

The Scientist and Engineer's Guide to
Digital Signal Processing

Second Edition

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by
Steven W. Smith

California Technical Publishing
San Diego, California

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Contents at a Glance

FOUNDATIONS

Chapter 1.	The Breadth and Depth of DSP	1
Chapter 2.	Statistics, Probability and Noise	11
Chapter 3.	ADC and DAC	35
Chapter 4.	DSP Software	67

FUNDAMENTALS

Chapter 5.	Linear Systems	87
Chapter 6.	Convolution	107
Chapter 7.	Properties of Convolution	123
Chapter 8.	The Discrete Fourier Transform	141
Chapter 9.	Applications of the DFT	169
Chapter 10.	Fourier Transform Properties	185
Chapter 11.	Fourier Transform Pairs	209
Chapter 12.	The Fast Fourier Transform	225
Chapter 13.	Continuous Signal Processing	243

DIGITAL FILTERS

Chapter 14.	Introduction to Digital Filters	261
Chapter 15.	Moving Average Filters	277
Chapter 16.	Windowed-Sinc Filters	285
Chapter 17.	Custom Filters	297
Chapter 18.	FFT Convolution	311
Chapter 19.	Recursive Filters	319
Chapter 20.	Chebyshev Filters	333
Chapter 21.	Filter Comparison	343

APPLICATIONS

Chapter 22.	Audio Processing	351
Chapter 23.	Image Formation and Display	373
Chapter 24.	Linear Image Processing	397
Chapter 25.	Special Imaging Techniques	423
Chapter 26.	Neural Networks (and more!)	451
Chapter 27.	Data Compression	481
Chapter 28.	Digital Signal Processors	503
Chapter 29.	Getting Started with DSPs	535

COMPLEX TECHNIQUES

Chapter 30.	Complex Numbers	551
Chapter 31.	The Complex Fourier Transform	567
Chapter 32.	The Laplace Transform	581
Chapter 33.	The z-Transform	605

Glossary	631
Index	643

Table of Contents

FOUNDATIONS

Chapter 1. The Breadth and Depth of DSP	1
The Roots of DSP	1
Telecommunications	4
Audio Processing	5
Echo Location	7
Imaging Processing	9
Chapter 2. Statistics, Probability and Noise	11
Signal and Graph Terminology	11
Mean and Standard Deviation	13
Signal vs. Underlying Process	17
The Histogram, Pmf and Pdf	19
The Normal Distribution	26
Digital Noise Generation	29
Precision and Accuracy	32
Chapter 3. ADC and DAC	35
Quantization	35
The Sampling Theorem	39
Digital-to-Analog Conversion	44
Analog Filters for Data Conversion	48
Selecting the Antialias Filter	55
Multirate Data Conversion	58
Single Bit Data Conversion	60
Chapter 4. DSP Software	67
Computer Numbers	67
Fixed Point (Integers)	68
Floating Point (Real Numbers)	70
Number Precision	72
Execution Speed: Program Language	76
Execution Speed: Hardware	80
Execution Speed: Programming Tips	84

FUNDAMENTALS

Chapter 5. Linear Systems	87
Signals and Systems	87
Requirements for Linearity	89
Static Linearity and Sinusoidal Fidelity	92
Examples of Linear and Nonlinear Systems	94
Special Properties of Linearity	96
Superposition: the Foundation of DSP	98
Common Decompositions	100
Alternatives to Linearity	104
Chapter 6. Convolution	107
The Delta Function and Impulse Response	107
Convolution	108
The Input Side Algorithm	112
The Output Side Algorithm	116
The Sum of Weighted Inputs	122
Chapter 7. Properties of Convolution	123
Common Impulse Responses	123
Mathematical Properties	132
Correlation	136
Speed	140
Chapter 8. The Discrete Fourier Transform	141
The Family of Fourier Transforms	141
Notation and Format of the real DFT	146
The Frequency Domain's Independent Variable	148
DFT Basis Functions	150
Synthesis, Calculating the Inverse DFT	152
Analysis, Calculating the DFT	156
Duality	161
Polar Notation	161
Polar Nuisances	164
Chapter 9. Applications of the DFT	169
Spectral Analysis of Signals	169
Frequency Response of Systems	177
Convolution via the Frequency Domain	180
Chapter 10. Fourier Transform Properties	185
Linearity of the Fourier Transform	185
Characteristics of the Phase	188
Periodic Nature of the DFT	194
Compression and Expansion, Multirate methods	200

Multiplying Signals (Amplitude Modulation)	204
The Discrete Time Fourier Transform	206
Parseval's Relation	208
Chapter 11. Fourier Transform Pairs	209
Delta Function Pairs	209
The Sinc Function	212
Other Transform Pairs	215
Gibbs Effect	218
Harmonics	220
Chirp Signals	222
Chapter 12. The Fast Fourier Transform	225
Real DFT Using the Complex DFT	225
How the FFT Works	228
FFT Programs	233
Speed and Precision Comparisons	237
Further Speed Increases	238
Chapter 13. Continuous Signal Processing	243
The Delta Function	243
Convolution	246
The Fourier Transform	252
The Fourier Series	255

