Medical Image Processing for Diagnostic Applications

Written Exam

06.08.2019

60 minutes, 60 points

Image Undistortion

a) Name and explain the two types of image distortion.

b) $x = \sum_{i=0}^{d} \sum_{j=0}^{d-i} u_{i,j}\, y'^{j}\, x'^{i}$

Evaluate x0 for d = 2.

c) Construct the measurement matrix M from $(x_0, y_0), (x_1, y_1)$ and (x_2, y_2) in terms of above equation

d) Write down the linear system that needs to be solved.

e) What is maximum rank of the measurement matrix? Can this linear equation will be solved when you have a full rank matrix?

f) Name two ways how this system can be solved.

Polynomial surface fitting

a) Given the equation of entropy, asked to name it

b) Given the equation of cross- entropy, asked to name it

c) Write one property of KL divergence

d) Given $(x_0, y_0), (x_1, y_1)$ and (x_2, y_2) values and write measurement matrix in terms of regression problem

Filtering

a) Given $h(s) = \int |w|\, e^{2\pi i \omega t}$
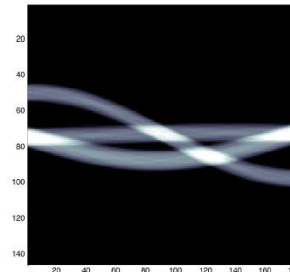How is the filter called?

b) Given $h(s) = \frac{1}{2} sinc(s) - \frac{1}{4} sinc^2(s)$
Write in discrete form?

c) How is the discrete filter called?

Reconstruction

a) How is this image called?

b) Explain these 3 lines in sinogram? Explain the location and shape of these lines?

c) **Fourier Slice Theorem**: (write in 4 blanks)
It states that the 1-D Fourier transform P(ω,θ) of a projection p(s,θ) in parallel beam geometry for a fixed rotation angle θ is identical to the 1-D profile through the origin of the 2-D Fourier transform F(ωcosθ,ωsinθ) of the irradiated object

ART

a) What is the main drawback of ART
   (Kaczmark method)?
b) Mention and explain 2 other ART methods?

Rigid Registration

$$R = \arg\min \| p_i - \boldsymbol{R}q_t - t \|$$

a) What is R and t? Explain briefly. Why
   optimization is required?
b) Explain rigid transformation
c) This is non-linear. How will you make it
   linear?