Tai Duc Nguyen - CS 435 - 04/10/2019

Assignment 1 Theory

Q1

Given a point in 3D space, (3,5,20) and an effective focal length of 10, where will this point appear on the 2D image plane?

Answer:

(x,y,z) = (3,5,20) f = 10 Hence, the (x,y) coordinate on the 2D image plane is:

$$(x_{2D}, y_{2D}) = \frac{f}{z_{3D}}(x_{3D}, y_{3D})$$

$$(x_{2D}, y_{2D}) = \frac{10}{20}(3, 5) = (1.5, 2.5)$$

Q2

If we have a focal length of 10 and a lens effective diameter of 5, what is the field of view of this camera system (in degrees)?

Answer:

Since:

$$tan\frac{\theta}{2} = \frac{D}{2f}$$

Hence:

$$tan\frac{\theta}{2} = \frac{5}{2 * 10} = \frac{1}{4}$$

$$\frac{\theta}{2} = tan^{-1}(\frac{1}{4}) = 14.036^{\circ}$$

$$\theta = 2 * 14.036 = 28.072^{\circ}$$

Q3

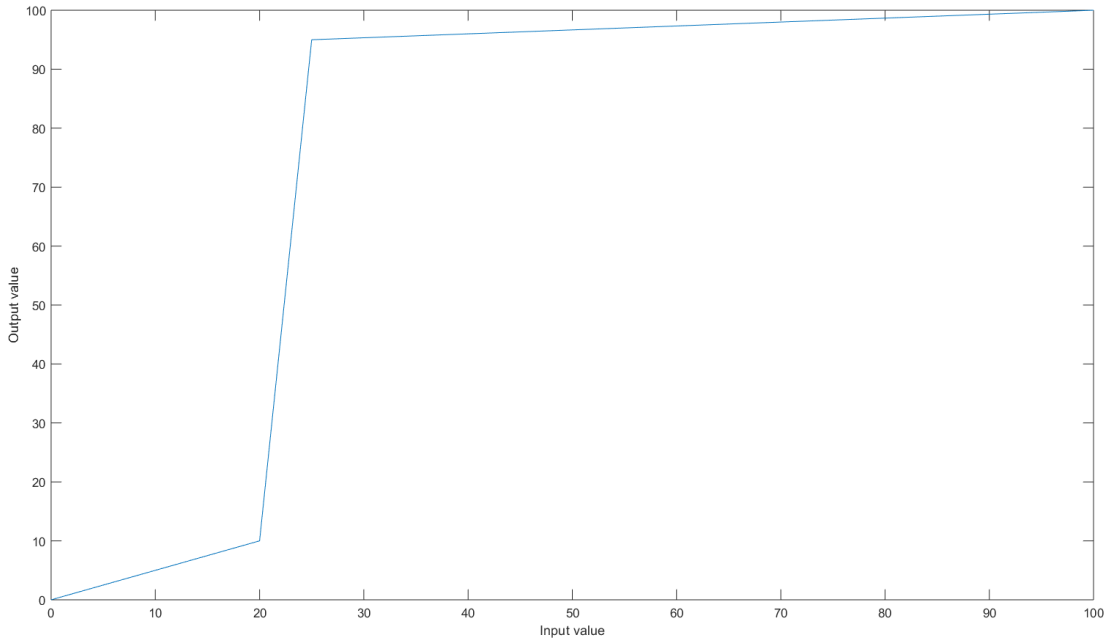
Based on observing a histogram perhaps we decided to create the following pixel intensity mappings in order to stretch the values of a particularly compressed area:

> [0,20] $\longrightarrow$ [0,10]
>
> (20,25] $\longrightarrow$ (10,95]
>
> (25,100) $\longrightarrow$ (95,100]

3a.

Draw a 2D graph showing these mappings. The x-axis will be the input values and the y-axis will be the output values.

Answer:



3b.

What are the equations for these mappings?

Answer:

Let us establish:

$$r1 = 0; s1 = 0; r2 = 20; s2 = 10; r3 = 25; s3 = 95; r4 = 100; s4 = 100;$$

Hence, we have the following mappings:

$$r_{new} = \begin{cases} (r - r1) * \frac{s2 - s1}{r2 - r1} + s1, r \in [r1, r2] \\ (r - r2) * \frac{s3 - s2}{r3 - r2} + s2, r \in (r2, r3] \\ (r - r3) * \frac{s4 - s3}{r4 - r3} + s3, r \in (r3, r4) \end{cases}$$

3c.

Given a value of 50, what will this value be mapped to?

