Real Data Validation of RoboCT Trajectory Optimization: Ensuring Quality in CT Imaging

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Cone beam computed tomography (CBCT) has established itself as a versatile technology in various industries and serves as a valuable tool for non-destructive testing and quality control. However, standard CBCT systems often face limitations, especially in terms of CT trajectories and scan volume. To overcome these limitations, robotic computed tomography (RoboCT) systems emerged, with two articulated-arm robots for independently positioning the X-ray source and detector on arbitrary sets of measurement poses. Using Robotic CT systems implies a new level of flexibility to the acquisition of computed tomography data, making it particularly useful for regions of interest analysis of large and complex objects. In this paper, a workflow for optimizing CT trajectories is proposed to further improve the capabilities of RoboCT and the quality of the CT reconstruction. This optimization process considers the very limited accuracy of articulated-arm robots [1, 2] and ensures that the resulting volume images meet all demands for image quality. Firstly, a radially complete set of potential projection views using a sphere trajectory is acquired. This set of projections provides a comprehensive range of data for the reconstruction process. The primary objective is to select a subset of these potential projections that optimizes scan time, signal quality and a data completeness metric approximating the Tuy-Condition, a critical parameter in achieving high-quality CT images [3]. Notably, this optimization process does not rely on a greedy approach. Instead, it evaluates the influence of each projection in contributing to an accurate and high-resolution CT image. By selecting the most relevant projections, this workflow utilizes the full flexibility of the RoboCT system to improve the accuracy and reliability of non-destructive testing and quality control. To validate the effectiveness of this optimization workflow, real data samples acquired at our RoboCT system at the Deggendorf Institute of Technology are used to test its performance in improving CT data acquisition and reconstruction in real-world scenarios.