***Answer the following questions:***

***Question (1)*** ***please make a table of two columns, one for the question no. and the other for your selection***

1) *The process of moving a filter mask over the image and computing the sum of products at each location is defined by_____________*
   *a) Convolution b) Rotation c) Linearity d)* ***Correlation*** *e) None of the above*
2) *The sum of all components of a normalised histogram is equal to_________*
   *a)Size of the image b) Size of rows of the image c) Size of columns of the image d)* ***One*** *e) MxN*
3) *Image restoration usually uses a model that is based on ____*
   *a)* ***Additive noise*** *b) Multiplicative noise c) Division noise d) Subtractive noise*
   *e) None of the above*
4) *Convolution is usually used in the ________ domain.*
   *a) Frequency b)* ***Spatial*** *c) Feature d) Featureless e) None of the above*
5) *Fourier transform is a ________________ transform*
   *a)* ***Linear*** *b) Nonlinear c) Bilinear d) Bicubic e) None of the above*
6) *Ideal filters can be ____________*
   *a) LPF b) HPF c) BPF d)* ***All of the above*** *e) None of the above*
7) *The Rayleigh density can be used to approximate ______*
   *a) Ideal histograms b) Non-Ideal histograms c) Butterworth histograms d) Gaussian histograms*
   *e)* ***Skewed histograms***
8) *Which of the following filters is effective in the presence of salt-and-pepper noise?*
   *a) Average filter b)* ***Median filter*** *c) Sobel filter d) Robert filter e) All of the above*
9) *____________ is the process of using known data to estimate values at unknown locations .*
   *a) Decimation b)* ***Interpolation*** *c) Formulation d) All of the above e) None of the above*
10) *An image element is usually called a _____________*
   *a)* ***Pixel*** *b)f(x,y) c) picture point d) All of the above e) None of the above*

***Question (2)***

a) *For the image shown in Fig. 2(a), find a transformation function (i.e. a look-up-table) that will change its histogram to match the one shown in Table 1. Draw the transformed image in Fig. 2(b). Also determine the histogram of the transformed image. Assume that the processed images can only take integer values between 0 and 7 (including 0 and 7).*

b) *Briefly explain the operation of the Alpha-trimmed mean filter. What are its uses for image processing?*

where the value of $d$ can range from 0 to $mn - 1$. When $d = 0$, the alpha-trimmed filter reduces to the arithmetic mean filter discussed in the previous section. If we choose $d = (mn - 1)/2$, the filter becomes a median filter. For other values of $d$, the alpha-trimmed filter is useful in situations involving multiple types of noise, such as a combination of salt-and-pepper and Gaussian noise.

**Alpha-trimmed mean filter**

Suppose that we delete the $d/2$ lowest and the $d/2$ highest gray-level values of $g(s, t)$ in the neighborhood $S_{xy}$. Let $g_r(s, t)$ represent the remaining $mn - d$ pixels. A filter formed by averaging these remaining pixels is called an *alpha-trimmed mean* filter:

$$\hat{f}(x, y) = \frac{1}{mn - d} \sum_{(s,t) \in S_{xy}} g_r(s, t)$$

***Question (3)***

*a)*

$$\text{Sobel operators: } H_x = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}; \quad H_y = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

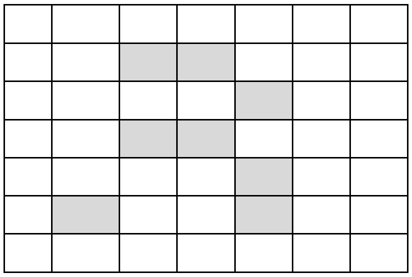
*For every pixel: 1) compute vertical gradient gx by convolving with Hx, 1) compute horizontal gradient gy by convolving with Hy, 3) find the gradient magnitude using A= sqrt(gx^2+gy^2). 4) if A>=T, this pixel is* an edge, otherwise, it is not an edge.

*b) Write a MATLAB function that will implement these steps in (a). Assuming the image size is W (width) x H (height). Also you can ignore the boundary problem by performing edge detection only on non-boundary pixels.*

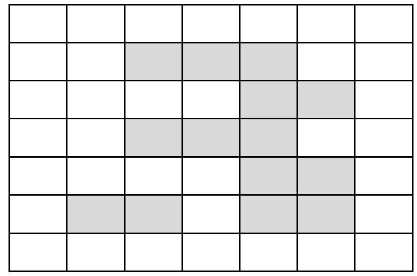
***Question (4)***

*a) For regular (global) thresholding you find threshold value or values for the entire image. In adaptive thresholding the image id divided into part, usually square, and threshold levels are found for each separate part. Global thresholding is useful when you want the image is similar in most parts. Adaptive thresholding is very useful when the image is changing in intensity, e.g., because of a light source from the right side. Then the threshold values should be quite different on the left and right side of the image.*

