

Purpose: To obtain artifact-free 3D images with high temporal resolution from truncated projection data recorded using a cardiac interventional system with a slowly rotating gantry and a small flat-panel detector.

Methods: In order to reconstruct time-resolved cardiac images from truncated projections, one must be able to achieve ultra-high temporal resolution, while also mitigating truncation artifacts. Both of these goals can be achieved using an adapted implementation of the prior image constrained compressed sensing (PICCS) algorithm. To demonstrate this, a canine animal model was scanned in vivo using an interventional C-arm system with a 40x40 sq cm detector in a single rotation 14-second acquisition. The projections were artificially truncated to simulate the use of a 20x20 sq cm detector commonly used in many cardiac intervention suites. The projections were gated retrospectively using the recorded ECG signal into 20 cardiac phases. The data from each phase were reconstructed using the PICCS algorithm. The reconstruction accuracy was assessed by evaluating image quality of both truncated and non-truncated datasets.

Results: The images reconstructed from truncated data using the PICCS algorithm resulted in a root mean square deviation of about 2.5% with respect to the non-truncated data. Furthermore, the truncated PICCS reconstructions did not contain artifacts that plagued the images reconstructed using the FDK algorithm from the same datasets. The temporal resolution achieved in this study was about 33 ms. The PICCS reconstructions were generated in under 2 minutes per phase for a 256x256x128 image volume using a GPU-based implementation. Note that the reconstruction of each phase can be processed in parallel.

Conclusions: Artifact-free time-resolved cardiac imaging is achievable using a cardiac intervention C-arm system with a slowly rotating gantry and the PICCS algorithm. Further optimization could bring the reconstruction time to a level adequate for the interventional setting.

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