ASSIGNMENT 1

Image Processing and Application - 9804

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Answer to the question no. 1

We know,

$$\frac{X}{Z} = \frac{x}{f}$$

Where, X = target size,
Z = distance from the lens
x = height of CCD array
f = distance between pinhole and CCD

$$\frac{X}{500mm} = \frac{7mm}{35mm}$$

$$X = 100mm$$

So the target size = 100mm on the size.
Given that we have total of 1024 elements per line, so the resolution of 1 line will be:

$$\frac{1024}{100} \approx 10\ elements \text{ / mm}$$

For line pairs, we divide by 2. We get, $\frac{10}{2} = 5$ line pairs / mm.
Therefore, the number of line pairs per mm is 5-line pairs / mm.

Answer to the question no. 2

Given, Affine transformation matrix, $A = \begin{bmatrix} 0.25 & 0.433 & 0 \\ -0.2598 & 0.15 & 0 \\ 50 & 75 & 1 \end{bmatrix}$

Without homogeneous coordinates we can write,

$$\begin{bmatrix} s_x cos\theta & s_y cos\theta \\ -s_x sin\theta & s_y cos\theta \\ x_c & y_c \end{bmatrix}$$

Where, x_c = translation in x axis
y_c = translation in y axis
s_x = scaling in x axis
s_y = scaling in x axis
θ = angle of rotation

angle of rotation,

$$\theta = \frac{0.15}{\sqrt{0.2598^2 + 0.15^2}}$$

$$\theta = \frac{0.15}{\sqrt{0.8999604}} = \frac{0.15}{0.3} = 0.5$$

Scaling in x-axis,

$$s_x = \sqrt{0.25^2 + 0.433^2} = 0.5$$

Scaling in y-axis,

$$s_y = \sqrt{0.2598^2 + 0.15^2} = 0.3$$

Answer to the question no. 3

Obtaining the transformation function T(r)

As we know,

$$
\begin{aligned}
s &= \mathrm{T}(\mathrm{r}) \\
&= \int_0^r p_r(w)dw \\
&= \int_0^r (-2w+2)dw \\
&= -r^2 + 2r
\end{aligned}
$$

Obtaining the transformation function G(z)

$$v = \mathrm{G}(z) = \int_0^z p_z(w)dw = \int_0^z 2wdw = z^2$$

Obtaining the transformation function G^{-1}

$z = G^{-1}(v) = \pm\sqrt{v},$

$so, z = +\sqrt{v}$

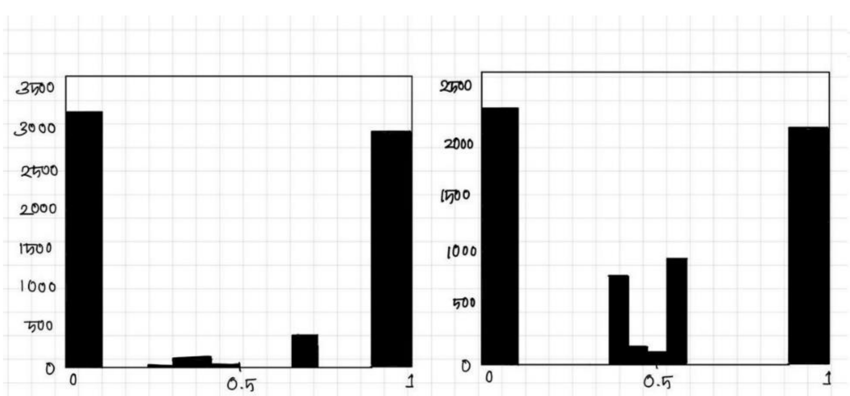
$z = \sqrt{2r - r^2}$

Therefore, we can say that $0 \leq z \leq 1$ when $0 \leq r \leq 1$

Answer to the question no: 4

a) The boundary points number between the black and white regions is larger in the image on the right. When the images are blurred with a 3×3 averaging mask, the boundary points will increase to a larger number of different values for the image on the right, that why the histograms of the two blurred images will be different.

b) Assume the image size is N x N, with the surrounded border of 0s. Blurring the image with a 3x3 averaging mask coefficient is 1/9. A larger N would result in a more significant number of 0/255 in the output histogram, where smaller N would result in a lower value. But we have to sure that the summation is equal to N x N.
If we consider the image as 80 x 80 and the black as 0 pixel and white as 1 pixel. The histogram can be plotted as:



Answer to the question no: 5

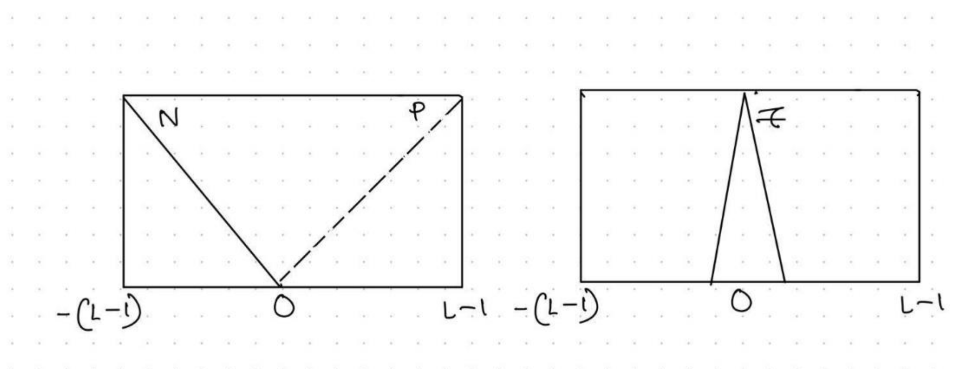
a)

If center pixel depth is > depth of all the neighbors, then it will reduce the center pixel's depth.
Similarly, if center pixel depth < depth of all neighbors then it will increase the depth of the center pixel.
For Z, it the pixel value will be unchanged which is V = 0 and z' = z.

b)
The IF-THEN rules are:

Using notation for positive as P, negative as N and zero as Z.
IF d_2 is P AND d_4 is P AND d_6 is P AND d_8 is P THEN v is P
IF d_2 is N AND d_4 is N AND d_6 is N AND d_8 is N THEN v is negative
ELSE v is *zero*

c) The values of d_i is from –(L-1) to (L-1)
Here, we can use the triangular membership functions for P, N and Z. So, we can find the membership functions are:



d) graphical representation of the rule set: