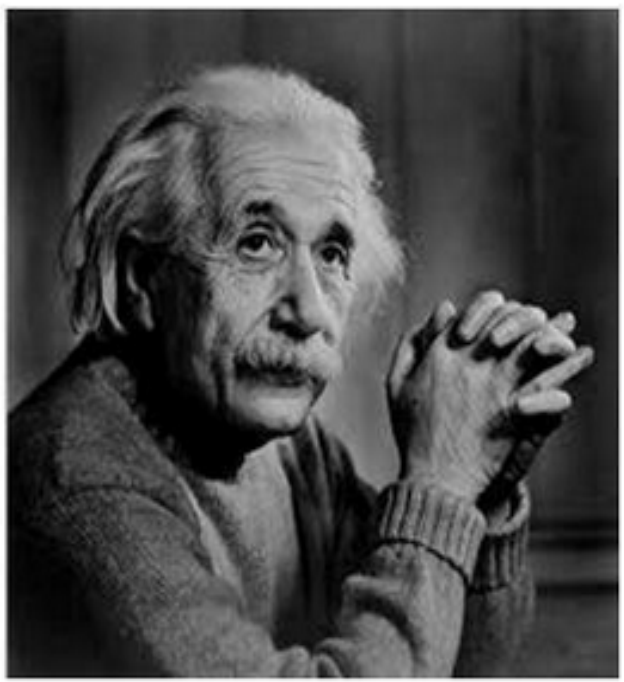
There are two methods of enhancing contrast. The first one is called Histogram stretching that increase contrast. The second one is called Histogram equalization that enhance contrast and it has been discussed in our tutorial of histogram equalization.

Before we will discuss the histogram stretching to increase contrast, we will briefly define contrast.

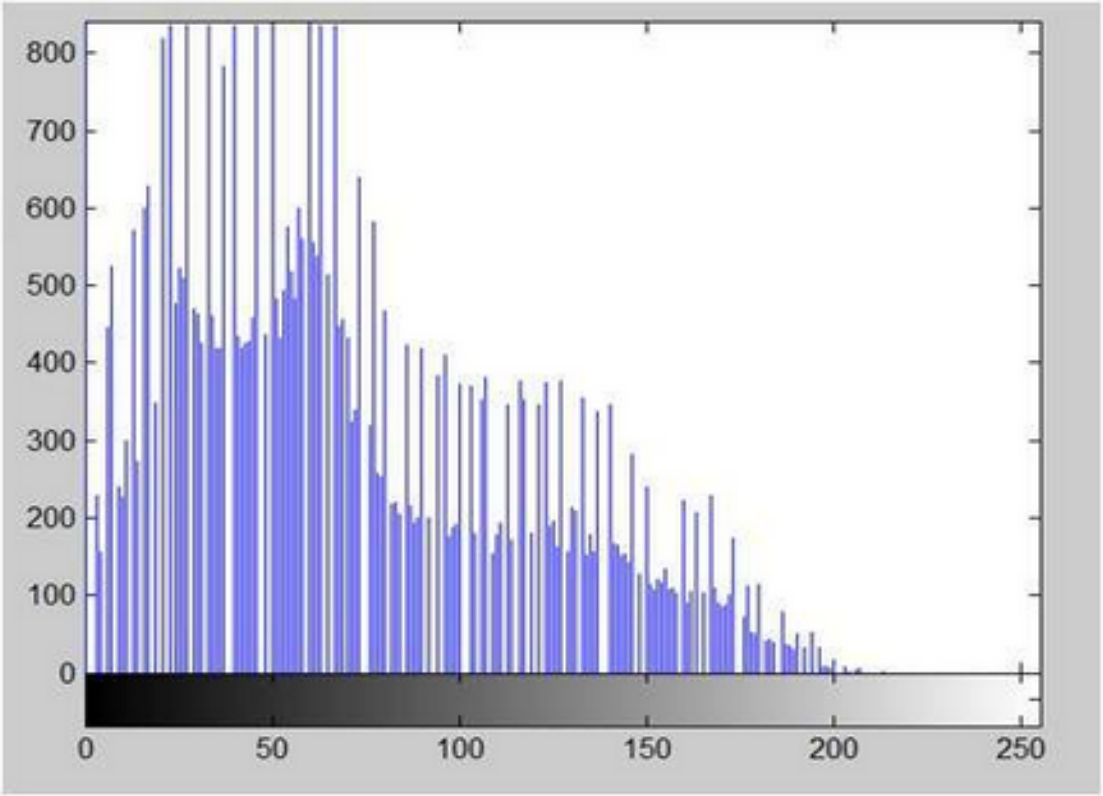
Contrast

Contrast is the difference between maximum and minimum pixel intensity.

Consider this image.



The histogram of this image is shown below.



Now we calculate contrast from this image.

Contrast = 225.

Now we will increase the contrast of the image.

