

Note: there are total 5 questions

1. Below you see a list of different image analysis operations and tasks that you should solve. Present in the tabular form the most appropriate (only one) operation/tool for each task (in reality one tool can fit many tasks and solving one task may need several tools):

Operation/Tool	Task
A. Non-local means algorithm	1. Register SPET- and MRI-images
B. Atlas-based segmentation	2. Detect lines
C. Fitting a polynomial to intensities	3. Register CT- and MRI-images
D. Hough-transformation	4. Remove intensity inhomogeneity from MRI
E. Harris operator	5. Corner point detection
F. Rigid registration using normalized mutual information	6. Segment sub-cortical structures (MRI-images)
G. Rigid registration using points	6. Segment sub-cortical structures from MRI-images
H. Watershed-segmentation	7. Remove noise from MRI-images
I. Segmentation using Markov Random Field model	8. Validate a segmentation method
J. PCA-based point distribution model	9. Measure if the shape of the heart is pathologic
K. Dice-index	10. Edge point detection
L. Canny operator	11. Segment brain tissue from MRI-images
	12. Count cells from microscopic images

2. Answer both:

a) Segment the following image using region growing when the biggest difference from the mean is $\epsilon=10$. Use the bold pixel (**92**) in the top-left corner as the seed.

92	83	80	85
85	85	77	69
75	99	62	59
71	65	62	54

b) Segmentation of medical images is challenging. Tell about different specific factors making segmentation challenging.

3. Answer to both:

The image contains a background and an object. The object area covers 30% from the whole image area. The intensity distribution of both classes can be approximated as a Gaussian distributions:

- Background class (mean 90; standard deviation 20)
- Object class (mean 30; standard deviation 30)

a) Sketch a rough histogram for the image and using the histogram determine optimal threshold for separating the background from the object. How did you choose the threshold?

- b) Calculate the optimal threshold according to Bayes Classifier between the background and the object.

4. Answer both

- a) Explain the general framework for intensity-based registration methods.
b) Below you will see two small (3x3) images, the reference (upper image) and the moving (lower image) image. Select only ONE: Correlation Coefficient, Mutual Information or Normalized Mutual Information and calculate the similarity/cost between these images using the selected cost/similarity.

Reference Image

0	1	0
1	2	3
2	3	3

Moving Image

0	2	0
1	3	2
2	2	3

5. You have developed a novel method for segmenting the right ventricle from cardiac MRI images. Describe how to validate the method.