Textbook: VLSI ARRAY PROCESSORS
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Chapter 1

An Overview
Outline of Chapter 1

1.1 Introduction
1.2 Array Processors for Signal and Image Processing
1.3 VLSI Architecture Design Principles
1.4 Overview of the Chapters
1.5 Other Closely Related Research Disciplines
1.6 Concluding Remarks
1.7 Problems
1.1 Introduction
1.2 Array Processors for Signal and Image Processing
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1.1 Introduction

- For the demands of modern real-time application
  - General purpose processor solution
  - Dedicated VLSI array processor
Y-Chart for Array Processor Design

Structural Representation
(Computer Architecture Area)

Functional Representation
(DSP Area)

Array Compiler
(Algorithm-Array Mapping)

DSP Application

Parallel Algorithm

Basic Operation

Boolean Logic

Processor Element

Interconnection Pattern

Bit Slice

Silicon Compiler
(Structure-Layout Mapping)

Cells

Layout Plan

WSI

Geometrical Representation
(VLSI Design Area)
1.1 Introduction
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Four Main Points of Attack in Designing VLSI Array Processors

1. Application
2. Algorithm
3. Architecture
4. Technology
1. Image Processing
2. Computer Vision
3. Nuclear Physics
4. Structure Analysis
5. Speech
6. Sonar
7. Radar
8. Seismic
9. Weather
10. Astronomical
11. Medical Signal Processing
1.2 Array Processors for Signal and Image Processing

Algorithm

1. Point Type
2. Filtering Type
3. Matrix Algebra Type
4. Transform Type
5. Sorting Type
# Throughput Requirements for DSP Algorithms

<table>
<thead>
<tr>
<th>Processing Function</th>
<th>Necessary Throughput</th>
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<tbody>
<tr>
<td>Linear Operations, $O(N)$</td>
<td>$10^2$-$10^5$ MOPS</td>
</tr>
<tr>
<td>- spatial filtering</td>
<td></td>
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<tr>
<td>- convolution</td>
<td></td>
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<tr>
<td>- edge detection</td>
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<tr>
<td>Second-order Operations, $O(N^2)$</td>
<td>$10^3$-$10^7$ MOPS</td>
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<tr>
<td>- sorting operation</td>
<td></td>
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<tr>
<td>- median filtering</td>
<td></td>
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<tr>
<td>- nearest-neighbor classification</td>
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<tr>
<td>High Order Operations</td>
<td>$10^4$-$10^8$ MOPS</td>
</tr>
<tr>
<td>- matrix based</td>
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<tr>
<td>- spectral processing</td>
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<tr>
<td>- adaptive operation</td>
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1.2 Array Processors for Signal and Image Processing

- SIMD Array
- MIMD Array
- VLSI Array Processor

Architecture
1.2 Array Processors for Signal and Image Processing

- **SIMD (single instruction multiple data stream) Array**

CU: Control Unit
PU: Processor Unit
MM: Memory Module
SM: Share Memory
IS: Instruction Stream
DS: Data Stream
MIMD (multiple instruction multiple data stream) Array
1.2 Array Processors for Signal and Image Processing

- **VLSI Array Processor: Derive Concurrency**

1. Parallel Processing
2. Pipeline Processing
1.2 Array Processors for Signal and Image Processing

- Manufacturing Technology
  1. CMOS: Low Cost SoC Technology
  2. BiCMOS
  3. GaAs: Very High Speed Application
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1.4 Overview of the Chapters

- Vertically Integrated VLSI (ASIC) System Design

- Algorithms/Specifications
- Problem Formulation/Algorithm Analysis
- Mapping Algorithm onto Array
- Array Processor Design
- Implementation

Application
Software
Hardware
1.4 Overview of the Chapters

- **The Book Chapters are Covered**

1. Introduction - An Overview
2. Signal and Image Processing Algorithms
3. Mapping Algorithm onto Array Structures
4. Systolic Array Processors
5. Wavefront Array Processors
6. System and Software Design
7. Implementation of Array Processors
8. Application to Signal and Image Processing