UNIVERDIDAD VERACRUZANA

INSTITUTO DE INVESTIGACIONES EN INTELIGENCIA ARTIFICIAL

VISIÓN ARTIFICIAL

HOMEWORK 4

LIBRO: DIGITAL IMAGE PROCESSING

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HISTOGRAM EQUALIZATION

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Objetive

- Write a computer program for computing the histogram of an image.
- Implement the histogram equalization technique discussed in Section 3.3.1.
- Download figures 3.15(1,2,3) and perform histogram equalization on them.

As a minimum, your report should include the original image, a plot of its histogram, a plot of the histogram equalization transformation function, the enhanced image, and a plot of its histogram. Use this information to explain why the resulting image was enhanced as it was.

Figure 1. Test image

Methodology

To generate the histogram of the image:

- Upload the image.
- Create an array of size 256 for the histogram.
- For each pixel in the image:
  - Get the intensity value of the pixel, which can range from 0 to 255.
  - Increase the value by 1 at the position of the array corresponding to the intensity value.
- Plot the resulting histogram, where the x represents the intensity values from 0 to 255 and the y represents the number of pixels with that intensity.

Explanation:

- Let image(x, y) be the intensity value of a pixel at position (x, y) of the grayscale image.
- Let number be the total number of pixels in the image.
- Let histogram(i) be the number of pixels with an intensity value i in the image.
- Then, for each pixel in the image, we can increment the value by 1 at the corresponding position in the histogram array: histogram(image(x, y)) = histogram (image((x, y)) + 1.
- In the end, the resulting histogram can be plotted with the intensity value i on the x and the value of h(i) on the y

To generate plot of the histogram equalization transformation function:

- Calculate the histogram of the image.
- Calculate the cumulative distribution function (CDF) from the histogram.
- Normalize the CDF.
- Calculate the transformation function T for each intensity value:
  - T(i) = CDF(i) * 255
- Apply the transformation function T to the original image.
- Save the transformed image.

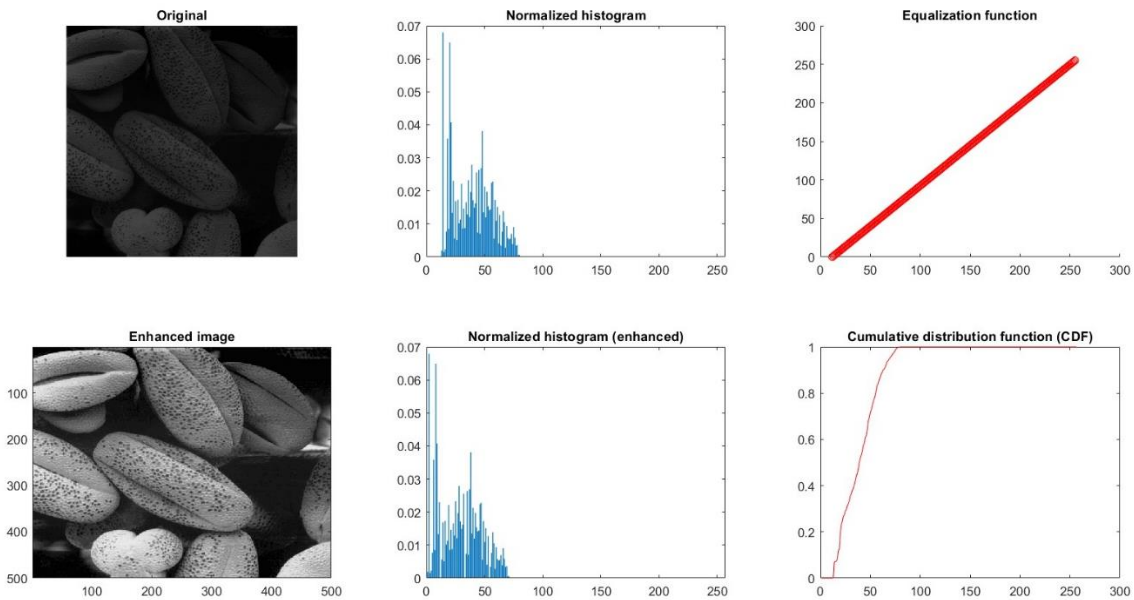
Explanation:

- Let I(x, y) be the intensity value of a pixel at position (x, y) of the grayscale image.
- Let N be the total number of pixels in the image.
- Let histogram(i) be the number of pixels with an intensity value i in the image.
- The histogram can be represented as a function histogram (i) that maps intensity values i to the number of pixels with that value.
- The cumulative distribution function (CDF) is defined as the cumulative sum of the normalized histogram.

