AbstractID: 7721 Title: Artifacts generated by interior tomography

Purpose: Although it is well known that quantitative tomography is impossible in systems with interior truncation, this geometry is being increasingly applied to applications such as cone-beam CT and cardiac SPECT. It has been shown that interior problem, represented by the truncated Radon transform, has a null-space (and thus could theoretically have an artifact) containing any smooth function in the fully sampled field of view. In practice, artifacts tend to be smooth. Our purpose is to theoretically understand what artifacts will be typically generated under the interior problem.

Method and Materials: A linear operator is constructed which generates members of the null-space of the internal Radon transform. A singular value decomposition of this operator is derived and the singular values are examined.

Results: The singular values are all non-zero, confirming that the null-space of the truncated Radon transform contains all smooth functions. However, the singular values drop rapidly. When combined with the positivity constraint, this limits the magnitude of all but the lowest singular vectors.

Conclusion: Although the null-space of the truncated Radon transform contains rapidly varying components, their amplitude will be exponentially small. This justifies the use of truncated images to quantitatively measure high-spatial-frequency objects such as organ boundaries. Although the formal null-space is infinite-dimensional, most of these dimensions are measured in practice with high accuracy. The artifacts generated from actual images can be described with high accuracy by only a few (2–10) parameters. Thus, supplements of the truncated data with low-quality non-truncated data or with simple priors can improve the quantifiable accuracy of truncated images.

Conflict of Interest (only if applicable):