Book Review:

High Performance VLSI Signal Processing: Innovative Architectures and Algorithms
Volume 2 - Systems Design and Applications
Edited by K. J. Ray LIU and Kung YAO
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One of the major breakthroughs in VLSI technology has been its ability to implement signal processing algorithms and architectures onto cost-effective ASIC and DSP chips.

Works in this area are highly interdisciplinary; they involve interaction among areas such as VLSI and circuit design, computer architecture, signal processing, communications and computer-aided design.

The editors collect in two volumes much of the research efforts and findings that have made the high performance implementation of signal processing possible in the '90s.

While in Volume 1 -reviewed in JCS&T´s Fourth Issue (May 2001)- the editors cover issues related to system design and methodology, in Volume 2 they covers aspects of algorithms, architectures, and applications. They have selected about 60 papers -from journal publications only- grouped in six chapters. Each chapter has a precise and well-referenced introduction, describing the evolution of the topic, followed by selected papers reprints.

Chapter 1 - Numerical Algebra and Adaptive Array Processing- shows the impact of VLSI on the computation of numerical algebra algorithms and their application in adaptive array processing where numerical algebra is a basic tool for design, analysis, and implementation. Ten reprinted papers deal with singular value decomposition (SVD), QR-decomposition (QRD), and recursive least squares (RLS) minimization with different algorithms and architectures. Among others, *A systolic array for SVD updating,* M. Moonen et al (SIAM Journal of Matrix Analysis Applications, April 1993), *A rotation method for computing the QR-decomposition,* F. T. Luk (SIAM Journal of Scientific and Statistical Computing, April 1986) and *Algorithmic engineering in adaptive signal processing,* J. G. McWhirter (Proceedings of the IEEE, June 1992).

Chapter 2 - Adaptive Filtering- shows the progress on numerically stable, fast, convergent, recursive least-squares (RLS) algorithms that are parallel, concurrent, and suitable for VLSI architectures. This chapter starts with a paper by J. M. Cioffi *A fast adaptive ROTOR's RLS algorithm* (IEEE Transactions on Acoustics, Speech, and Signal Processing, April 1990); other papers are *Givens rotation based least-squares lattice and related algorithms*, F. Ling (IEEE Transactions on Signal Processing, July 1991), *Recursive triangular array ladder algorithms*, P. Strobach, *and Systolic array designs for Kalman filtering*, S. Y. Kung and J. N. Hwang (both on IEEE Transactions on Acoustics, Speech, and Signal Processing, January 1991).

Chapter 3 - Coding and Data Compression- explores some basic concepts of VLSI algorithms and processor architectures relevant to high-performance coding applications. This chapter includes ten papers, two dealing with Viterbi decoding of convolutional codes, two on decoding of Reed-Solomon block codes, three on Huffman entropy, others are on lossless data compression, vector quantization encoding of images and high dimensional demodulation/decoding. Among them, we can find *Systolic array processing of the Viterbi algorithm* by C. Y. Chang and K. Yao (IEEE Transactions on Information Theory, January 1989), *Reed-Solomon VLSI codec for advanced television* by S. R. Whitaker, J. A. Canaris, and K. B. Cameron (IEEE Transactions Circuits and Systems for Video Technology. June 1991) and *Parallel demodulation of multidimensional signals* by E. Biglieri (IEEE Transactions on Communications, October 1992).

Chapter 4 - Image Processing and Video Technology- collects some comprehensive and understandable papers on the impact of VLSI on image and video. Due to the page limitation, the editors' selection is focused only in video technology but mention more than a hundred extra references. This chapter start with an excellent survey paper by P. Pirsch, N. Demassieux, and W. Gehrke *VLSI architectures for video compression -A survey* (Proceedings of the IEEE, February 1995) followed by D. J. Mlynek and J. Kowalczuk reprinted paper *VLSI for digital television* (Proceedings of the IEEE, July 1995) in which a complete digital television system is considered, other papers are on architecture design issues for discrete cosine transform algorithms and wavelets

transform for video communications. Motion estimation and block matching algorithms, video codec and high-quality video in a wireless communication environment are also treated.

Chapter 5 - Digital Signal Processing and Speech Processing – addresses the impact of VLSI on conventional 1-D signal and speech processing. Similar to the previous chapter, the selected papers cover the main activities in these areas. Discrete Fourier Transform real time implementation, look-up table approach for Residue Number System structure solution, IIR filtering with bit-level systolic array, non-linear filters and dynamic programming are treated. Examples are the review and comparison made by D. S. Richards in *VLSI median filters* (IEEE Transactions on Acoustics, Speech, and Signal Processing, January 1990), and W. G. Bliss and L. L. Sharf's *Algorithms and architectures for dynamic programming on Markov chains* (IEEE Transactions on Acoustics, Speech, and Signal Processing, June 1989). Applications to speech recognition are also considered. The hundred extra references the editors made in this chapter may also be noted.

Chapter 6 - Neural Network - considers only some basic VLSI engineering and architectural aspects of Artificial Neural Networks (ANN). Of the eight reprinted papers, three of them deal with analog and two with digital circuits of ANNs, two consider mapping and architecture, and one treats simulation and architecture. M. Maher et al.'s reprinted paper *Implementing neural architectures using analog VLSI circuits* (IEEE Transactions on Circuits and Systems, May 1989) belongs to the first group, and Y. Fujimoto et al.'s *Massively parallel architectures for large scale neural network simulations* (IEEE Transactions on Neural Networks, November 1992) is the selected paper for the last mentioned group.

This book is especially appropriate for those who have a basic understanding of signal processing and have an interest in high-performance implementation of signal/image processing, including those with an interest in analysis, system, software, or hardware within this area.

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