

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 $[0^\circ, 45^\circ, 90^\circ, 135^\circ]$. 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.

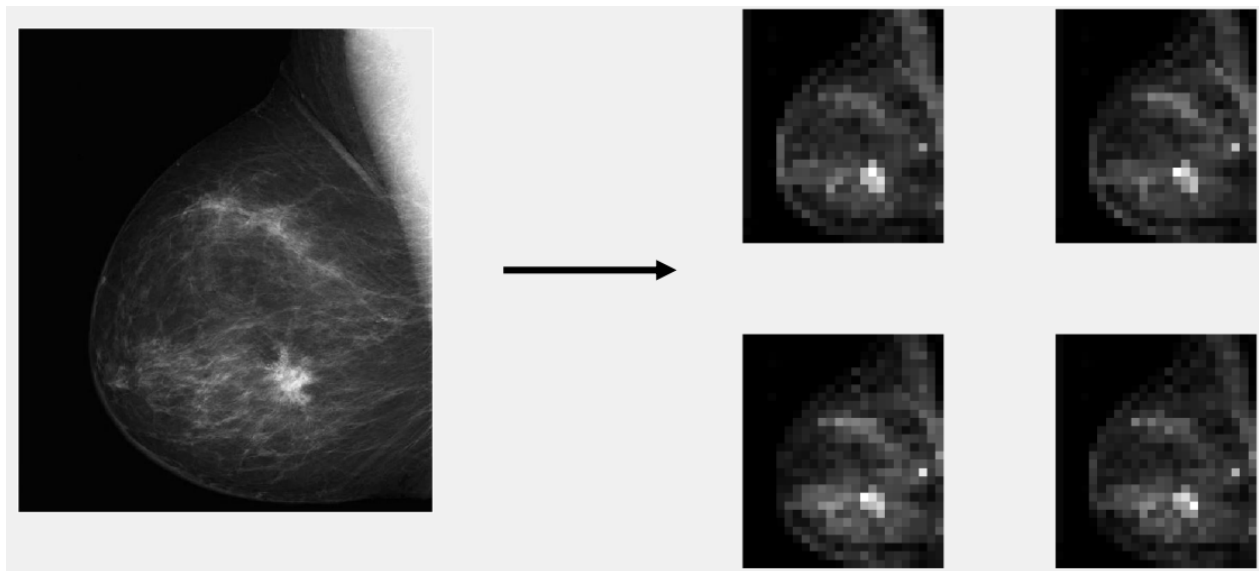


Figure 1 Visualization of the feature descriptor "Contrast" at four different angles/directions with $D = 1$.

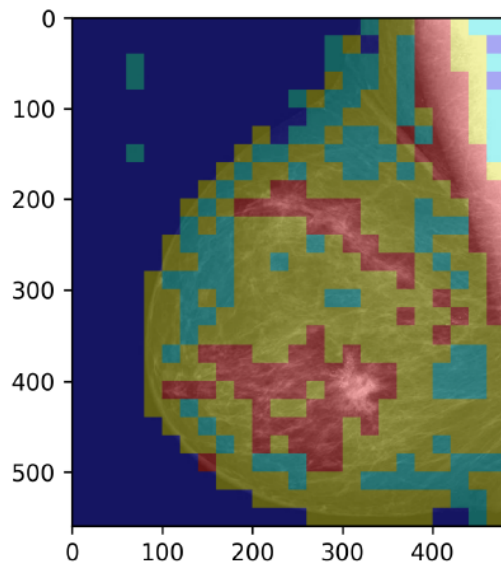


Figure 2 Visualization of texture-based clustering after k-means clustering