Lab 1

Medical Imaging

IST 2021-2022

Consider the 3D CT image stored in ct.mat, where the image intensity of each pixel (*i*,*j*,*k*) corresponds to the CT index, defined as $CT_{ijk} = \dfrac{\mu_{ijk} - \mu_{H_2O}}{\mu_{H_2O}} \times 1000$, where $\mu_{H_2O} = 0.206 cm^{-1}$ with FOV_{xyz} = 200×200×260 mm^3.

1. Display a histogram of the CT image intensities (i.e. CT indexes), and then a histogram of the corresponding attenuation coefficients, by converting CT indexes to attenuation coefficients.
2. Display 15 representative slices of the image of attenuation coefficients for each orientation - axial (*x*,*y*), sagittal (*x*,*z*) and coronal (*y*,*z*):
    a. applying rotations when appropriate;
    b. using an adequate intensity scale for tissue visualization;
    c. using an intensity scale that is matched across slices.
3. Simulate the planar X-ray image that would be obtained by projection along *x*, assuming that the incident X-ray beam has an intensity I_0 = 1100 photons/pixel.
    a. Compute the voxel size along each direction
    b. Write down the attenuation equation, and apply it
    c. Display the resulting projection image
4. Now simulate the planar X-ray image that would be obtained by projection along *x* and *y*:
    a. Quadrupling the current intensity at the same time as using half the X-ray tube voltage: what changed? (hint: look at the histograms!)
    b. What would happen to the image if the X-ray energy was significantly increased? Discuss this, explaining why $\mu_{bone} >> \mu_{tissue}$ at low X-ray energies, while the two values of μ become closer as the X-ray energy increases.