Department of Robotics and Mechatronics Engineering

University of Dhaka

Assignment

Course Name: Digita Image Processing and Robot Vision.

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① What is Histogram Specification?

Ans: Histogram specification, also known as histogram matching, is the process of generating images with a specified histogram. It is a quick and easy way to 'calibrate' one image to match another. In other words, it is a process ~~the~~ of transforming a image in such a way that the Cumulative Distribution Function (CDF) of values in each band matches the CDF of bands in another image.

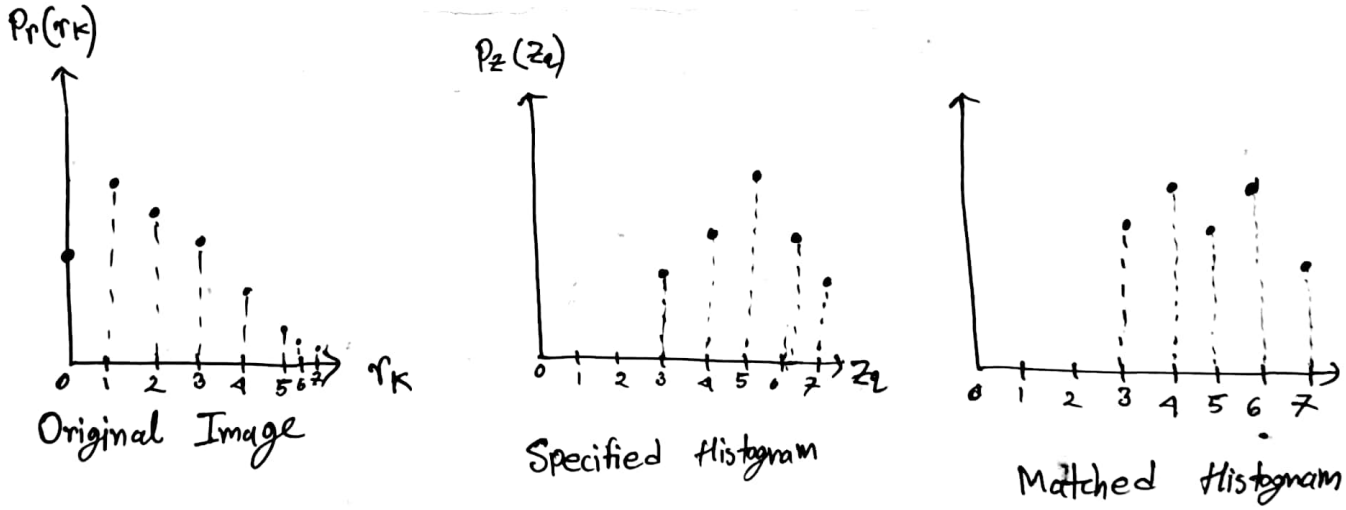

Fig: Histogram Matching.

(2) Derive the mathematical formulation of Histogram Matching.

Ans.:

Let,

r = intensity levels of the input image

z = " " " " ~~de~~ output (processed) image

$P_r(r)$ = PDF of input image

$P_z(z)$ = ~~PDF of~~ specified PDF that we wish the output image to ~~have~~ have.

Let s be a random variable with the property,

$$s = T(r) = (L-1)\int_0^r P_r(\omega)\,d\omega \quad \text{——} (i)$$

where ω is dummy variable of integration.

Defining a function G on variable z with the property,

$$G(z) = (L-1)\int_0^z P_z(v)\,dv = s \quad \text{——} (ii)$$

where v is a dummy variable of integration.

Now, $G(z) = s = T(r)$

$$\therefore z = G^{-1}(s) = G^{-1}\left[T(r)\right]$$

In case of discrete forms, we work with histograms instead of PDFs.

The discrete formulation of Eq (i) is,

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} P_r(r_j) \quad ; k = 0, 1, 2, \ldots, L-1$$

Similarly, given a specific value of s_k, the transformation function is,

$$G(z_q) = (L-1)\sum_{i=0}^{q} P_z(z_i)$$

For a value of q, so that,

$$G(z_q) = s_k$$

$$\therefore \boxed{z_q = G^{-1}(s_k)}$$

(3) Comparison of histogram equalization and histogram matching.

Ans:

Comparison	Histogram Equalization	Histogram Matching
Definition	(i) It is a process used to enhance the contrast of an image by redistributing the intensity values of the pixels of the image.	(i) It is a process used to match the histogram of an input image to a specified histogram.
Advantages	(ii) Transforms the original image's histogram to a new approximately uniform histogram.	(ii) Finds a mapping function that transforms the original image's histogram to a specified histogram.
	(iii) It is simpler and faster for all type of images.	(iii) Suitable for correcting illumination, enhancing visual quality and making two images have similar contrast.
Dis-advantages	(iv) Images may look artificial or unnatural. (v) May amplify the noise in the image. (vi) It may lose some details from the image.	(iv) Computationally expensive. (v) Requires prior knowledge of the target histogram. (vi) More complex process. (vii) May sometimes produce unsatisfactory result.

