Applying Linear Transforms to Dyadic Sections of Rudin-Shapiro Sequences

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The Rudin-Shapiro Sequences are the basis vectors in the Rudin-Shapiro Transform (RST), which is a linear and unitary transform. The matrix representation of the RST is symmetric and Hadamard, and the RS sequences are thus the rows (and columns) of the RST matrix. The RS sequences have a number of properties of which the most important is their ability to generate flat polynomials when Fourier transformed. This means that $|\mathcal{F}c| \leq K$ is valid for a $K$ which is small when $c$ is an RS sequence in comparison with the case where $c$ is an arbitrary vector of same length and energy. A vector with this property is said to have a spread spectrum. Consequently, the RST is a decomposition of a vector into a spread spectrum basis. Applying the RST is done by means of a fast algorithm, which is the same as the wavelet packet Haar transform algorithm except for appropriate exchanges and time reversals of low and high pass filters. The RST matrix has a dyadic structure inherited from this Haar transform like construction. This presentation demonstrates how this structure leads to a method for predetermining the result of applying arbitrary linear transforms to dyadic sections of RS transformed signals, and how this alteration affects the result of inversely transforming the RS transformed signal. It is also shown that the effect of applying linear transforms to the basis vectors of the RST is limited to very few coefficients. The presentation includes denoising of RS modulated...