A 3-D Sparse FIR Frustum Filter for Enhancing Broadband Plane Waves - Supplementary Results

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I. Introduction

This is the supplementary results and MATLAB source code repository for our paper titled "A 3-D Sparse FIR Frustum Filter for Enhancing Broadband Plane Waves".

II. Distortion of the Proposed Filter

This section quantifies the deviation of our proposed sparse FIR frustum filter from an equivalent conventional FIR frustum filter, resulting from the spatial upsampling, masking and hard-thresholding processes in the filter construction.

In order to numerically evaluate the distortion of the proposed sparse filter, the normalized root mean square error (NRMSE) of the sparse filter $H(\mathbf{z})$ with respect to the conventional filter $H_{conv}(\mathbf{z})$,

$$\text{NRMSE} = \frac{\|H(\mathbf{k}) - H_{conv}(\mathbf{k})\|_2}{\sqrt{F_x F_y F_{ct}}\,\{\max(|H(\mathbf{k})|) - \min(|H(\mathbf{k})|)\}}$$

is measured, where $\|\cdot\|_2$ denotes the 2-norm of a tensor, F_x, F_y, F_{ct} are FFT lengths in their respective dimensions, $\mathbf{k} = (k_x, k_y, k_{ct})$, and $H(\mathbf{k})$ is the discrete Fourier domain representation of the filter $H(\mathbf{z})$.

The gradual increase of NRMSE when increasing the hard-thresholding coefficient h_{th} is clearly seen in Figure 1.

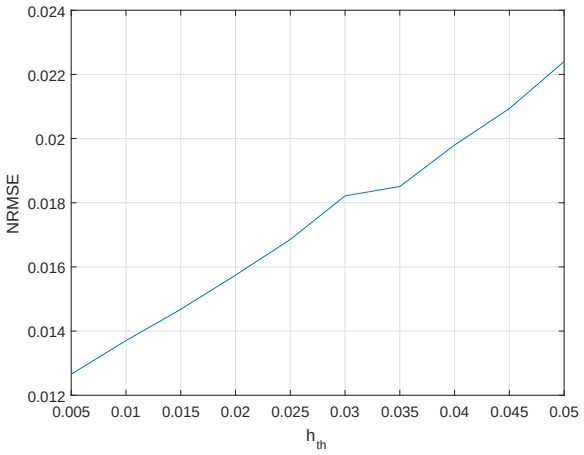

Fig. 1. NRMSE between the proposed sparse filter $H(\mathbf{z})$ and the equivalent conventional filter $H_{conv}(\mathbf{z})$.

III. Reduction of Computational Complexity

This section investigates the effect of the hard-thresholding coefficient h_{th} on the computational complexity reduction of the proposed sparse FIR frustum filter.

From Figures 3 and 2, it is clearly seen that the amount of computational resources required reduces exponentially with increasing h_{th}, though it comes with a corresponding cost in NRMSE.

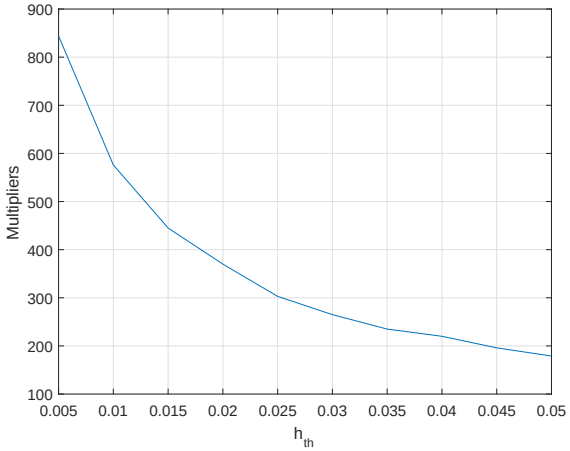

Fig. 2. Total complex multipliers required to implement the proposed sparse FIR frustum filter.

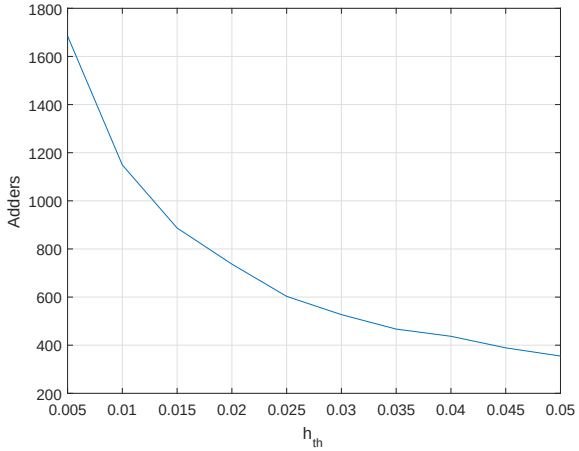

Fig. 3. Total complex adders required to implement the proposed sparse FIR frustum filter.