NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

School of Electronic Engineering and Computer Sciences

Digital Image Processing (EE 433)

ASSIGNMENT # 1

SUBMITTED TO:

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SUBMITTED BY:

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Question: 01:

A) Data:

No. Of bits for data in a single packet = 8 bits

Total size of the packet = 10 bits

Image Dimensions: 1024 x 1024

Modem speed = 56Kbits per second

No. Of bits to represent 256 gray levels = 8 (2^8 = 256)

Required:

Total minutes to transfer the image =?

Solution:

It is given that we need 2 extra bits for every 8 bit of image data to form a single packet. These extra bits are the indication to the network for the starting and ending of the packet. There are 256 gray levels which can be represented by 8 bit and for every 8-bit 2 bits extra are required. We must multiply the number of pixels with the 10 to get the total number of bits that will be transferred over the network. After that, we must divide total bits with throughput to get the actual time.

Total bits = 1024 x 1024 x 10

= **10485760 bits**

Total Minutes = 10485760 / (56000)

= **187.245 seconds**

= **3.12 minutes**

B) Data:

No. Of bits for data in a single packet = 8 bits

Total size of the packet = 10 bits

Image Dimensions: 1024 x 1024

Modem speed = 750Kbits per second

No. Of bits to represent 256 gray levels = 8 (2^8 = 256)

Required:

Total minutes to transfer the image =?

Solution:

Total bits = 1024 x 1024 x 10

= **10485760 bits**

Total Minutes = 10485760 / (750000)

= 13.98 seconds

= 0.23 minutes

Question: 2(a)

$$s_k = T(r_k) = \int_0^r p_w(w)dw$$

ds / dr = dT(r) / dr

ds / dr = d $[\int_0^r p_w(w)dw]$ **/ dr**

By Leibnitz rule that derivative of integral (definite) w.r.t its upper limit is simply integrand evaluated at limit

ds / dr = $\mathbf{p_r(r)}$ **….(1)**

A basic result from an elementary probability theory is that if $p_r(r)$ and T(r) are known and inverse satisfies the condition of being single valued and monotonically increasing then PDF $p_s(s)$ can be achieved through following formula

$\mathbf{p_s(s) = p_r(r)\,|dr / ds|}$ **…(2)**

from (1), we have dr / ds = 1/ $p_r(r)$, putting this value in (2), we will get:

$\mathbf{p_s(s) = p_r(r)\,|1 / p_r(r)|}$ **….(3)**

So, we get: $\mathbf{p_s(s) = 1}$**.**

Because $p_s(s)$ is a PDF and it will be zero outside the interval of [0,1] and its integral over all values of s must be 1. We can say that $\mathbf{p_s(s)}$ in (3) is uniform probability density function.

Question: 2(b)

Discrete histogram approximates the continuous probability density function and no new intensity levels are created in this process. In discrete version there is no probability distribution function. There is the summation of discrete probability. By doing so (summation), we basically spread the histogram through the whole range of gray level. We basically use the discrete sum to approximate the continuous integral of cumulative probability distribution function of pixels.

In continuous domain, there are infinite values between any interval. In case of digital images, histogram is discrete and have fixed range of values. When this range is elongated, the number of values is maintained. Discrete equalization simply reassigns or reallocates one intensity with other and does not distribute this intensity. It simply means that the pixels having equal intensity values will have equal intensity values after discrete histogram equalization.

