Sampling Technique for Fourier Convolution Theorem Based k-space Filtering

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Key Findings: The novelty of this research is the sampling technique used to determine the *Sinc-shaped convolving function*. The sampling technique uses a k-space region which spatial extent can be fine-tuned by the numerical values of bandwidth and sampling rate so to determine the strength of the k-space filter. The benefit for Magnetic Resonance Imaging is k-space filters with additional parameters usable to fine-tune the filter strength.

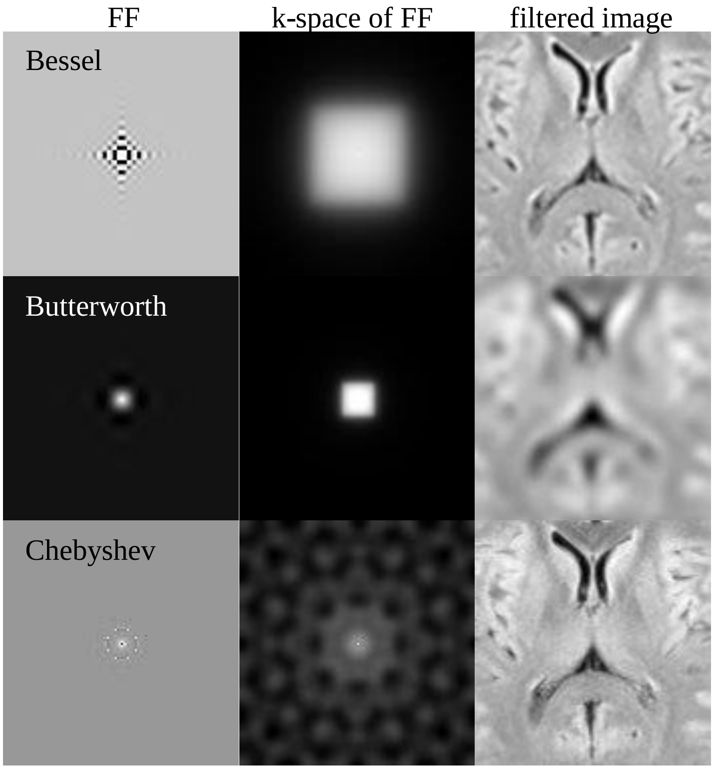

Fig. 1 Proof of concept - low pass k-space filtering. Top row, middle row, and bottom row present: Bessel, Butterworth, and Chebyshev filtering sessions. Each column, from left to right, shows *Sinc shaped filtering function* (FF), k-space of FF, and filtered image. The gain was set to 1.0 dB for the Butterworth filter. The ripple factor was set to 0.5 for the Chebyshev filter.

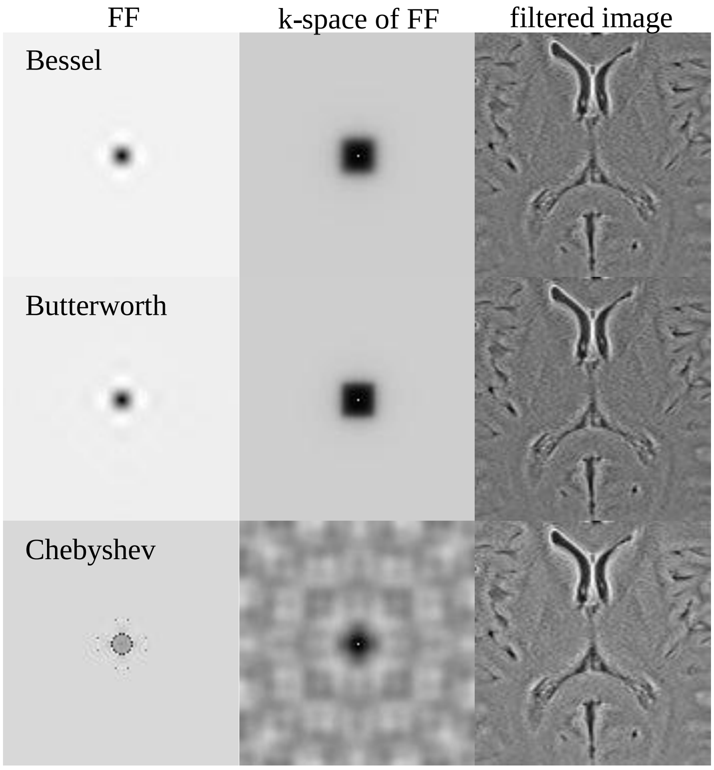

Fig. 2 Proof of concept - high pass k-space filtering. Top row, middle row, and bottom row present: Bessel, Butterworth, and Chebyshev filtering sessions. Each column, from left to right, shows *Sinc shaped filtering function* (FF), k-space of FF, and filtered image. The gain was set to 0.5 dB for the Butterworth filter. The ripple factor was set to 0.5 for the Chebyshev filter.