Answer:

Since 50 is between 25 and 100,

$$r_{new} = (r - r3) * \frac{s4 - s3}{r4 - r3} + s3$$

$$r_{new} = (50 - 25) * \frac{100 - 95}{100 - 25} + 95 = 25 * \frac{5}{75} + 95$$

$$r_{new} = \frac{5}{3} + 95 = 96.67$$

Assignment 1 Programming

Original image

Grayscaled image

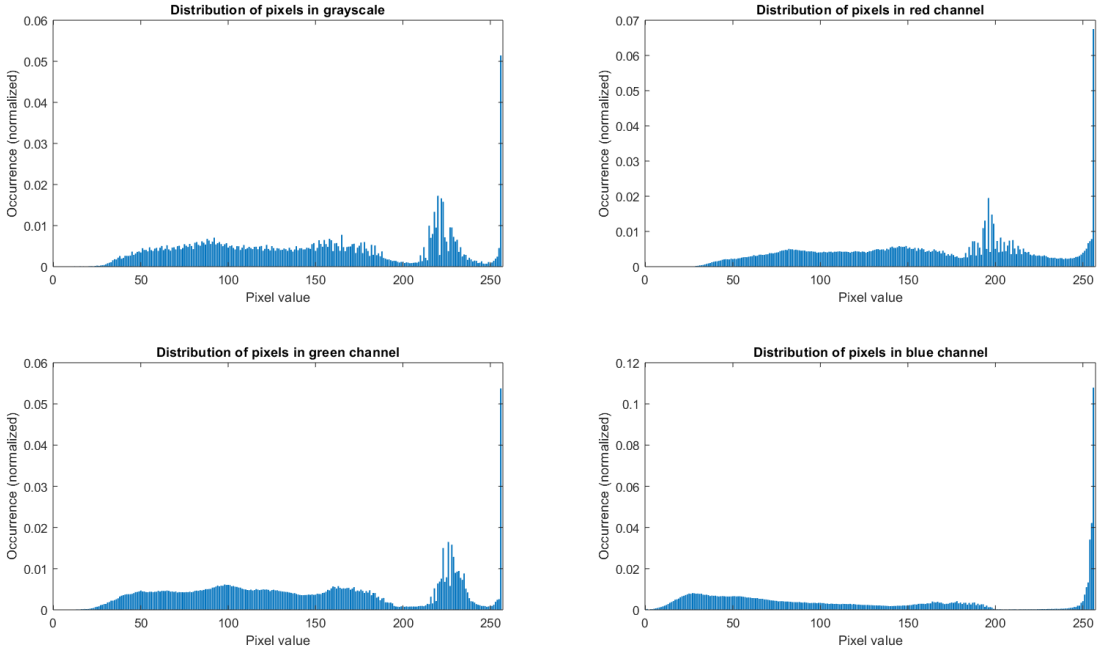
Binary images

25%

50%

75%

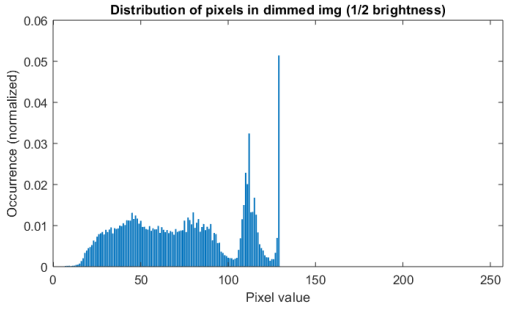
Histograms

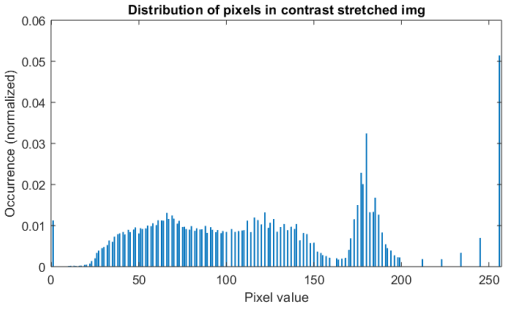


Contrast stretching

Looking at the distribution of pixel values in the dimmed image, there are potentially 4 peaks, which situated in between: [0, 68], (68, 100], (100, 123], (123, 129]. Since the image is dark, we apply contrast stretching so that the image appear lighter and less blurry

> [0, 68] $\longrightarrow$ [0,100]
>
> (68, 100] $\longrightarrow$ (100,160]
>
> (100, 123) $\longrightarrow$ (160, 200]
>
> (123, 129] $\longrightarrow$ (200, 255]


Distribution of pixels in dimmed img (1/2 brightness)
Occurrence (normalized)
Pixel value
0
0.01
0.02
0.03
0.04
0.05
0.06
0
50
100
150
200
250


Distribution of pixels in contrast stretched img
Occurrence (normalized)
Pixel value
0
0.01
0.02
0.03
0.04
0.05
0.06
0
50
100
150
200
250


Dimmed image


Contrast stretched image