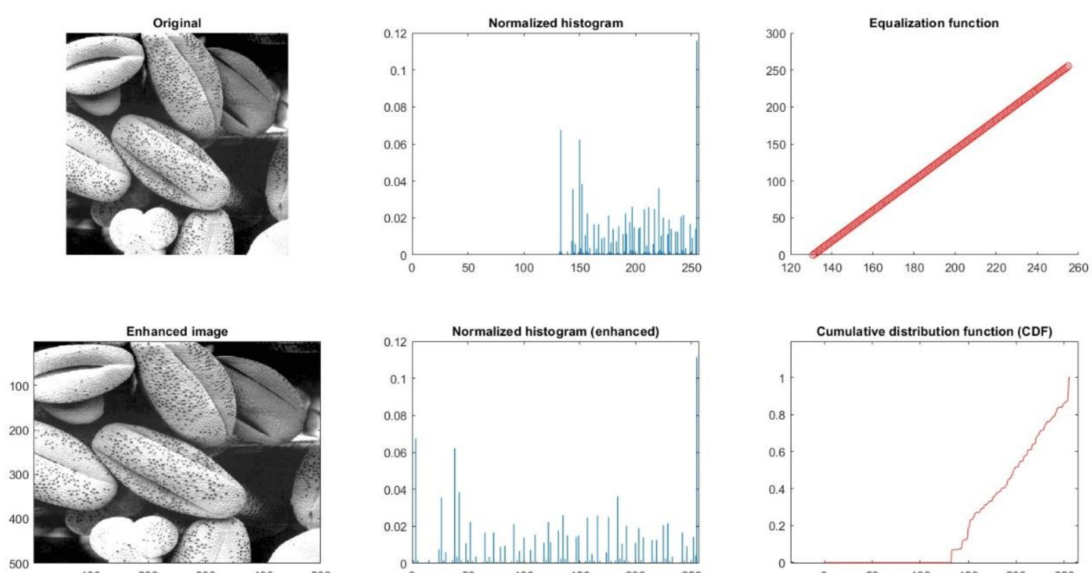
Generate other histogram enhanced with the same histogram's funcion.