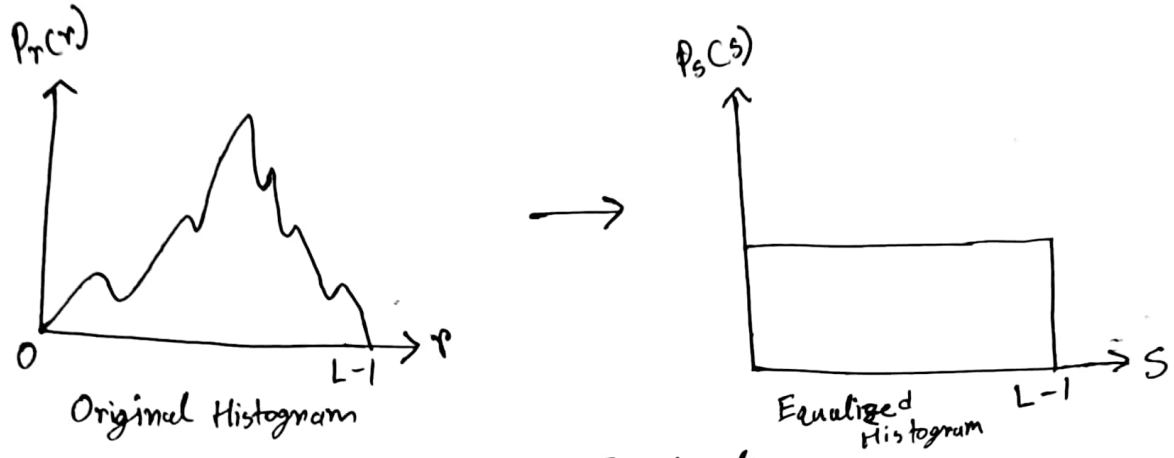

Fig. : Histogram Equalization.

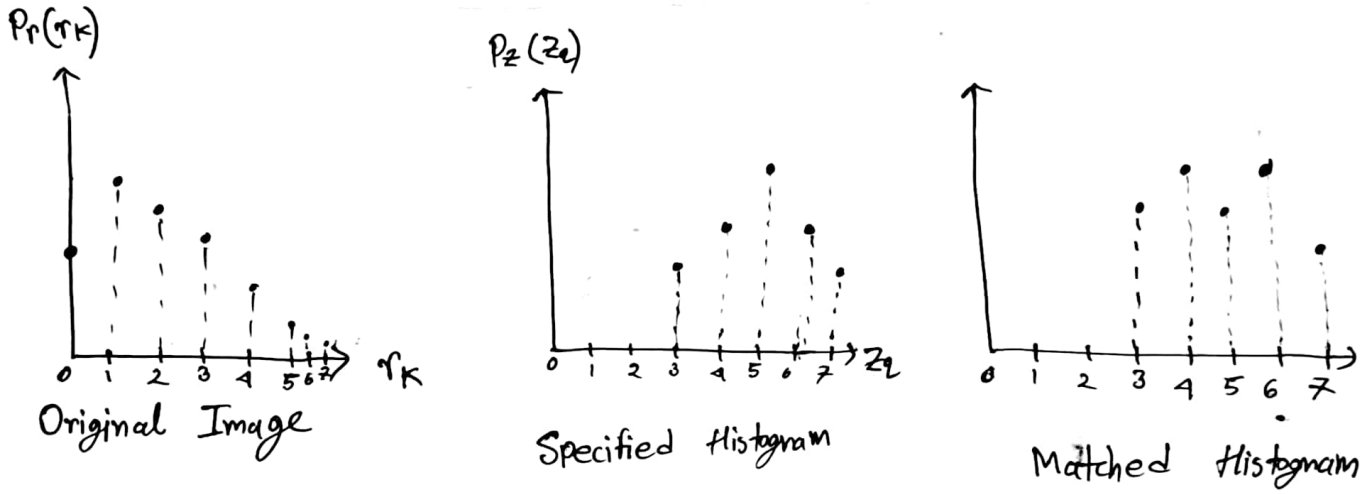

Fig : Histogram Matching.

④ How does Histogram Matching overcome the limitation of Histogram Equalization?

Ans.:

The process of histogram equalization spreads an image's intensity values over the range of possible ~~values~~ intensity values. Although it is done to improve contrast but sometimes it may not give satisfactory result. Applying equalization will produce a very high contrast image, if ~~the~~ an image's intensity values fall within a small range. As a result, the image appears artificial and unnatural. Moreover, losing significant features may follow from this.

In Histogram Matching, ~~we ta~~ a reference image with a desired contrast is taken, and a transformation function is generated using which ~~to~~ the input image's histogram can be matched with the ~~output imag~~ reference image's histogram. Thus, this technique have more control

over the output image. The natural appearance as well as crucial details like edges and texture can be preserved in this way.

This is how histogram matching overcomes the problem of histogram equelization.