Medical Image Processing for Diagnostic Applications (VHB)

Gedächtnisprotokoll

19.03.2018

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 x_0 for $d = 2$.

c) Construct the measurement matrix $\boldsymbol{M}$ ($(x'_1, y'_1) \dots (x'_4, y'_4)$ given)

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

e) Can this system be solved if $\boldsymbol{M}$ has full rank?

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

Defect Pixel Interpolation

a) Write down the 5 steps for defect pixel interpolation by bandlimitation.

b)

$$g(t) = f(t) \cdot w(t)$$
$$F(\xi) = \widehat{F}(s)\,\delta(\xi - s) + \widehat{F}(N - s)\,\delta(\xi - N + s)$$

Calculate $G(s)$. What operation is needed for this and how is it defined?

c)

$$\widehat{G}(s) = \frac{1}{N}\left(\widehat{F}(s)\,W(0) + \overline{\widehat{F}}(s)\,W(2s)\right)$$
$$\overline{\widehat{G}}(s) = \frac{1}{N}\left(\overline{\widehat{F}}(s)\,\overline{W}(0) + \widehat{F}(s)\,\overline{W}(2s)\right)$$

Solve for $\widehat{F}(s)$.

Image Reconstruction

a) In which order does the filtering and backprojecting need to be in filtered backprojection?

b) Explain a way how parallel beam backprojection can be used for fan beam.

c) Write down Tuy's condition.

d) What is the name of this filter?

$$h(s) = \int_{-B}^{B} |\omega|\, \mathrm{e}^{2\pi \mathrm{i} \omega s}\, \mathrm{d}\omega$$

e)

$$h(s) = \frac{1}{2}\operatorname{sinc}(s) - \frac{1}{4}\operatorname{sinc}^2\left(\frac{1}{2}s\right)$$
$$= \frac{1}{2}\frac{\sin(\pi s)}{\pi s} - \frac{1}{4}\left(\frac{\sin(\frac{\pi s}{2})}{\frac{\pi s}{2}}\right)^2$$

Derive a discrete version of this filter.

f) What is the name of this discrete filter?

Rigid Registration

a)

$$\underset{\varphi,\, t_1,\, t_2}{\arg\min} \sum_{k=1}^{N} ||\boldsymbol{p}_k - \boldsymbol{R}\boldsymbol{q}_k - \boldsymbol{t}||^2$$

How are $\boldsymbol{R}$ and $\boldsymbol{t}$ called and what do they do?

b) Why is optimization necessary here?

c) Describe two other possible ways to do rotation.