Wavelets intrinsically give us the capability of localized signal decomposition and analysis in space and frequency. However, the popular Fast Wavelet Transform (FWT) that is typically used as an “off the shelf” component in most wavelet based compression algorithms like the Embedded Zerotree (EZW), organizes the intermediate coefficients only by frequency, and not by space. We present the Recursive Merge Filter (RMF) discrete wavelet transform (DWT) algorithm, that organizes intermediate coefficients with respect to both space and frequency. This allows close coupling and pipelining with the encoder, fine grained coding, and “cheap growing” of larger DWTs from smaller ones in a constant number of filter operations. The RMF algorithm computes the DWT of an array of length N in a bottom-up fashion, by successively “merging” two smaller DWTs (four in 2-D), and applying the wavelet filter only on the “smooth” or DC coefficients (Figure 1).

The correctness of the RMF algorithm follows from the input/output equivalence of RMF and the FWT algorithms, as the correctness of the FWT has been proven correct in the literature. After the $i^{th}$ (merge + filter) step of the RMF, the $N/2^i$ complete DWTs occupy exactly those positions of the array, as were occupied by the original data elements which correspond to their inverse DWT. We call this the spatial coherence property, which has its roots in the localization property of wavelet transforms. This property makes the RMF ideal for close coupling with wavelet coding algorithms, and enables fine grained as opposed to monolithic encoding. We demonstrate how it can be applied to the Embedded Zerotree Wavelet (EZW) and Wavelet based Hierarchical Vector Quantization (WHVQ) algorithms.

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