Increasing the contrast of the image

The formula for stretching the histogram of the image to increase the contrast is

$$g(x,y) = \frac{f(x,y)-fmin}{fmax-fmin} * 2^{bpp}$$

The formula requires finding the minimum and maximum pixel intensity multiply by levels of gray. In our case the image is 8bpp, so levels of gray are 256.

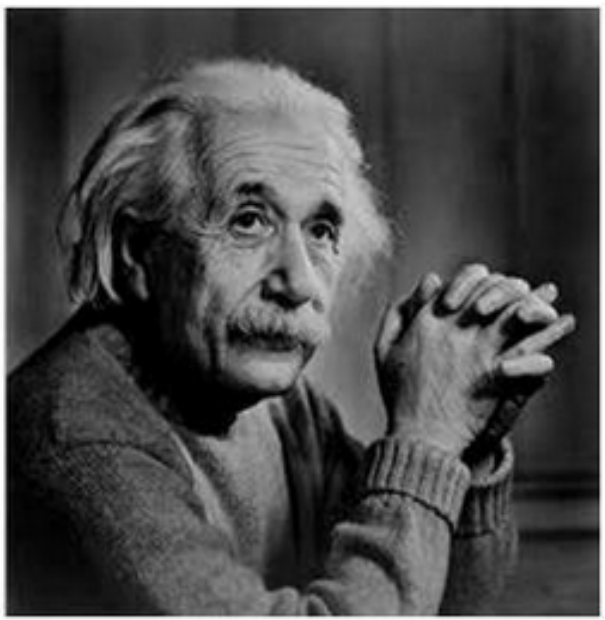
The minimum value is 0 and the maximum value is 225. So the formula in our case is

$$g(x,y) = \frac{f(x,y)-0}{225-0} * 255$$

where f(x,y) denotes the value of each pixel intensity. For each f(x,y) in an image , we will calculate this formula.

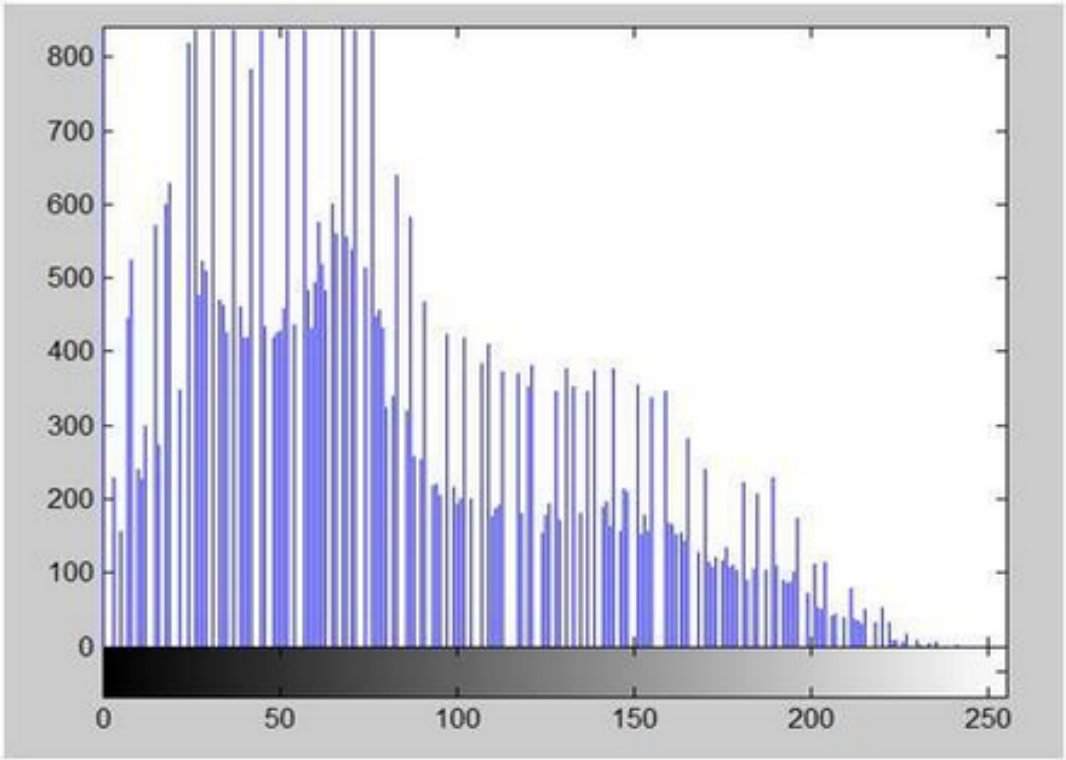
After doing this, we will be able to enhance our contrast.

The following image appear after applying histogram stretching.



The stretched histogram of this image has been shown below.

Note the shape and symmetry of histogram. The histogram is now stretched or in other means expand. Have a look at it.



In this case the contrast of the image can be calculated as

Contrast = 240

Hence we can say that the contrast of the image is increased.