Question: 3

In case of discrete values, i.e. CDF, only an approximation to the desired histogram can be achieved. As we know that discrete version of continuous transformation is given by the following mathematical equation. The following equation is a mapping from gray levels of original image to corresponding levels s_k based on original image's histogram.

$$s_k = T(r_k) = \sum_{j=0}^{k} p_r(r_j) \qquad k = [0, L-1]$$

$$= \sum_{j=0}^{k} \frac{n_j}{n} \qquad \text{...(a)}$$

in above summation, *n* represent the total number of pixels while $n_j$represents the number of pixels having gray level r_j. The following equation also computes the transformation function G from the give histogram $p_z(z)$.

$$V_k = G(z_k) = \sum_{i=0}^{k} p_z(z_i) = s_k \qquad k, i = [0, L-1] \qquad \textbf{...}\text{(b)}$$

The following equation is the basis for implementing the histogram matching for the digital images:

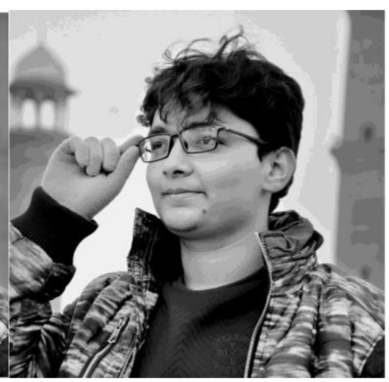
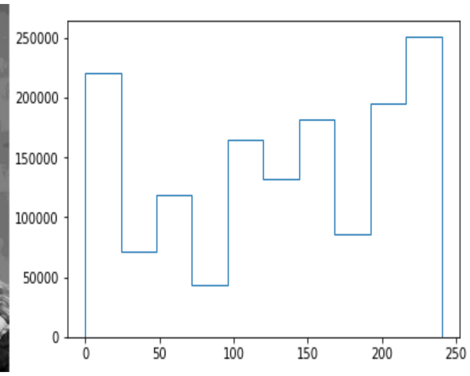
$$z_k = G^{-1}[T(r_k)] \qquad \text{...(d)}$$

The above equation gives us an approximation of desired levels of image with that histogram. Equation **(b)** which computes the transformation function will be used in histogram matching. For any value of z this transformation yields corresponding value of v. Finding the value of z is the objective of histogram matching so we are going to use some iterative method to find it as we are dealing with integers it will be easy. From (b) we know that $\mathbf{G(z_k)-s_k=0}$. This is the same thing as equation **(d) except** that we do not have to find the inverse of G because we are going to find z iteratively. Since we are dealing with integers, the closest we can get to satisfy $\mathbf{G(z_k)-s_k=0}$ is to take smallest value of z from [0, L-1] such that $\mathbf{G(z_k)-s_k >=0}$. This is how we find the inverse transformation function of histogram equalization.

Question: 4(a)

We know that the rightmost bit or least significant bit is responsible for the odd numbers. By setting lower bits to 0 we ensure that there is no odd intensity level. We are setting lower 4 bits to 0. The sum of lower 4 bits is 16. It means that setting lower bits to zero punishes the histogram by 16 at max. In this case the histogram will be slightly shifted to the right and there will be a slight decrease in intensities of the pixel and as a result frequency of darker colors will be slightly increased. But if there is some image whose intensities lies in range of [0,15] by setting lower bit to 0 the resultant image will be black color. For example, in 8-bit slicing if intensity is 00001110 which 14, by setting lower bits to 0 we will have intensity of 0 for the resultant image. But if in 8-bit slicing if intensity is 10110110 which is 182 by setting lower bits to zero, we will have intensity of 176 for the resultant image. In this case intensities will be slightly disturbed.

In second image lower bit are set zero, you can see the blurrness in second image.

Question: 4(b)

We know that leftmost bit contributes most to the resultant value of the intensity. If we are going to set higher order bits to 0, this will greatly decrease the intensity values especially for higher intensities' pixels. The histogram in this case will be shifted to extreme left. Setting higher bits to 0 is basically going to reduce the gray level of the pictures. Suppose in 8-bit slicing if intensity is 11110110 which is 246 setting higher 4 bits to 0, we will have intensity 6. Setting higher 4 bits to 0 is as if there are 16 gray levels in the resultant image. The details of the picture will be diminished. If there are pictures whose pixel intensities are greater than 240, then setting higher 4 bits to zero will completely the darken the initially bright pictures.

In second image the higher bits are set one and you can see that image has almost blacken but little details are still visible.