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Propositions accompanying the thesis

“Improving Robustness of Tomographic Reconstruction Methods”

by Folkert Bleichrodt

1. The limited precision of the floating-point representation rarely leads to visible artifacts in the reconstructed tomography image. However, this limited precision can impose a major obstacle for consistency optimization of alignment parameters.
(Chapters 2 and 3)

2. Consider the update step of DART, where the following problem is solved:

\[
\min_{x \in \mathbb{R}^N} \|Wx - p\|_2^2 \quad \text{subject to} \quad x_i = \nu_i \text{ for } i \in F.
\]

See Chapter 4 for the notation.
Let \(D \in \mathbb{R}^{N \times N}\) be a diagonal matrix with nonnegative real entries

\[
D_{ii} := \begin{cases} 
0 & \text{if } i \in U \\
C & \text{if } i \in F,
\end{cases}
\]

where \(C\) is a constant and \(U = \{1, \ldots, N\} \setminus F\). For sufficiently large \(C\), replacing the update step by

\[
\min_{x \in \mathbb{R}^N} \|Wx - p\|_2^2 + \|D(x - \nu)\|_2^2,
\]

leads to an SDART algorithm that yields reconstructions similar to DART.
(Chapter 4)

3. Let \(W \in \mathbb{R}^{M \times N}\) be a discretized Radon transform operator for the parallel beam geometry (see Eq. (5.1) of this thesis). Let \(e = (1, \ldots, 1) \in \mathbb{R}^M\) and let \(S\) be a linear reconstruction algorithm. The problem

\[
\min_{\tau} \|W(S(p - \tau e)) - (p - \tau e)\|_2
\]

can be solved using two evaluations of the algorithm \(S\).
(Chapter 5)

4. Even if 50\% of the pixels in each projection image is replaced by a large value, and the location of these “corrupted” data are unknown, meaningful reconstruction results with limited artifacts can still be obtained.
(Chapter 6)
5. Radio tomographic imaging can potentially be used for anonymous tracking of customers, even those without a smartphone.

6. The tomographic reconstruction community would benefit greatly from a centralized, unified database of tomographic datasets and corresponding high quality reconstructions. For experimentalists this is a tool to validate precision and accuracy of new tomographic scanner setups. Algorithm developers can test and compare the accuracy of their methods.

7. In a PhD project that is aimed to develop and implement numerical algorithms, the development time is equally important as the final computation time of the algorithm. Having a working algorithm is the first milestone, while efficiency can be considered as a next step.

8. Reconstruction is only part of an entire pipeline consisting of: acquisition, preprocessing, reconstruction, post-processing and quantitative analysis. Therefore, when optimizing this pipeline, each step should not optimize its output, but should optimize the input of the next step in the pipeline.

9. When interfacing between Matlab and C-type languages, the mixing of column-major order and row-major order of arrays forms the recipe for a major headache.