Guided Quaternary Reaching Method for
Wavelet-based Image Compression

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In this paper, a simple — easy to understand, easy to implement — high performance wavelet-based image compression algorithm using guided quaternary reaching (GQR) method is proposed. Compared with JPEG2000, GQR algorithm has two remarkable merits: 1). much lower algorithmic complexity and 2). higher compression efficiency. In a wavelet-based image compression system, wavelet coefficients are rearranged into hierarchical subbands. By nature, image signals are 2-dimensional and hence the significance of wavelet coefficients are 2-dimensionally distributed within each subband. After quantization, most coefficients become small integers or zeros. To a relatively large threshold, the whole scenery sees that significant coefficients sparsely and 2-dimensionally disperse in a wide tract of insignificant coefficients. Therefore, linear scan patterns inevitably cause losses in compression efficiency. A 2-dimensional scan pattern is entailed to rapidly reach the locations of significant coefficients by skipping as many as possible the insignificant ones. GQR algorithm utilizes quaternary reaching method — which is called as quadtree partitioning in SPECK algorithm — as a 2-dimensional scan pattern. For enhanced compression performance, the scan process is guided by a previously encoded value map which signifies the all-zero regions. The value map helps to rule as many as possible zeros out of the bit plane coding procedure. Experimental results show that, under the same quantization scheme, a plain designed GQR compression algorithm may gain 1 – 2 dB in PSNR against JPEG2000. Accordingly, the visual image quality gets noticeably promoted. Keep in mind that, the current implementation of GQR algorithm adopts some much simpler techniques than JPEG2000. For example, 1). all magnitude refinement bits are directly written to bit stream without entropy coding; 2). there is only one coding pass; 3). use the simplest quantization with fixed visual weighting; 4). no any rate-distorting optimization scheme. Consequently, it is easy to conclude that a 2-dimensional scan pattern overwhelmingly outperforms linear scan patterns in wavelet-based image compression systems. GQR method also has been successfully applied to DCT-based image coding system under the help of a newly proposed frequencywise rearrangement technique. Moreover, it has significantly improved lossless compression efficiency based on a redundant system generated by the combination of DCT and wavelet transform.