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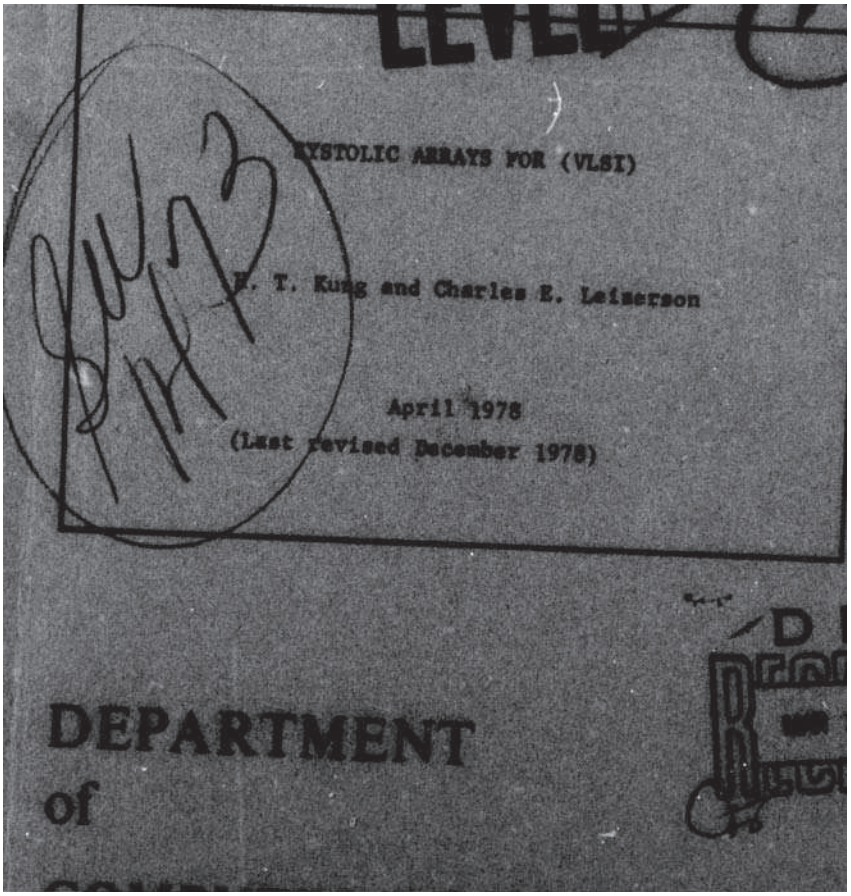

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SYSTOLIC ARRAYS FOR (VLSI)

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[In the forthcoming book Introduction to VLSI Systems by C. A. Mead and L. A. Conway]

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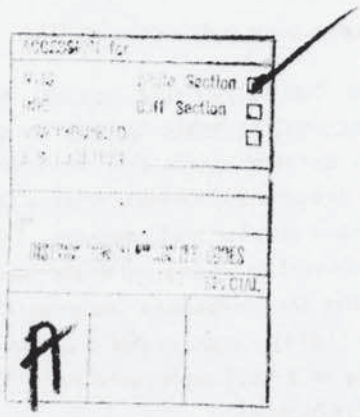

And now I see with eye serene
The very pulse of the machine.
--William Wordsworth

Abstract

A systolic system is a network of processors which rhythmically compute and pass data through the system. Physiologists use the word "systole" to refer to the rhythmically recurrent contraction of the heart and arteries which pulses blood through the body. In a systolic computing system, the function of a processor is analogous to that of the heart. Every processor regularly pumps data in and out, each time performing some short computation, so that a regular flow of data is kept up in the network.

Many basic matrix computations can be pipelined elegantly and efficiently on systolic networks having an array structure. As an example, hexagonally connected processors can optimally perform matrix multiplication. Surprisingly, a similar systolic array can compute the LU-decomposition of a matrix. These systolic arrays enjoy simple and regular communication paths, and almost all processors used in the networks are identical. As a result, special purpose hardware devices based on systolic arrays can be built inexpensively using the VLSI technology.

1. Introduction

Developments in microelectronics have revolutionized computer design. Integrated circuit technology has increased the number and complexity of components that can fit on a chip or a printed circuit board. Component density has been doubling every one-to-two years and already, a multiplier can fit on a very large scale integrated (VLSI) circuit chip. As a result, the new technology makes it feasible to build low-cost special purpose, peripheral devices to rapidly solve sophisticated problems. Reflecting the changing technology, this paper proposes new multiprocessor

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