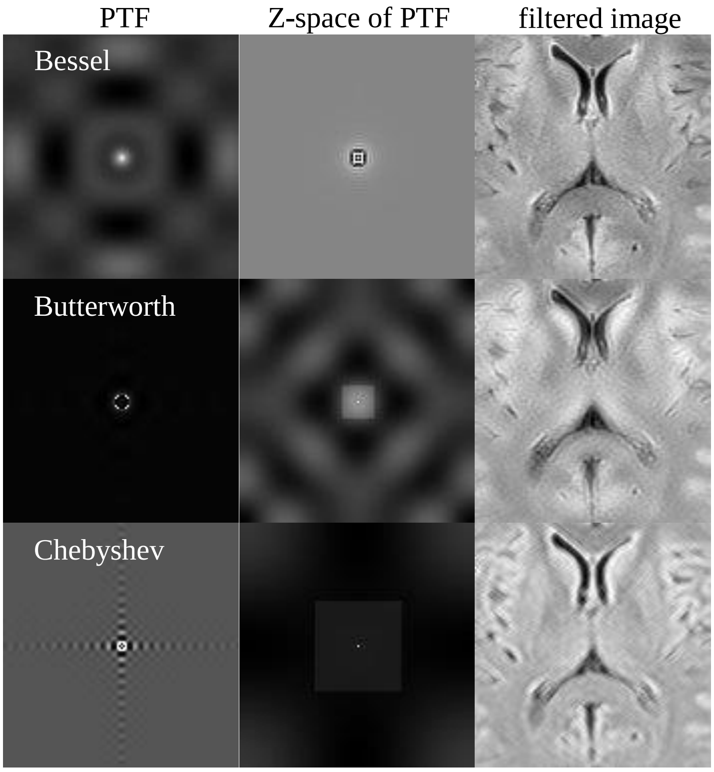

Fig. 3 Proof of concept – low pass Z-space filtering. Top row, middle row, and bottom row present: Bessel, Butterworth, and Chebyshev filtering sessions. Each column, from left to right, shows *Sinc shaped pulse-transfer function* (PTF), Z-space of PTF, and filtered image. The gain was set to 1.0 dB for the Butterworth filter. The ripple factor was set to 0.5 for the Chebyshev filter.

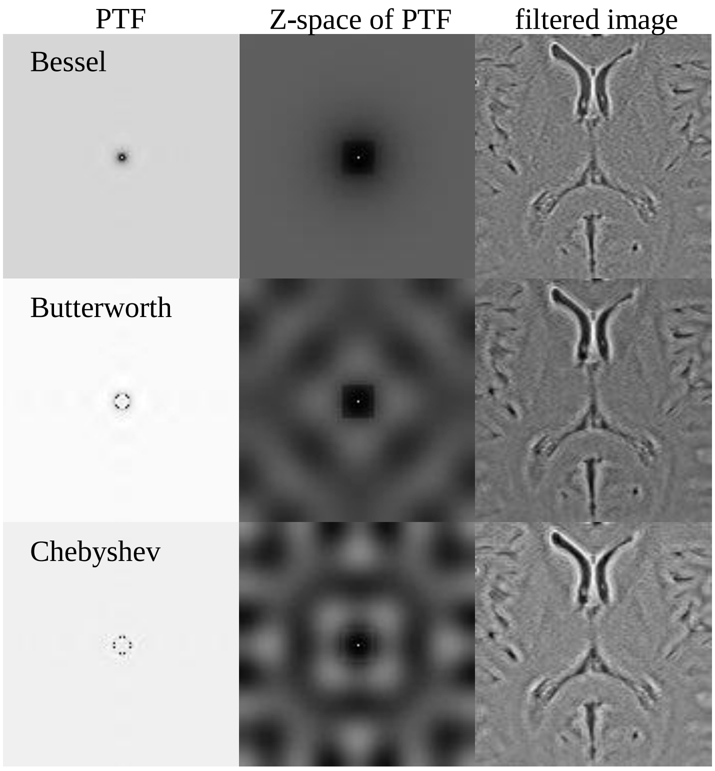

Fig. 4. Proof of concept – high pass Z-space filtering. Top row, middle row, and bottom row present: Bessel, Butterworth, and Chebyshev filtering sessions. Each column, from left to right, shows *Sinc shaped pulse-transfer function* (PTF), Z-space of PTF, and filtered image. The gain was set to 1.0 dB for the Butterworth filter. The ripple factor was set to 0.5 for the Chebyshev filters.

Concluding remarks: The spatial size of the rectangle determines filtering strength. This research also provides a benefit in relation to the use of k-space filters in Magnetic Resonance Imaging. The benefit is the central k-space region which spatial extent can be tuned by the numerical values of bandwidth and sampling rate. The spatial extent of the central k-space region regulates filtering strength. Figures 1 and 2 present this concept. Figures 3 and 4 extends the concept to Z-space. This paper hence proposes k-space filters with additional parameters usable to fine tune the filter's strength.