Scan Time Reduction by Fewer Projections - an Approach for Circular and Spherical Trajectories

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For most computed tomography scans a circular or helical trajectory is used to acquire the necessary radiographic projections. However, these standard trajectories are not necessarily the best choice since the shape of the inspected object is not considered which leads to a suboptimal sampling of the part. In contrast, workpiece-specific and more efficient scan strategies hold the potential for time and cost savings. Such adaptions might be of particular interest for future robotic CT systems that allow greater flexibility in the positioning of X-ray tube, object, and detector than conventional setups or multi-source applications with predefined positions by the setup. We propose a scan planning algorithm to adapt the acquisition trajectory considering the shape of the investigated part. For this task, we present an algorithm that is able to identify the projections from a set of projections that contribute most to the reconstruction of the object. As input information, only the localization of the area of interest and projections from the feasible range of motion are necessary. Also, a reasonable amount of projections to pick from needs to be provided, which can originate from an earlier scan or computer simulations that consider the range of motion of the available CT setup. The optimization method has been implemented for circular and spherical trajectories and can be extended towards arbitrary acquisition paths. Since for modern CT systems the duration for the scan itself takes significantly longer than the reconstruction, this approach appears to be well-suited to significantly reduce the throughput time if several identical parts need to be inspected. Additionally, new applications such as inline CT are conceivable and certain artifacts can be suppressed if spherical trajectories are used instead of circular ones. For the subsequent reconstruction itself no previous knowledge of the object is included, i.e. the reconstruction workflow does not need to be modified. We demonstrate the capabilities of the optimization method for two industrial relevant examples and show that a scan time reduction of more than 50 % is feasible for some cases by reducing the number of acquired projections. Furthermore, for all investigated projection numbers and parts the optimized trajectory yields an identical to clearly improved image quality in the reconstructed volume than the reference trajectories.