Venkatakrishnan Ranganathan
MP3 - **MSAI_495 Computer Vision**

HISTOGRAM EQUALIZATION

The main principle behind histogram equalization is to stretch the range of pixel intensities in an image so that the full range of brightness values is utilized. This is done by first computing the histogram of the image, which is a graph of the number of pixels at each intensity level.

1. We import the Image module from the PIL library using the **from PIL import Image** statement.
2. We load the image in grayscale mode using the **Image.open** function and convert it to grayscale using the **convert** method with the argument **'L'**.
3. We compute the histogram of the image.
4. We quantize the histogram by dividing it into num_bins (0, 32, 64, 128) bins. We compute the size of each bin by dividing the range of pixel values (256 for 8-bit grayscale images) by the number of bins. We then sum up the histogram values within each.
5. We compute the cumulative distribution function (CDF) of the histogram by iterating over the histogram and summing up the values.
6. We normalize the CDF to have values between 0 and 255 using a list comprehension that subtracts the minimum value of the CDF and multiplies the result by 255 divided by the range of the CDF.
7. We compute the equalized histogram by rounding the normalized CDF to the nearest integer.
8. We compute the lookup table for the equalization by creating a list of 256 elements, where each element corresponds to the equalized value of the pixel with that index. We map each pixel value to its corresponding bin and then use the index of the bin to look up the equalized value.
9. We apply the equalized histogram to the image using the **point** method of the image object with the equalized histogram as the argument.
10. Finally, we save the equalized image using the **save** method of the image object.

Analysis

One of the main drawbacks is that it can result in an overly contrasted image, which can make the image appear unnatural. This can happen if the original image has a narrow range of intensities, in which case the mapping function can cause many pixels to be mapped to the same intensity level.

The histogram equalization output can be affected if we vary the bin size. The reason for this is that the number of bins determines how the image intensity values are divided up and redistributed in the equalization process.

When we divide the intensity values into smaller bins, the equalization process becomes more fine-grained and can result in better contrast enhancement. This is because each bin will contain a smaller range of intensity values, which can result in more accurate redistribution of the pixel intensities.

On the other hand, if we divide the intensity values into larger bins, the equalization process becomes less fine-grained and may result in less accurate redistribution of the pixel intensities. This can lead to overemphasizing some pixel values and underemphasizing others, resulting in a less effective contrast enhancement.

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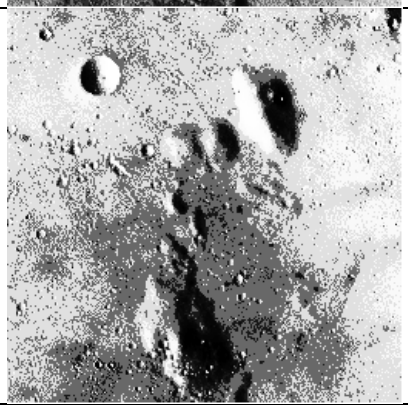
Bin Size	Image
No Binning	
128	
64	
32	

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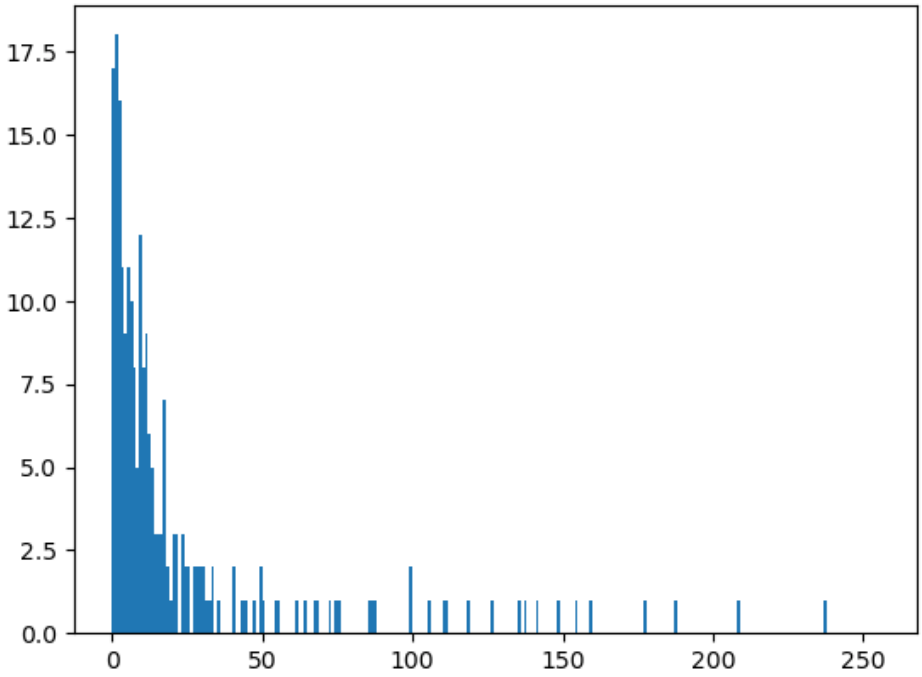
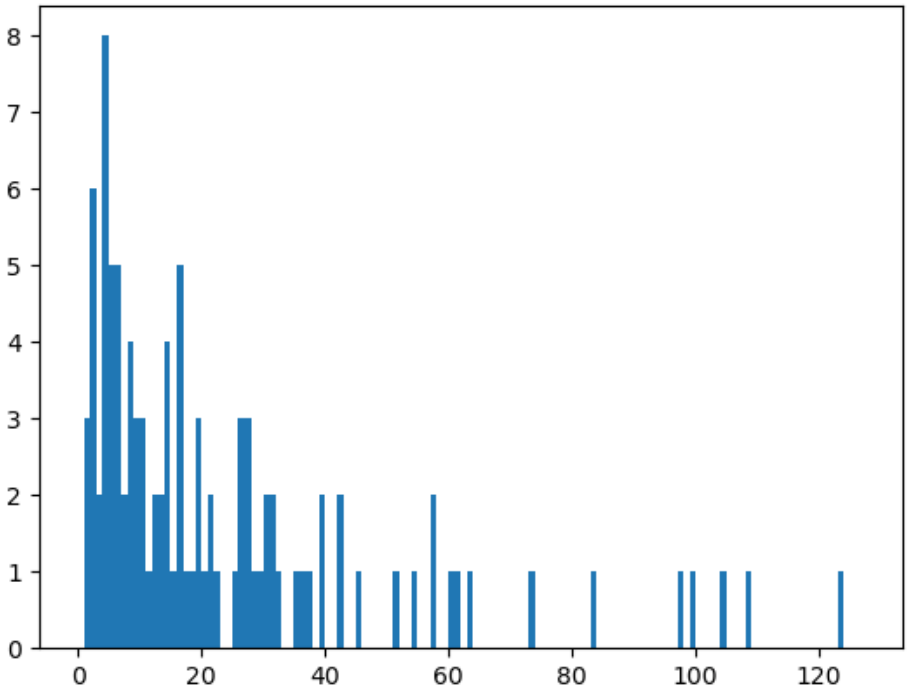
Visualizing Histograms

1. **Original**



2. **Quantized**



3. **Equalized**