Lab 2

Medical Imaging

IST 2021-2022

Consider the formation using a 1st generation scanner of a CT image of the modified Shepp-Logan phantom, which approximately models X-ray attenuation in a human head.

Note: for this lab you will need the `scikit-image` processing toolbox.

1. Generate the modified Shepp-Logan phantom using `shepp_logan_phantom`. Use the function `rescale` to get a 256x256 dimension.
2. Simulate the sinogram obtained by collecting projections covering [0;180[° in steps of 1° (using `radon`).
3. Simulate the associated reconstructed image using filtered backprojection (using `iradon`).
4. Repeat the simulations in 2. and 3. by covering: [0;60[°, [0;90[°, [0;120[° and [0;360[°, in steps of 1°.
5. Repeat the simulations in 2. and 3. by covering [0;180[°, in steps of 0.5, 5 and 10°.
6. Repeat the simulations in 2. using the original angles, by adding noise to the projection data (using the `random.poisson` function of the `numpy` library), considering a maximum number of counts per pixel of 10^3 photons. Note: as in this case noise follows the Poisson distribution, it depends on the signal level, so the output of the noise generation function will already correspond to the noisy sinogram. Prior to applying this function, you should rescale your sinogram intensities to the [0, 255] interval and convert the images to uint8 type (8-bit unsigned integers) to make the noise more noticeable.
7. Now reconstruct the image from the noisy projection data using `iradon` (with the original ramp, i.e. Ram-Lak, filter).
8. Repeat 7, by replacing the original Ram-Lak filter by modified filters (available in `iradon`), and explain the results as a function of their different frequency responses.