

Table of Contents

	Page
Contents	v
Preface	ix
1. Real-World Signal Processing	
1.1 Introduction. Chapter overview; What is real-world DSP? MOS-VLSI signal processors with real-time capability	1
1.2 Review of Signals and Signal Processing. Enhancement of signal-to-noise; System models and the transfer function ..	6
1.3 Spectra—Time and Frequency as Complementary Domains. Time and frequency, two ways to study a system; System prototypes, the second-order system and the delay line; The spectrum and spectral fingerprints	8
1.4 Limitations of Analog Systems. Dynamic-range example, analog vs. digital audio; Analog filter tradeoffs, ideals and reality	16
1.5 Digital Signal Processing. Flexibility, key advantage to DSP; DSP issues and terminology; Sampled data; Throughput expansion, data compression, and pipelining	20
1.6 Non-Recursive Filters—The Moving Average as an Example. Finite impulse-response filters; Digital filters	29
1.7 Recursive Filters From Their Analog Counterparts. Analog feedback filters and their recursive digital counterparts; Introducing recursive filters; The digital filter in block-diagram form; Comparing software- and hardware-multiplier handling of the 1st-order low-pass; How do difference equations relate to the analog system? Impulse response as a probe of system dynamics	34
1.8 Digital Audio Example	47

2. Sampled Signals and Systems	
2.1 Introduction. Building blocks of a sampled-data system . . .	53
2.2 Review of Fourier Series and Fourier Transforms. Fourier-series analysis; The Fourier transform and its properties . .	54
2.3 The Convolution Theorem. Fourier transform of a product; Properties of convolutions; The convolution theorem in Fourier transforms, Related signal-spectrum theorems: Parseval, correlation, auto correlation	63
2.4 Limits to Information. Tone bursts and frequency uncertainty; The uncertainty principle of information	72
2.5 Sampled Data. Sampling, aliasing, and anti-aliasing filters .	74
2.6 Fourier Transform of Sampled Data. Special functions in sampled data; Spectral properties of sampled data; Summary of spectral features of sampled data; Example: sinusoidal signal generator	79
2.7 Laplace and z -Transforms. Review of analog filter concepts; Stability facts for analog systems; Poles, spectral response, and filter behavior; The z -transform (equivalent of Fourier/Laplace transform for sampled data)	88
2.8 Simple Digital Filters. Finite impulse-response (FIR) filters; Numerical analysis filters; Infinite impulse-response (IIR) filters; Recursive filters in numerical analysis	99
3. The Discrete Fourier Transform and the Fast Fourier-Transform Algorithm	
3.1 Introduction	117
3.2 The Discrete Fourier Transform	118
3.3 Fast Fourier-Transform Algorithms. Multiply-time bottleneck of conventional DFT; Real-time analysis of speech; The FFT algorithm; Signal flow graphs, decimation-in-time FFT, and bit reversal; Decimation-in-frequency FFT and the inverse FFT; Butterflies for complex signals and spectra; Real-valued signals; FFT program example	121
3.4 Windows and Window Weighting. Why window weighting? Gaussian window; Cosine bell window; The Hamming and Blackman windows; Kaiser-Bessel window; Window weighting summary	139
3.5 Spectral Analysis Example	152
3.6 FFT Applications: Decimation, Convolution, Deconvolution. Spectral consequences of decimation and interpolation; FFTs for rapid convolution; Deconvolution for image enhancement; Fourier filtering and inverse FFT fidelity; Transformations into the spectral domain: multicomponent-exponential example	153

4. Digital Filters	
4.1 Digital Filter Overview. Digital filters. when, why, what, how? Comparison of digital filter types; Summary of key digital filter relationships	173
4.2 Finite-Impulse-Response Filters. FIR filter concepts and properties; The Fourier-series approach to FIR filters; The window method of FIR filter design; Computer-aided optimization for FIR filter design; Filter simulation and finite word-length effects; Hardware implementation of FIR filters	182
4.3 Infinite-Impulse-Response Filters. The second-order section as a prototype; Biquads for special purposes; Higher-order filter synthesis; Hardware implementation of the biquad; Mapping analog design to digital design: impulse-invariant and other common transformations; Review of high-performance analog filters; CAD approach to high-performance IIR filters	207
5. The Bridge to VLSI	
5.1 Chapter Overview and Issues. Introduction; Computing-speed-performance evaluation; First words about accuracy.	235
5.2 Some VLSI-DSP Design Philosophy. A philosophical framework for VLSI-DSP; Desirable features of a DSP processor; DSP chip families defined	246
5.3 DSP Architecture Issues: Tradeoffs, Pipelining, and Parallelism. On-chip/off-chip tradeoffs and processor performance; Data-flow bottlenecks and their resolution	256
5.4 Finite-Wordlength Arithmetic. Introduction; Arithmetic error sensitivity; Overflow, underflow, and rounding; Filter quantization-error tradeoffs in fixed-point arithmetic; Accuracy in FFT spectral analysis.	272
5.5 Analog I/O Methods: Dynamic-Range and Throughput Tradeoffs. Overview of analog I/O requirements and methods; I/O dynamic range and throughput requirements; Expanded I/O dynamic range with minimum speed loss; Nonlinear I/O digitization: companding and the LOGDAC.	293
6. Real DSP Hardware	
6.1 Introduction; Chapter Overview	307
6.2 Key DSP Hardware Elements. Multipliers; Multiplier-accumulators (MAC); Arithmetic logic units (ALU); Shifters: scaling control; Data-address generator; Program sequencer; Memory issues	309

6.3	System Selection. DSP system alternatives; Microcoded systems; Single-chip DSP microprocessor survey.	352
6.4	DSP Microprocessor: ADSP-2100. Introduction; System configuration; Microprocessor architecture; Instruction set.	368
7.	Software Development for the DSP System	
7.1	Introduction.	401
7.2	Software Development Tools for the DSP Microprocessor. Development system philosophy and functions; Target system specification phase; Assembler; Linker; Simulator; Prom splitter; Target emulation; DSP system example: real-time isolated-word recognizer	402
7.3	Microcoded System Software Development. Differences between GP and Word-Slice software development; Meta assemblers: from user-defined mnemonics to microcode bits.	437
8.	DSP Applications	
8.1	Introduction.	447
8.2	Major Elements of a DSP System. The digital transceiver; Digital detection; Digital heterodyning, decimation, and interpolation.	449
8.3	Real-Time Detection. Examples based on correlation principles; Examples based on <i>a priori</i> knowledge of the underlying system; Coherent detection or lock-in techniques; Spectrum analyzers; Spectral analysis and estimation.	468
8.4	Modelling in Real Time: Telecommunications and Speech. Why modelling; Telecommunications; Coding of speech	508
8.5	Real-Time Signal Generation and Music Synthesis. Introduction and section overview; Fast function generation; What makes music? Analysis of musical sounds; How digital music synthesis is done; Parametric (FM) synthesizer design.	524
8.6	Image Processing. Introduction to image processing; Machine vision: acquisition, enhancement, recognition; Medical image-processing	555
	Bibliography	xv
	Index	xxvii