*b) the opening of the binary image, F,*



$F \ominus H$



$(F \ominus H) \oplus H$

*c)*

b) Stage A

$A_1 = Zmed - Zmin$

$A_2 = Zmed - Zmax$

if $A_1 > 0$ and $A_2 < 0$

go to Stage B

else increase window size

if window size $\leq Sxy$ repeat Stage A

Else output Zmed

Stage B

$B_1 = Zxy - Zmin$

$B_2 = Zxy - Zmax$

if $B_1 > 0$ and $B_2 < 0$

output Zxy

else output Zmed

To get $\underline{\underline{Z}}$

First with Filter of 3x3  0000[0]4577

zmin = 0  zmax = 7  Zmed = 0

$A_1 = 0$  $A_2 = -7$  $(A_1 > 0$ & $A_2 < 0) \Rightarrow$ False

increase window size 5x5

00000 00003 33[3]33 33444 45677

Zmin = 0  Zmax = 7  Zmed = 3  Zxy = 0

$A_1 = 3$  $A_2 = -4$  $A_1 > 0$ & $A_2 < 0$

$B_1 = 0 - 0 = 0$  $B_2 = -7$  $B_1 > 0$ & $B_2 < 0$ False

output [Z med = 3]  [Z = 3]

To get X → First with Filter 3x5

000 3[4]5677

min  med  max

$A_1 = 4$  $A_2 = -3$  $Zxy = 7$

Stage B ⇒ $B_1 = 7$  $B_2 = 0$

output Zmed = 4  [X = 4]

To get y → First with mask 3x3

0 0 0 3 [3] 4 6 7 7

$Z_{min}$ $Z_{med}$ $Z_{max}$

$A_1 = 3$ $A_2 = -4$ $A_1 > 0$ & $A_2 < 0$ → True

B ⇒ $Z_{xy} = 0$

$B_1 = 0$ $B_2 = -7$ $B_1 > 0$ & $B_2 < 0$ → false

output $Z_{med} = 3$ **y = 3**

***Question (5)***

A) Redundancies Types

a) Coding Redundancy.

*Let's assume, that a discrete random variable rK in the interval [0 , 1] represents the gray levels of an image and each rK occurs with probability Where L is the number gray levels , nK is the number of times that the Kth gray level appears in image . n is the total number of pixel in the image . The average length of the code words assigned to the various gray level values where l(rk) no.of bits used to represent each gray pr(rk) probability that gray level occurs*

b) Spatial and Temporal Redundancy.

i.e. Video sequence (Correlated pixels are not repeated.)

c) Irrelevant Information.

Information that ignored by human visual system

*b)*

**Coding efficiency and Huffman coding**

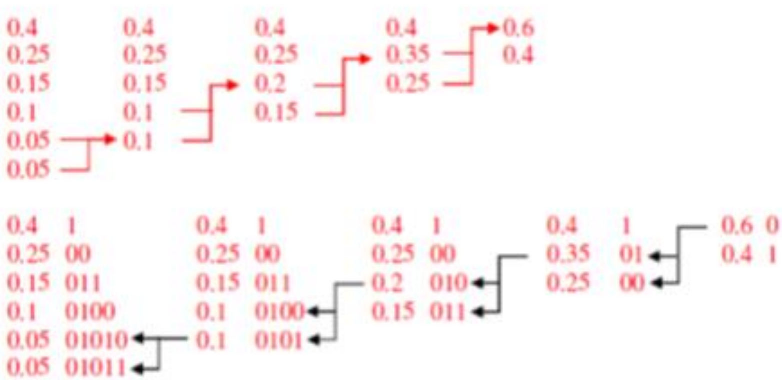
You have a source with 6 symbols $\{a_1, a_2, a_3, a_4, a_5, a_6\}$.

The probability for each symbol is z=[0,15 0,25 0,05 0,05 0,4 0,1].

a) Calculate the entropy of the source.

$H(z) = -(0,15 \cdot \log_2(0,15) + 0,25 \cdot \log_2(0,25) + 0,05 \cdot \log_2(0,05) + 0,05 \cdot \log_2(0,05) + 0,4 \cdot \log_2(0,4) + 0,1 \cdot \log_2(0,1)) = 2,20$

b) Create a Huffman code for the source.




Code = [011 00 01010 01011 1 0100]

***GOOD LUCK***

c) Calculate the average word length of the source.

0.4*1+0.25*2+0.15*3+0.1*4+0.05*5+0.05*5 = 2.25

d) Calculate the coding efficiency for the Huffman code.

$$100 \cdot \frac{2,20}{2,25} = 97,8\%$$