Visual Communications and Image Processing III

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This special section contains 15 papers that address some recent trends in the area of visual communications and image processing. The papers in this special issue can be divided roughly into three parts. The first 11 papers are concerned with visual communications, ranging from the study of image compression algorithms to congestion control in packet video network. The next 3 papers deal with topics in various image processing areas including image filtering, phase estimation, and character pattern expansion. The last paper discusses parallel architectures for image processing purposes.

The paper by Rao and Pearlman presents a multirate vector quantization algorithm for coding image pyramids. Multirate coders are useful for coding image subbands and pyramids since an adaptive bit allocation scheme employed by a pyramid/subband coding system would alter the distribution of bits among the subbands depending on the input image. Thus, any given subband would potentially have to be coded at different rates. This algorithm, however, has the advantage of using the same codebook for different bit rates. The penalty incurred from the use of a fixed codebook is negligible compared to the case in which the codebook is allowed to vary with rate.

Ebrahimi and Kunt introduce an image coding algorithm based on Gabor decomposition. Gabor functions, originally developed for signal analysis in communication theory, have a specific feature that optimizes the localization of signals (uncertainty) in the conjoint spatial and frequency domains. It is interesting that the human receptive field profiles seem to match this family of functions very well. Therefore, it may be advantageous to use Gabor functions for image coding. One contribution of this paper is the proposal of a fast computational method for calculating Gabor decomposition. Simulation results of compressing still and motion pictures using this approach are also reported.

In the area of motion estimation, the paper by Fuh and Maragos presents a more complete model for estimating the displacement field in spatiotemporal image sequences. The model allows for shape deformations of corresponding spatial regions and for affine transformations of the image intensity region. The authors have developed an iterative method to solve for the model parameters corresponding to affine shape deformation and affine transformation. Simulations based on camera-captured images and moving sequences of cloud imagery have shown more accurate motion estimation than many other conventional approaches.

Model-based coding is an emerging research subject in advanced visual communication. The paper by Kimoto and Yasuda deals with the detection analysis of a human walker in monocular sequences based on 3-D stick models. The authors propose a hierarchical three-layer motion representation using stick models with different degrees of coarseness to fulfill different needs. This work has advanced the state of the art in model-based coding.

Husøy introduces two types of low-complexity IIR filter banks for coding images and video—tree structured and fully parallel. The computational complexity of the IIR-based structures is significantly lower than their FIR counterparts. To reduce the complexity further, the author develops multiplier-free IIR filter banks. Based on simulation results from still image and video, the performance of the low-complexity IIR structure is found to be comparable to that of FIR filters.

Akansu and Liu evaluate the effectiveness of signal decomposition for block transforms and filter banks based on their energy compaction. For autoregressive sources and some real test images, the authors have shown that filter banks outperform block transforms.

Pei and Chen demonstrate an innovative application of mathematical morphology to subband decomposition. In contrast to the conventional filter banks for subband analysis/

synthesis, the authors have chosen mathematical morphology because of its ability to exploit geometric features and the potential for high-speed hardware implementation.

The paper by Saghri and Tescher presents an efficient multispectral image coding technique with design constraints of near-lossless coding and an upper bound on maximum coding error. The proposed method is a two-stage process in which the Karhunen-Loève transform is applied to remove spectral correlation and then an adaptive discrete cosine transform coding technique is applied to the resulting spectrally decorrelated data.

Ngan, Koh, and Wong suggest a new image coding algorithm that combines the strength of vector quantization (VQ) and discrete cosine transform (DCT). To enhance further the perceptual quality of the coded images, a model of the human visual system is included when choosing the coding parameters. This algorithm is reported to provide better picture quality at very low bit rates compared to the conventional algorithms employing VQ or DCT alone.

Several international video communication standards are currently at their final phase of standardization if not possibly finished by the publication date of this journal. The paper by Léger, Omachi, and Wallace outlines one of the most popular worldwide video standards—the still image compression standard developed by the Joint Photographic Expert Group (JPEG) of the International Standardization Organization (ISO). In addition to the basic specifications of the JPEG standard, two applications using this standard are described in this paper. One is picture compression for the printing industry in Japan, and the other is the photovideotex service proposed in Europe. Equipped with this and other international image transmission standards, we may expect widespread usage of visual communications in the near future.

Lee, Tzou, and Li deal with the network aspect of visual communication in an ATM environment. Similar to noise in an analog channel, packet loss is inevitable in an ATM network. However, knowing the characteristics of video coders and assuming that video coders can prioritize their packets, the effects of packet loss on the received pictures can be reduced. In this paper, methods for analyzing packet video network performance are presented. In addition, a new congestion control scheme is suggested and the analysis shows it improves network performance significantly.

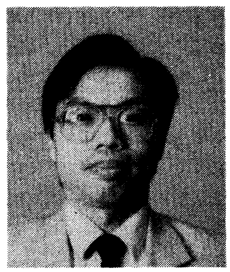
Zeng, Zhou, and Neuvo present a new class of hybrid (linear-nonlinear combined) filters, namely, FIR stack hybrid (FSH) filters. FSH filters are an extension of the known FIR median hybrid (FMH) filters, which have been extensively studied in the last few years. An efficient method of designing such a filter is proposed by the authors and will probably be the main contribution of this paper. Examples of using this filter for image noise reduction show impressive results.

Kang, Lay, and Katsaggelos describe algorithms for estimating the phase information of a signal using its bispectrum. Phase information is essential in image processing; however, the popular second-order statistics analysis cannot reveal this information. Three algorithms are proposed by the authors to estimate the principal value of signal phase information. The use of this phase information is demonstrated by image restoration examples.

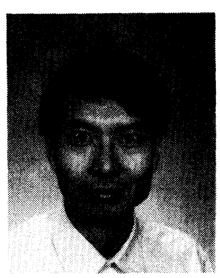
The paper by Ju, Jou, Chang, and Tsay addresses the issue of zigzag appearance often observed in expanded patterns. Due to the huge number of Chinese characters in use, a large storage space is needed for all the characters in various fonts and sizes. Consequently, in cost-sensitive applications such as desktop publishing, only characters in a few smaller font sizes are stored. Larger characters are then expanded from the smaller ones. The authors develop a pyramid smoothing-expanding method to alleviate the zigzag problem. The smoothing method has been shown to be very effective.

Faruque, Fong, and Bray present an efficient parallel architecture that divides the executable instructions and memory operations of an image processor and executes them concurrently. The authors also develop an analytical method to evaluate the overall performance of the proposed architecture.

We would like to thank the people who have contributed to this special issue and express our sincere appreciation to the reviewers for their dedication.



Kou-Hu Tzou received his BS degree in telecommunication engineering from National Chiao-Tung University, Taiwan, in 1975 and the MS and D.Sc. degrees in electrical engineering from Washington University, St. Louis, in 1980 and 1983, respectively. He is a member of the technical staff in the Video Signal Processing Research Group at Bellcore. His current research interests are high-definition TV coding for broadband ISDN, packet video, and visual signal processing and VLSI implementation. Before joining Bellcore in 1987, Dr. Tzou was with the Signal Processing Department of GTE Laboratories as a member of the technical staff and the principal investigator for the image processing project. At GTE Laboratories, he engaged in research on hardware implementation of a speech coder, image coding for progressive transmission, low-rate video coding, and application of a human visual system model to image processing. Dr. Tzou has published more than 50 technical papers on channel coding, image compression, and fast-algorithm architecture and hardware. He holds three U.S. patents related to image coding. He taught several short courses on digital image coding and transmission and HDTV signal processing. He is a senior member of IEEE and a Fellow of SPIE.



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