Computer vision
Assignment 1
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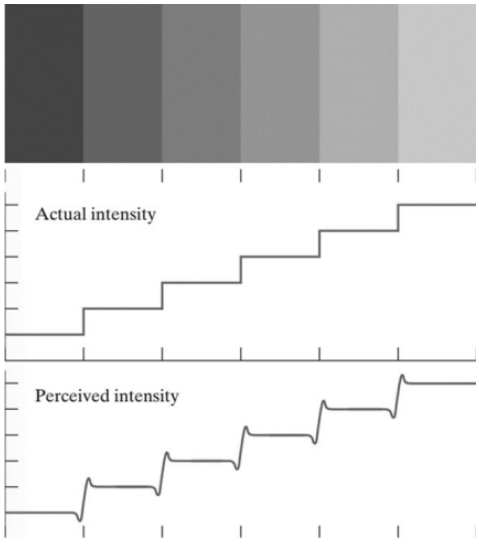
1.

Luminance refers to the amount of light passed through or reflected from a surface (the angle of light beam is also important) which is quantifiable and measurable. On the other hand brightness refers to the subjective perception of how bright or dim a surface or a place is , this means it's not measurable and also not equal to luminance but there exists a way to find their relation.
Illuminance is the definition that connects luminance to brightness.
Illuminance refers to the amount of light that falls onto a specific surface or area.
This image tries to illustrate the human perception of different colors and the actual intensity of the colors .First image from the top shows 6 different colors decreasing their intensity from right to left and this decreasing pattern shown in the second plot from the top but third plot defines what is actually perceived by human eyes.



It means if we actually have two different colors in two different regions that are evenly distributed ,human perception of the brink in between these two regions is just like the second image on the bottom which indicates the brink has higher intensity over its surroundings. It refers to differences in human perception of colors and the actual color it has just like the difference in brightness and the actual luminance .

2.

a) **K** = 1 - (251/255)/0.98 = 0.02 , **C** = 1 - (251/255)/0.98 = 0 , **M** = 1 - (151/255)/0.98 = 0.4
Y = 1 - (51/255)/0.98 = 0.8

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.274 & -0.322 \\ 0.211 & -0.523 & 0.312 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

b) Using this : Y = 0.665, I=0.36 , Q= -0.039

c) Y=162, Cb=69, Cr= 179

d) Color spaces :

CMYK : subtractive color model unlike RGB .This color space used in color printing because its idea is just like adding inks together to filter every color but that specific ink color, so by having different colors like cyan, magenta and yellow it is possible to create most of the colors that are in the RGB color space but there exist a drawback which is CMYK is unable to have brighter colors that are in RGB color space because of the subtractive nature it has. RGB to CMYK transformation can be found in this link
As I said, it's the right choice for color printing and painting. So for situations which need ink or any type of painting it's better to use CMYK because the observable data in the computer in this color format is much closer to what is going to be printed (because of its subtractive nature).

YIQ : Because of the TV system this color space is created to transfer needed data with data needed to be transferred and also smaller bandwidth .This color space distinguish luminance from chrominance and associate one channel to luma and two channels to chrominance .This color space like YCbCr extract luminance because of human visual perception , human visual perception is more sensitive to change in brightness rather than color ,Thus by using this color space that has smaller range of colors (chrominance) compared to RGB color space smaller bandwidth needs to be associated to channels of chrominance and higher bandwidth to luminance to provide cheaper cost of transformation. YIQ also takes advantage of human color response characteristics because the eye is more sensitive to changes in orange to blue (I) rather than changes in purple to green (Q) thus smaller bandwidth can be associated to transfer Q channel data compared to I channel data. In image processing histogram equalization applied to a channel in RGB color space can harm the color balance but in YIQ color space applying histogram equalization to a Y channel won't harm the color balance , it only equalizes the brightness of the image . In broadcasting like TV systems it's better to use YIQ because it needs smaller bandwidth compared to YCbCr because in YCbCr all channels have the same bandwidth in transformation Thus YIQ has lower transmission cost if the transmission cost is important otherwise for better quality YCbCr in broadcasting is much better to be used.

YCbCr : This color space has similar usage like YIQ for efficient storage and efficient transmission etc ,which also distinguishes luminance from chrominance like YIQ. Cb and Cr show blue difference and red difference correspondingly.This color model used in standard video compression standards like jpeg and mpeg. In data compression it is

3.

$p_r(r) = -2r + 2$, $p_z(z) = 2z$

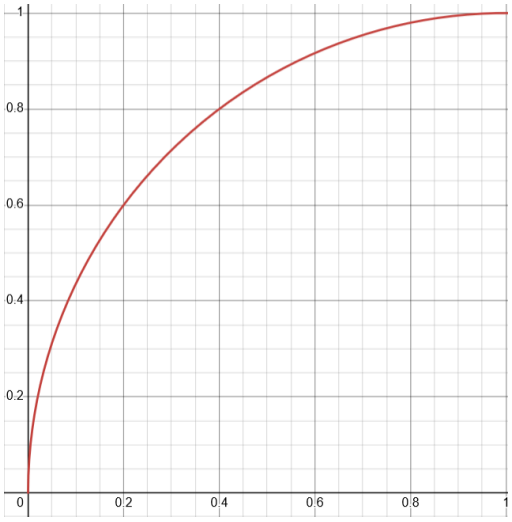
Now by finding their equalized version :

$$s = T(r) = \int_0^r -2w + 2\,dw = -r^2 + 2r \quad , v = G(z) = \int_0^z 2t\,dt = z^2$$

Now by finding inverse of G(z) and plugging it to T(r) which means $G^{-1}(T(r)) = z$ we would get almost the same histograms :

$$G^{-1}(T(r)) = \sqrt{-2r^2 + 2r}$$

Thus this is the final version of how it's mapping function would look like :



4.

a) Every step is one column in this table to get the final equalized version .

Color	scaled	count	PMF	CDF	s	Equalized
1	0.14	8	8/25	8/25	2.24	2
2	0.28	8	8/25	16/25	4.48	4
3	0.42	2	2/25	18/25	5.04	5
5	0.71	7	7/25	1	7	7

b)

First we gotta convert intensities to bit format :

001	010	001	001	001

010	101	011	101	010
010	101	101	101	010
010	101	011	101	010
001	001	001	010	001

And now we can slice each bit of all intensity into their own plane.

MSB

0	0	0	0	0
0	1	0	1	0
0	1	1	1	0
0	1	0	1	0
0	0	0	0	0

Middle

0	1	0	0	0
1	0	1	0	1
1	0	0	0	1
1	0	1	0	1
0	0	0	1	0

LSB

1	0	1	1	1
0	1	1	1	0
0	1	1	1	0
0	1	1	1	0
1	1	1	0	1

c)Stretched version :

0	2	0	0	0
2	7	4	7	2
2	7	7	7	2

2	7	4	7	2
0	0	0	2	0

References :

- https://wizlogo.com/rgb-to-cmyk