Medical Image Computing

(MT-M-3-ILV-IM2)

Exercise 2

Start Date: 2.12.2021

Due Date: 21.12.2021

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0. General information

0.1. Report submission: Please add all authors of your group to the report. Group size: 2-3 students. Each author has to upload the full submission (report+code). The report must be attached in PDF form.
Please note: Feel free to switch groups during the semester.
0.2. Code submission: Please add a single compressed package containing all relevant code and data.
0.3. All relevant information can be found in the Sakai Course Site: https://sakai.mci4me.at/portal/site/Course-ID-SLVA-38757
0.4. In case of any questions please use the Sakai Forum, or e-mail to: marco.augustin@mci4me.at
0.5. Image data to use in the exercise is attached to the exercise specification in Sakai.
0.6. All built-in functions can be used from Matlab or Python libraries.
0.7. **Lecture slides:** "07_MIC_Features", "08_MIC_AI"
0.8. **Useful Matlab functions**: graycomatrix, graycoprops, blockproc, struct2array, reshape, permute, isnan, cat, kmeans, imresize
0.9. **Useful Python functions:** graycomatrix, graycoprops, append, KMeans
Python example in scikit-image:
https://scikit-image.org/docs/dev/auto_examples/features_detection/plot_glcm.html#sphx-glr-auto-examples-features-detection-plot-glcm-py

1. Image texture descriptors (5 points)

An image ("breastXray.tif") shall be loaded and texture features be extracted from non-overlapping blocks of 20 x 20 pixels. The gray-level co-occurrence matrix (GLCM) for each block shall be determined using a position operator at four different directions. Based on the GLCMs, four feature descriptors should be determined to construct a design matrix for the second part of the exercise.

1.1. Load the image "breastXray.tif". What is the original image size and hence how many blocks/regions are processed in the following steps?
1.2. Determine the gray level co-occurrence matrix (GLCM) for each region/block using a position operator $[D_x, D_y]$. Choose a distance, e.g. D = 1, and extract the GLCM at four different directions [0°, 45°, 90°, 135°]. The number of gray levels should be set to 16. What is the size of one GLCM?
1.3. Calculate the correlation, contrast, energy and homogeneity for each GLCM. Show processed images based on the descriptors, i.e. Correlation at four directions with D = 1, Contrast at four

directions with D =1, etc., using subplots (see Figure 1). How many features did you extract? Comment on the differences between the different texture descriptors.

1.4. Build a design matrix based on your blocks where each block/region is an observation (sample) and the texture descriptors are the features. What is the size of your design matrix?

1.5. *(BONUS, 1 extra point)* Try two different pixel distances D, e.g. 1 and 3, and show the processed images using subplots. Comment on the influence of the distance parameter. Decide for one of the two distances D to be used in the design matrix for the second part of the exercise.

2. Texture-based clustering (2 points)

2.1. Cluster the blocks represented by the design matrix using k-means clustering. Use k=4 and use at least 10 repeats for the initialization.

2.2. Visualize the blocks corresponding to the four different labels as an overlay to the original image, i.e. mask the original image with the labels found by the k-means algorithm. Which regions in the image were found? Describe the characteristics of the regions.

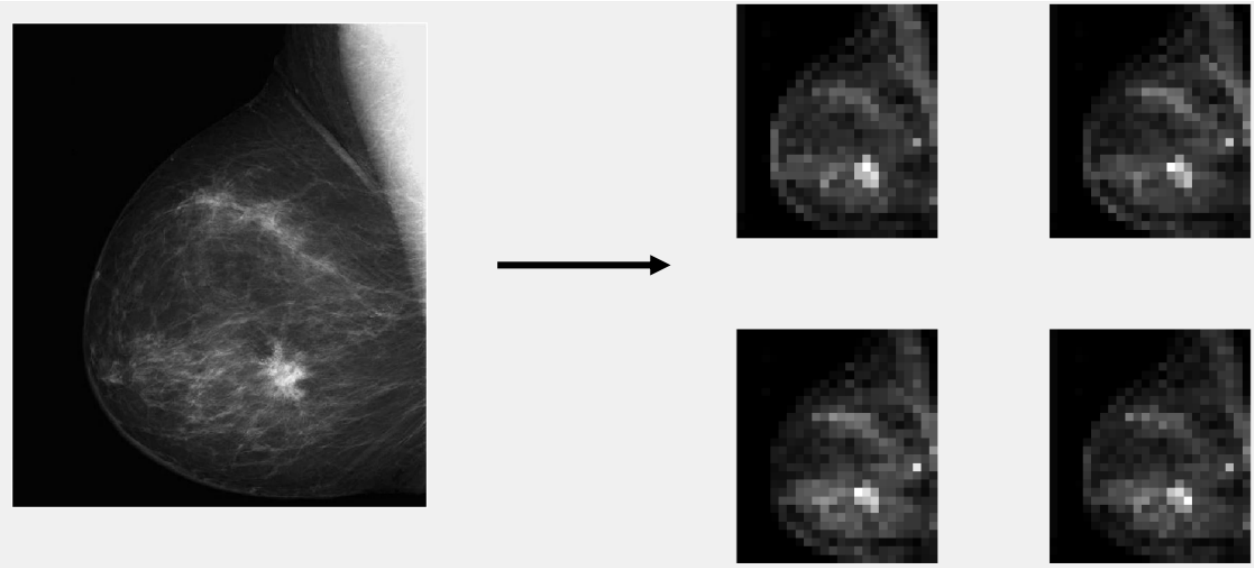

Figure 1 Visualization of the feature descriptor "Contrast" at four different angles/directions with D = 1.

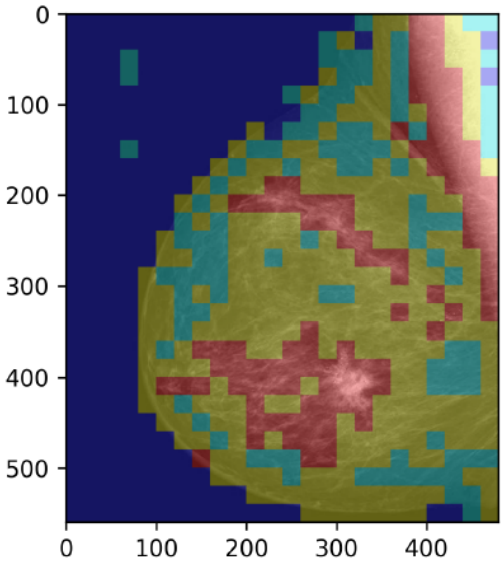

Figure 2 Visualization of texture-based clustering after k-means clustering