Comparison of two ring artefact removal filters used for neutron tomography reconstruction

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Summary

The reduction of ring artefacts in transmission tomography reconstruction, by filtering sinograms, is a common practice for most radiation modalities. Using simulated and measured neutron transmission data, an analysis of two ring artefact suppression schemes is given. The choice of the ring filtering parameters has to take the noise characteristics of the measured raw projection data into account.

Introduction

The appearance of ring artefacts in transmission tomography data is quite common. They are due to deficiencies in the measured projections and show as vertical lines in the sinogram representation of all projections of a single slice. A vertical line in the sinogram is due to a single pixel or a group of n pixels on the detector, which is less or more sensitive than the average pixel and shows even after flatfield correction. Most annoying ring artefacts are due to partly dead pixels, which cannot be identified easily on the projection images. Their effect only show in the sinogram or later on the reconstructed slice images. Therefore ring artefact mitigation starts with the analysis of sinogram images or analysis of reconstructed slices.

Analysis of two ring filtering algorithms

The first ring filtering method sums first sinogram rows (i.e. over all angles) and divides it by the number of rows (ave) and generate a smoothed version of this sum (smoothing width 3,5,7,9 pixels). The difference diff = ave – smooth(ave) is then subtracted from each row. This is a very simple and efficient correction scheme.
The second method relies on morphological filtering the sinogram i.e. using a combination of a morphological "Top hat" and a "Bot hat" operation on the data. A filtering threshold is determined depending on the number of detected lines in the sinogram.

Summary and conclusion

Using simulated an measured neutron transmission data two ring filtering algorithms are evaluated. A careful choice of filtering parameters is necessary. Standard software for transmission tomography reconstruction should provide different ring filtering options.