



HANDBOOK OF VISUAL COMMUNICATIONS

Handbook of Visual Communications

Edited by

Hseuh-Ming Hang

*Department of Electronics Engineering and Microelectronics
and Information Systems Research Center
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Rensselaer Polytechnic Institute
Troy, New York*



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1. "Entropy-constrained vector quantization," *IEEE Trans. ASSP-37*, pp. 31-42, Jan. 1989.

2. "Vector quantization to waveform coding of images," *Image Processing*, Nov. 1989, pp. 970-978.

3. "Coded subband coding of images," *IEEE Trans. ASSP-36*, pp. 1445-1453, Sept. 1988.

4. "Optimal pruning with applications to tree-structured transform theory," pp. 299-315, March 1989.

5. "Coding of images and video," In *Proc. Int. Conf. on Image Processing*, pp. 2561-2654, Oct. 1991.

6. "Vector quantization for an arbitrary set of quantizers," *IEEE Trans. ASSP-36*, pp. 1445-1453, Sept. 1988.

7. "Image coding scheme with vector quantization and transform coding," *IEEE Trans. ASSP-37*, pp. 2551-2554, Feb. 1989.

8. "Transform coding with application to the JPEG standard," *IEEE Trans. ASSP-39*, pp. 2551-2554, Feb. 1991.

9. "Coding for vector quantization of images," In *Proc. Int. Conf. on Image Processing*, Nov. 1992.

10. "Adaptive decoding of standard transform coded images," *Algorithms and Techniques III*, Feb. 1992.

11. "Image coding using vector quantization," In *Proc. Int. Conf. on Image Processing*, vol. 1, pp. 428-431, Oct. 1982.

12. "Image coding using non-adaptive spatial vector quantization," *Inf. on Circuit Syst. and Comput.*, Asilomar, CA, 1982.

13. "Vector quantizer of video signals," *Electron. Lett.*, 1982.

Chapter 7

Transform Coding

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This chapter presents the role of discrete transforms, especially discrete cosine transform (DCT) and lapped orthogonal transform (LOT), in image coding. The application of these transforms both in still frame and image sequence coding is illustrated. Other functions such as quantization, motion estimation, human visual sensitivity, and variable length coding that are inherent to the overall coding scheme are also described.

7.1 Introduction

While various discrete transforms [1-8] such as Walsh-Hadamard, Haar, slant, discrete Fourier (DFT), DCT, discrete sine (DST), LOT, and discrete wavelet transform (DWT) have been investigated for application to image coding, only DCT has emerged as the most practical and efficient transform. The LOT [5, 6] and DWT (see [7, 8] and Chapter 8 in this book) have been extensively simulated in still frame and image sequence coding and have proven to be formidable competitors to the DCT. It is to be cautioned that transform by itself is only a part of the overall compression scheme, as the coding process may involve