Helical Cone-Beam Computed Tomography using the Differentiated Backprojection

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Abstract: The thesis examines the use of the differentiated backprojection (DBP) with subsequent inverse Hilbert transform (HT), which is a theoretically-exact and stable (TES) reconstruction algorithm, for helical cone-beam computed tomography. Special attention in this examination is attributed to the question if the method is suitable to process redundant data, i.e., data which have been measured but which are not necessary to achieve a TES reconstruction. Helical cone-beam CT has been chosen as an application because it is the scanning technique most common in modern CT scanners and because it requires new image reconstruction algorithms to account for the ongoing growth of CT detectors in terms of detector rows.

The first part of the thesis introduces the DBP-HT method in two and three dimensions and gives all relevant proofs. It also contains a section of original work about different strategies of computing a finite inverse Hilbert transform using Söhngen's formula on discrete data. The second part of the thesis comprises three chapters presenting original research: First, the general properties of the DBP-HT method are examined and different implementation strategies are compared. Subsequently, a new algorithm is introduced, which allows for the first time to perform a TES reconstruction while beneficially including all measured data at maximum pitch. Finally an extension of this algorithm which enables TES reconstruction using all data at arbitrary pitch is presented. The thesis concludes with a discussion of the results and an outlook onto possible further work.