Medical Imaging

IST 2022-2023

Lab 3

Consider the SPECT imaging of the 2D phantom stored in `derenzo.mat`, containing several hot spots of different sizes, with FOV = 256 x 256 mm^2. For the exercise, assume a parallel beam geometry with a rotation increment of 0.5º and a maximum number of photon counts of 255. Please note that, given that a 2D phantom is considered, only 1 of the 2 dimensions of the gamma camera is used in this simulation.

1. Load the phantom, get its dimensions, and display it.
2. Simulate the sinogram and reconstructed SPECT image of the phantom by filtered back-projection, first without and then with noise (using the `random.poisson` function of the `numpy` library; note that values need to be converted to uint8 type prior to applying this function).
3. Define appropriate ROIs for one of the big, the medium, and the small hotspots (using `roipoly` in Matlab /Python).
4. Illustrate and quantify the partial volume effects (PVE's) in the reconstructed image, by performing the following analysis and comparing the results with those obtained from the phantom (ground truth):
   a. Plot the intensity profile of a specific line in the object/image, going through various hot spots;
   b. Compute the average image intensities and SNR in each ROI.
5. Repeat the analysis in 4., by now changing the spatial resolution and/or the SNR of the image (through manipulation of the appropriate image acquisition parameters).

Notes:

- Make sure to constrain the reconstructed image to have the same size as the phantom.
- Make sure to normalize both the phantom and the reconstructed image (to 1) so that the intensities are comparable between images.