CS 663 : Digital Image Processing

Assignment 1

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Question 3

a) We have a non-discrete image I(x) with a continuous domain and real-valued intensities within [0,1]. Since the images have a continuous domain, we will get a uniform distribution over intensities [0,1] on histogram equalisation.
Here the histogram is divided into two intervals, both of which are continuous. Therefore, h_1(I) and h_2(I) on histogram equalisation will give uniform distributions over the domains [0, a] and (a,1] respectively.

Mass of h_1(I) in the given histogram = α ⇒ Mass of h_2(I) in the given histogram = $1 - \alpha$

It is given that the mass of h_1(I) and h_2(I) is conserved after transformation. We also know that the transformation is done on the respective intervals.

Therefore, for the interval [0,a] , the resulting uniform histogram has $P(I) = \frac{\alpha}{a}$ since

$$P(I) * (a - 0) = \alpha$$

Similarly for the interval (a,1] , the resulting uniform histogram has $P(I) = \frac{1-\alpha}{1-a}$ since

$$P(I) * (1 - a) = 1 - \alpha$$

Mean Intensity is given by $E(I) = \int_0^1 I\,P(I)\,dI = \int_0^a I\,P(I)\,dI + \int_a^1 I\,P(I)\,dI$

$$= \frac{\alpha}{a}\int_0^a I\,dI + \frac{1-\alpha}{1-a}\int_a^1 I\,dI$$

$$= \frac{\alpha}{a}\,\frac{a^2}{2} + \frac{1-\alpha}{1-a}\,\frac{1-a^2}{2}$$

$$= \frac{1+a-\alpha}{2}$$

b) Given a is the median intensity.

Therefore a *is s.t.* $P(0 < x < a) = P(a < x < 1)$ *i.e.* $\alpha = 1/2 = 0.5$

Mean of the original distribution is also = a

Mean Intensity of resulting histogram = $\frac{1+a-0.5}{2} = \frac{0.5+a}{2}$

c) As seen above, the mean Intensity achieved by bi-histogram equalisation is close to the original mean brightness of the image ('**a'** in the case given above) whereas on global histogram equalisation the mean intensity tends to be close to the middle of the given intensity scale (0.5 in this case).

Thus bi-histogram equalisation will do a better job in scenarios where we expect the brightness of the final image to be close to the original image while still bringing out the details. For example, in the case of electronic applications, we want to preserve the original brightness in order to avoid unnecessary enhancement and artefacts.

d)

Original Image Histogram Equalised Bihistogram Equalised

As observed above both Histogram equalised and bi-histogram equalised give greater insight into the details of the image as compared to the original. However, as expected the brightness/mean intensity of the histogram equalised is close to grey that is middle intensity of the grayscale. However, the Bi-histogram equalised image has mean intensity closer to the original image that is more on the dark side.

References -

Bi-Histogram Equalization with Brightness Preservation Using Contras Enhancement

Preserving brightness inhistogram equalizationbased contrast enhancement techniques