# Industrial & Medical Image Processing Lab

## Session 03

**Document the results of the exercises in a protocol. Upload both, protocol and source code in a zip-file.**

## Exercise 3.1

3P

Evaluation of activity in a certain Region-Of-Interest (ROI) is a common procedure in nuclear medicine. The series of DICOM images (roi1-roi7) shows a petri dish filled with a radioisotope, imaged with a gamma-camera. A typical task is the monitoring of clearance rates of a tracer. Usually a ROI is defined and the intensity measured, which was detected by a gamma-camera or an alternative modality for nuclear medicine.

**Theory:**

The recorded image intensity is proportional to the radioactive nuclei available. Their number follows the law of radioactive decay

$$N(t) = N(t_0)e^{-\lambda t}$$

Hereby, $N(t)$ is the number of nuclei at the time $t$, $N(t_0)$ is the number of nuclei when the measurement starts and $\lambda$ is the decay constant. Calculation of the half-life period $T_{\frac{1}{2}}$ follows

$$T_{\frac{1}{2}} = \frac{\ln(2)}{\lambda}$$

Assumed that the gamma-camera takes its measurements in a linear part of its dynamic range, the cumulative image intensity at time $t$ is proportional to $N(t)$. Therefore, $T_{\frac{1}{2}}$ can be computed directly from intensity data.

- Load the DICOM images (*dicomread*), choose an appropriate ROI, compute the cumulative image intensities and plot them vs. the acquisition time (get it via *dicominfo*). This illustrates the reduction of cumulative image intensity caused by radioactive decay of the isotope.

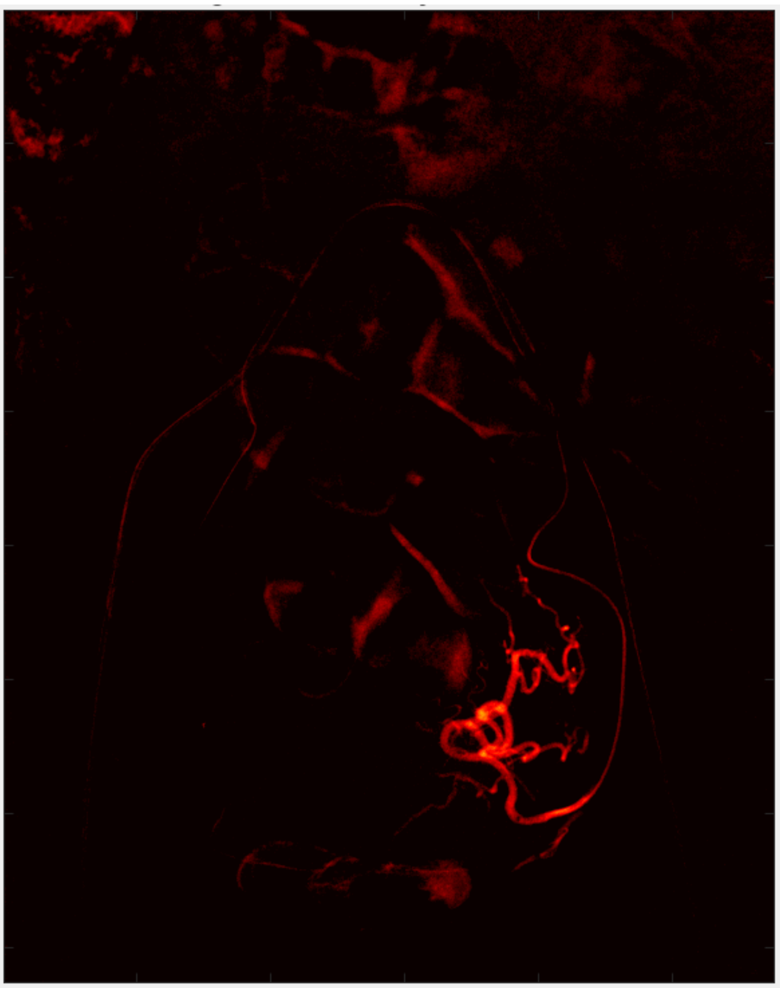
Once $T_{\frac{1}{2}}$ is computed, what kind of radioisotope was used with the petri dish?

## Exercise 3.2

2P

An angiography is an x-ray investigation in order to diagnose vascular occlusion, stenosis or atherosclerotic anomalies. First an ordinary x-ray of the area of interest is acquired. Subsequently, an arterial or venous line is established, a contrast agent (usually iodine based) injected and one or more further x-ray images acquired. Afterwards a so called digital subtraction angiography is computed by simply taking the difference of the acquired images.

Perform a digital subtraction angiography. Given are two x-ray images of a pelvis, one before (DSA1.jpg) and one after injection of a contrast agent (DSA2.jpg). Display the images in one figure using '*subplot*'.



Resulting image from the digital subtraction angiography

## Exercise 3.3

(a) Implement a segmentation method which uses local-adaptive thresholding. Follow the algorithm below: 3P

- Compute the local weighted average value (=smoothing with a Gaussian) of the input image
- Multiply a global threshold with the weighted image (results in a threshold matrix)
- Generate output image by segmentation of the input image by the threshold matrix

The function call could look e.g. like this

*SegImg= MyAdaptiveThresholding(Img, Sigma, Threshold)*

Use 'rice.png' provided by Matlab for implementation purpose.

(b) Explain and document the theory behind the threshold computation after Otsu (Matlab „*graythresh*"). Segment the subsequent images with the conventional method after Otsu and compare the result with the local-adaptive segmentation. 2P

- *sonnet.png*
- *journal.png*
- *barcode.png*
- *jb007.png*

(c) Could the Otsu threshold be used as input parameter for the local-adaptive segmentation and what threshold results in the best segmentation respectively? Document your results. 2P
Hints:

- The size of the smoothing kernel is computed by N=ceil(3*sigma)*2+1;
- Use the threshold relative (in %) to the local-weighted image, i.e. the threshold can hold values e.g. -20, 0, 5 or 30%.

(d) Use the implementation from (a) and try to decipher the code in „*surprise.png*". What's the secret? 1P