

Advanced Wiener Filter for Helical Windmill Artifact Reduction

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Purpose:

Inadequate sampling along the longitudinal direction in a helical fan-/cone-beam CT can cause a windmill artifact rotating with black/white patterns in the axial planes. Furthermore, this artifact contaminates structural information in the coronal plane images with black/white stripe patterns. Conventional denoising method, to our experience, results either in poor image resolution or in insufficient denoising effect. The purpose of this work is to minimize the windmill artifact while preserving the edge structural data.

Materials and Methods:

For preserving structural edge information, 3-dimensional wiener sifter is applied. Since the noise, which has been filtered in a particular plane, does not only contain black/white stripes, but also edge components, this method sifts out stripe noise only from monoplane filtered noise and weights the noise optimally.

This work presents a new artifacts reduction technique based on adaptive wiener filtering. The wiener sifter is capable of preserving structural edge information while eliminating windmill artifacts. The noise sifted out by use of the filter, however, is not still suitable for 1) the additional edge compensation is needed and 2) the scale of noise is rather too small.

Therefore, noise data was optimally weighted prior to subtraction. The weighting function is generated to minimize the variance of the corrected image. In addition, wiener sifter uses prior edge data to mask the edge components.

Results:

The results were evaluated with three-dimensional images of anesthetized pigs, monkeys and QRM phantom. Conventional z-filtering resulted in decrease of image resolution. Edge structure of the phantom was removed and ghost structure is generated by conventional wiener filter. These problems were largely solved with proposed method, advanced wiener filter. Advanced wiener filter eliminated large part of windmill artifacts while preserving edge structural data. This method performed particularly well in irregular-shaped phantom images. The windmill artifact was effectively deleted without creating a ghost nonexistent shape.

Conclusions:

The proposed method leads to improvement of the image quality of non-overlapping reconstructed image. It is a simple and efficient image domain processing without modifying the CT system or manually adjusting the projection data.

Keywords: Windmill artifact, helical CT, artifact reduction