

Practice Questions

- Image thresholding is used to segment different objects from image. In local thresholding, the image is divided into different non overlapping sub images and threshold is calculated and applied on all images independently. You are given 6x6 gray scaled image (f). Divide this image into 4 non overlapping subimages (g_i) of size 3 x 3 each where $i = 0, 1, 2, 3$. Calculate threshold T_i for each subimage such that $T_i = 0.5 * (\max(g_i) - \min(g_i))$ and apply it on image to generate binary image.

10	98	121	78	63	180
15	80	110	83	105	170
60	87	152	30	62	165
15	210	150	45	48	73
71	105	85	57	59	75
78	10	175	51	53	5

- Morphological operations are applied on image to make any structural changes. Apply following equation on binary image created in first part. Here A is binary image, B is 3 x 3 structuring element given below. Assume that $X_0 = A^c$ and iterations will stop if $X_{k+1} = X_k$.

$$X_{k+1} = (X_k \ominus B) \cup A$$

0	1	1
0	1	0
0	1	0

- Consider the 5x5 image in the square with its x and y coordinates indicated on the top and left of the square respectively.

	0	1	2	3	4
0	50	100	100	100	50
1	100	50	200	150	100
2	100	200	30	200	100
3	100	150	200	50	100
4	50	150	150	100	50

Using a neighborhood of 3x3, compute the local threshold for the pixel at position (2,2), using the formula:

$$T = m - \min(I)$$

m = Mean value of the neighborhood, $\min(I)$ = minimum gray level in the image

4. Colored based image clustering is used to put pixels having similar color shades in one cluster. Suppose we want to convert the colored image given in figure-1 into three color clusters (C1, C2, C3). The centers for these clusters are given.

$$C1 = (210, 20, 45) \quad C2 = (45, 198, 15) \quad C3 = (21, 15, 183)$$

You are asked to place **pixels (1, 5) and (10,10)** of image given in figure-1 in one of these three clusters. Use K-means clustering and given cluster centers to solve this. **Assume that the first pixel in top left corner is (1,1).**

5. Thresholding is a basic step to convert a gray scaled image into a binary image using a specific threshold value. To find this threshold value is the most critical part. Assume that we have designed a basic algorithm to calculate adaptive threshold T. Algorithm for computing T is

1. Use initial threshold to put input image gray levels into two bins (classes)
2. Compute Global mean (M_G) for whole image, local means (m_1 and m_2) and scatters (S_1 and S_2) for both bins
3. Compute between class mean (M_B) and scatter (S_B) using $\text{abs}(m_1 - m_2)$ and $\text{abs}(S_1 - S_2)$
4. Compute new T using $T = M_B + S_B$
5. Repeat steps (1-4) to find such T which maximizes the product of M_B and S_B

You are given a 5x5 image in fig.3. Assume initial $T = 100$. Run one iteration of above mentioned algorithm to find T and draw binary image after first iteration. Show all steps of your processing.

10	70	110	78	115
210	45	51	51	65
209	245	187	71	35
10	195	205	199	201
10	191	15	55	65

6. A 5x5 gray scaled image is given in figure-1. This image contains a bright region on a relatively dark background. Apply following steps to extract that region properly **(2 + 7 + 3 = 12)**

191	110	115	207	171
159	90	207	206	179
155	210	175	145	210
147	205	177	192	191
160	165	192	191	90

Figure-1: Image for Q1

- a. Find a threshold T to convert this image into binary such that

$$T = \max(f(x,y)) - k * \min(f(x,y))$$

where $\max(f(x,y))$ and $\min(f(x,y))$ are maximum and minimum gray levels in image respectively and $k = 0.3$

- b. Use morphological region filling operation to fill gaps if present in binary objects obtained from **part a**
- c. Apply a proper morphological operation on **output of part b** with suitable structuring element to remove small objects while keeping only main bright region. Draw final output binary image

Edge detection algorithms are normally based on image gradient. You are given two 3x3 gradient images which are generated by applying horizontal (fig-2) and vertical (fig-3) sobel operators on same image.

-30	-150	30
-190	-450	190
-330	-450	330

-30	-190	-330
-150	-450	-450
30	190	330

Figure-2: Horizontal sobel output Figure-2: Vertical sobel output

- a. Use these gradient images to find out gradient magnitude image and generate a binary edge map by applying threshold on gradient magnitude image. The threshold is set in such a way that edges with top 25% gradient magnitude value are kept and rest all are ignored.
 - b. *K means clustering* is applied on gradient magnitude image which is generated in part a with $K = 2$ and centers of both clusters (C_A, C_B) are found. $C_A = 610$ and $C_B = 550$ are centers for cluster A and cluster B respectively. Cluster A consists of all corner pixels and cluster B contains all other pixels. Use these cluster centers and gradient magnitude image to find the location of corner pixels. Draw output binary image showing corner pixels with '1' and other pixels with '0'.
- 7. Differentiate the followings (Your answer should not be longer than 3 lines.)**
- a. Median filtering and adaptive median filtering
 - b. RGB color space and HSI color model