Results

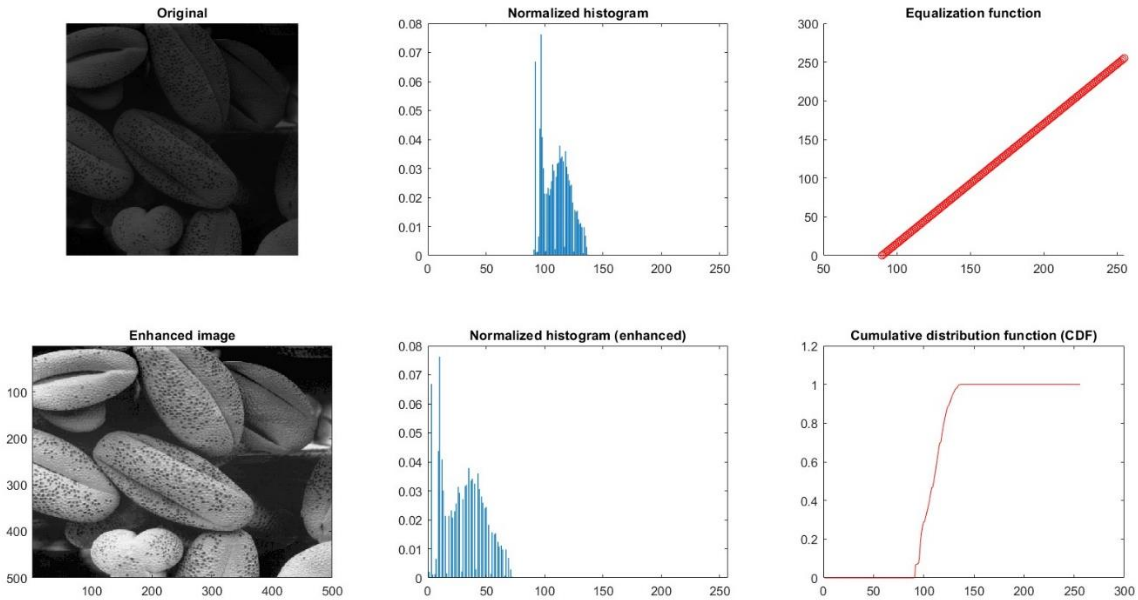
Result with figure 3.15(a)1



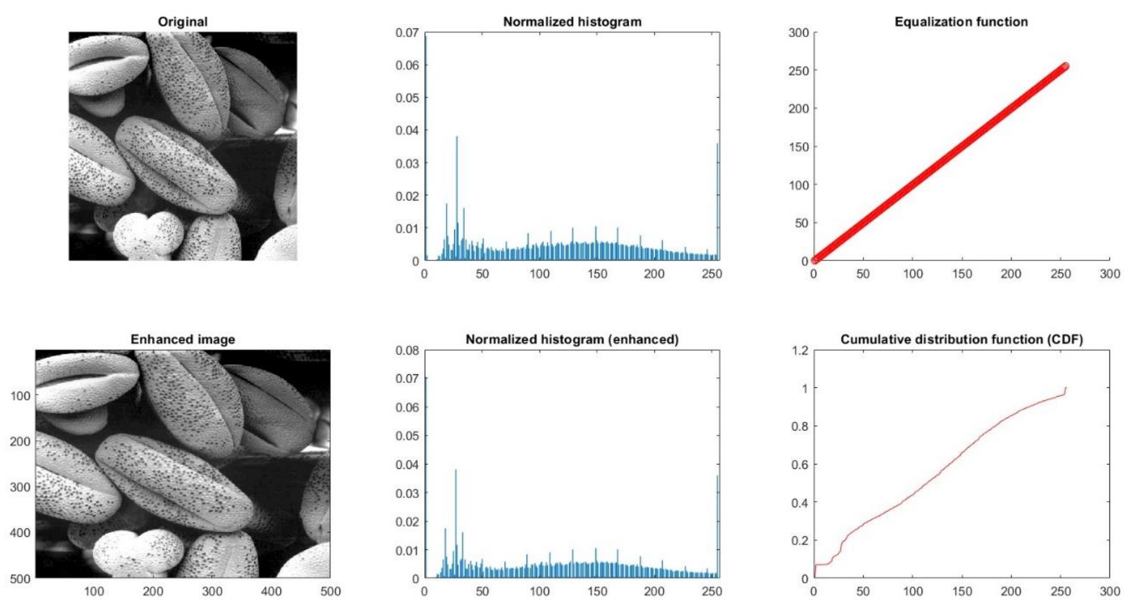
Result with figure 3.15(a)2



Result with figure 3.15(a)3



Result with figure 3.15(a)4



Conclusion

We can conclude that when we apply the equalization transformation of a histogram to an image, what we are doing is redistributing the pixel values so that the values are more uniform. When applying this function, the image is modified by the adjustments made. We can notice that there is a change in the image by the distribution of the values.

Despite the fact that they all have a different distribution with respect to their original diagram, when adjusting with their histogram we can observe a change in the intensity of the gray scale of the image. However, this could not apply to any image, depending on the quality and range of its grayscale its transformation can be done by equalizing its histogram on the image.

One disadvantage is that the verse is artificial or highly processed due to the amount of distribution that you have to notice the limit for the images and not have an overfit in their appearance.

The histogram of a grayscale image provides valuable information about the intensity distribution of the pixels in the image, and the equalization transform of a histogram can significantly improve the visual quality of the image.

Both techniques are essential for digital image processing and their application in various fields, such as medicine, science, and technology, among others.

Annex: Code

```
% Read the image
im=imread('Fig3.15(a)4.jpg');
image=imread('Fig3.15(a)4.jpg');
% Determinate dimension imagen
[r,c]=size(image);
% Create histogram vector for counting pixel occurrences from 0 to 255
histogram= zeros(256,1);
for r=1:1:r
    for c=1:1:c
        % we add one for fit the scale
        point=image(r,c)+1;
        % Update histogram each time a pixel value is found
        histogram(point)=histogram(point)+1;
    end
end
% We regulate histogram
hist=histogram/(r*c);
n=256;
% The gray-levels in an image may be viewed as random
% variables in the interval [0,1]. A transformation function of
% particular importance in image processing has the form
cumulative=zeros(n,1);
a=hist(1);
for i=2:1:n
    a=a+hist(i);
    cumulative(i)=a;
end
tolerancia=eps(10.0);
%cpd
for i=1:1:n
    % Absolute valore
    if abs(cumulative(i)-0.0)> tolerancia
        al=i-1;
        break
    end
end
for i=n:-1:1
    if abs(cumulative(i)-1)<tolerancia
        acom=i-1;
        break
    end
end
% Fit values
value=(n-1)/(acom-al);
for r=1:1:r
    for c=1:1:c
        image(r,c)=value*(image(r,c)-al);
    end
end
```

```
% Create histogram vector of the enhanced image
histo_vec=zeros(n,1);
for r=1:1:r
    for c= 1:1:c
        point=image(r,c)+1;
        histo_vec(point)=histo_vec(point) + 1;
    end
end
% 90:255
hist_normalizad=histo_vec/(r*c);
dominio=al:acom;
range=value*(dominio-al);
colormap("gray")
figure(1)
subplot(2,3,1),imshow(image),title('Original');
subplot(2,3,2),bar(hist),title(['Normalized histogram']);
subplot(2,3,3),scatter(dominio, range, 'r');title(['Equalization function']);
subplot(2,3,4),imagesc(image);title(['Enhanced image']);
subplot(2,3,5),bar(hist_normalizad);title('Normalized histogram (enhanced)');
subplot(2,3,6),plot(cumulative,'r');title('Cumulative distribution function (CDF)');
```

References

- Haris Papasaika-Hanusch. *Digital image processing using matlab*. Institute of Geodesy and
  Photogrammetry, ETH Zurich, 63, 1967.