

# ON PARENT-CHILD CODING GAIN IN ZERO-TREE BASED CODERS

*Ali Bilgin and Michael W. Marcellin*

Dept. of Electrical and Computer Engineering, University of Arizona, Tucson, AZ 85721.

E-mail: {bilgin,mwm}@ece.arizona.edu

We attempt to quantify the coding gain due to parent-child dependencies in sub-band transforms. These dependencies are generally credited for the excellent MSE performances of zero-tree based compression algorithms such as EZW and SPIHT.

It is a simple matter to devise an experiment to remove the ability of zero-tree coders to exploit the parent-child dependence. The goal is to prevent the tree-structures from exhibiting spatial coherence, without disturbing the decaying spectrum property of the transform. To achieve this goal, subbands are rotated by 90 degrees with respect to the previous scale prior to zero-tree coding. Once zero-tree encoding and zero-tree decoding are performed, the subbands are rotated back to achieve the original orientation of each subband, prior to the inverse wavelet transform. This operation essentially destroys the parent-child dependencies in the tree-structures. Thus, the resulting compression performance must be largely independent of parent-child relationships. We refer to the difference between the “normal” and “rotated” compression performance as the parent-child coding gain,  $G_{PC}$ .

The average parent-child coding gain is plotted as a function of encoding rate for a set of 18  $512 \times 512$  natural images in Figure 1. Results for both SPIHT with arithmetic coding (SPIHT-AC) and SPIHT without arithmetic coding (SPIHT-NC) are included. Results indicate that, for natural images, the parent-child coding gain is typically around 0.40 dB for SPIHT-NC, and 0.25 dB for SPIHT-AC. These numbers are substantially smaller than what is widely believed. Similarly, we have observed that if the rotation experiment is performed using integer wavelet transforms to enable lossless decompression, the lossless file sizes are largely unchanged.

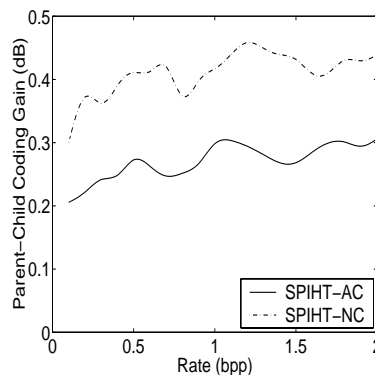


Figure 1: Average parent-child coding gain of SPIHT for a set of 18 natural images.