Diagnostic Medical Image Processing
Prof. Dr.-Ing. Andreas Maier
Exercises (DMIP-E)
WS 2016/17

LEHRSTUHL FÜR MUSTER-ERKENNUNG

Reconstruction in 3-D

Frank Schebesch, Tobias Würfl, Matthias Utzschneider,
Yixing Huang, Asmaa Khdeir, Houman Mirzaalian

Exercise Sheet 7

22 Analytic and Iterative Reconstruction

(i) The X-ray transform models the process of how CT raw data is acquired. In 3-D, is there a difference between this transform and the Radon transform? Include the respective integrals in your answer.
Hint: How and in which geometry are the integrals computed?

(ii) The algebraic reconstruction technique (ART) is a practical application of the Kaczmarc method. To get an idea how it works, assume that the following two equations describe two lines in the solution space of a synthetic CT projection:

$$3y - x = 5,$$
$$11x + 4y = 19.$$

Compute two iteration steps using ART to find an approximate solution $\mathbf{X}^{(2)} \in \mathbb{R}^2$. Initialize your algorithm with $\mathbf{X}^{(0)} = (0, 0)^\mathsf{T}$.
How good is this estimate? Compute the exact solution of the linear system and compare. Comment on the convergence rate for this specific example.

(iii) What is the main drawback of the elementary ART? Name and explain in a few words three different techniques of how we can tackle this problem.

2+2+2

23 Data Completeness

(i) What is Orlov's condition? What is Tuy's condition? Show for each condition a trajectory that meets its criterion.

(ii) Use Tuy's condition to explain under which condition the FDK algorithm performs an exact reconstruction.

(iii) In the lecture, we have taken a closer look at one specific algorithm that can be used for a helical trajectory. Which reconstruction algorithm was that? This algorithm used a concept called π-lines. Explain them in your own words and discuss the treatment of redundant data.

2+1+1

Submit to your tutor until the last exercise session on 01/18/2017 or 01/19/2017.

Total: 10