DIGITAL FILTERS

Chapter 14. Introduction to Digital Filters	261
Filter Basics	261
How Information is Represented in Signals	265
Time Domain Parameters	266
Frequency Domain Parameters	268
High-Pass, Band-Pass and Band-Reject Filters	271
Filter Classification	274
Chapter 15. Moving Average Filters	277
Implementation by Convolution	277
Noise Reduction vs. Step Response	278
Frequency Response	280
Relatives of the Moving Average Filter	280
Recursive Implementation	282
Chapter 16. Windowed-Sinc Filters	285
Strategy of the Windowed-Sinc	285
Designing the Filter	288
Examples of Windowed-Sinc Filters	292
Pushing it to the Limit	293

Chapter 17. Custom Filters	297
Arbitrary Frequency Response	297
Deconvolution	300
Optimal Filters	307
Chapter 18. FFT Convolution	311
The Overlap-Add Method	311
FFT Convolution	312
Speed Improvements	316
Chapter 19. Recursive Filters	319
The Recursive Method	319
Single Pole Recursive Filters	322
Narrow-band Filters	326
Phase Response	328
Using Integers	332
Chapter 20. Chebyshev Filters	333
The Chebyshev and Butterworth Responses	333
Designing the Filter	334
Step Response Overshoot	338
Stability	339
Chapter 21. Filter Comparison	343
Match #1: Analog vs. Digital Filters	343
Match #2: Windowed-Sinc vs. Chebyshev	346
Match #3: Moving Average vs. Single Pole	348

APPLICATIONS

Chapter 22. Audio Processing	351
Human Hearing	351
Timbre	355
Sound Quality vs. Data Rate	358
High Fidelity Audio	359
Companding	362
Speech Synthesis and Recognition	364
Nonlinear Audio Processing	368
Chapter 23. Image Formation and Display	373
Digital Image Structure	373
Cameras and Eyes	376
Television Video Signals	384
Other Image Acquisition and Display	386
Brightness and Contrast Adjustments	387
Grayscale Transforms	390
Warping	394

Chapter 24. Linear Image Processing	397
Convolution	397
3×3 Edge Modification	402
Convolution by Separability	404
Example of a Large PSF: Illumination Flattening	407
Fourier Image Analysis	410
FFT Convolution	416
A Closer Look at Image Convolution	418
Chapter 25. Special Imaging Techniques	423
Spatial Resolution	423
Sample Spacing and Sampling Aperture	430
Signal-to-Noise Ratio	432
Morphological Image Processing	436
Computed Tomography	442
Chapter 26. Neural Networks (and more!)	451
Target Detection	451
Neural Network Architecture	458
Why Does it Work?	463
Training the Neural Network	465
Evaluating the Results	473
Recursive Filter Design	476
Chapter 27. Data Compression	481
Data Compression Strategies	481
Run-Length Encoding	483
Huffman Encoding	484
Delta Encoding	486
LZW Compression	488
JPEG (Transform Compression)	494
MPEG	501
Chapter 28. Digital Signal Processors	503
How DSPs are different	503
Circular Buffering	506
Architecture of the Digital Signal Processor	509
Fixed versus Floating Point	514
C versus Assembly	520
How Fast are DSPs?	526
The Digital Signal Processor Market	531
Chapter 29. Getting Started with DSPs	535
The ADSP-2106x family	535
The SHARC EZ-KIT Lite	537
Design Example: An FIR Audio Filter	538
Analog Measurements on a DSP System	542

Another Look at Fixed versus Floating Point 544
Advanced Software Tools 546

COMPLEX TECHNIQUES

Chapter 30. Complex Numbers	551
The Complex Number System	551
Polar Notation	555
Using Complex Numbers by Substitution	557
Complex Representation of Sinusoids	559
Complex Representation of Systems	561
Electrical Circuit Analysis	563
Chapter 31. The Complex Fourier Transform	567
The Real DFT	567
Mathematical Equivalence	569
The Complex DFT	570
The Family of Fourier Transforms	575
Why the Complex Fourier Transform is Used	577
Chapter 32. The Laplace Transform	581
The Nature of the s-Domain	581
Strategy of the Laplace Transform	588
Analysis of Electric Circuits	592
The Importance of Poles and Zeros	597
Filter Design in the s-Domain	600
Chapter 33. The z-Transform	605
The Nature of the z-Domain	605
Analysis of Recursive Systems	610
Cascade and Parallel Stages	616
Spectral Inversion	619
Gain Changes	621
Chebyshev-Butterworth Filter Design	623
The Best and Worst of DSP	630
Glossary	631
Index	643

Preface

Goals and Strategies of this Book

The technical world is changing very rapidly. In only 15 years, the power of personal computers has increased by a factor of nearly *one-thousand*. By all accounts, it will increase by *another* factor of one-thousand in the next 15 years. This tremendous power has changed the way science and engineering is done, and there is no better example of this than Digital Signal Processing.

In the early 1980s, DSP was taught as a graduate level course in electrical engineering. A decade later, DSP had become a standard part of the undergraduate curriculum. Today, DSP is a *basic skill* needed by scientists and engineers in many fields. Unfortunately, DSP education has been slow to adapt to this change. Nearly all DSP textbooks are still written in the traditional electrical engineering style of detailed and rigorous mathematics. DSP is incredibly powerful, but if you can't understand it, you can't use it!

This book was written for scientists and engineers in a wide variety of fields: physics, bioengineering, geology, oceanography, mechanical and electrical engineering, to name just a few. The goal is to present practical techniques while avoiding the barriers of detailed mathematics and abstract theory. To achieve this goal, three strategies were employed in writing this book:

First, the techniques are *explained*, not simply proven to be true through mathematical derivations. While much of the mathematics is included, it is not used as the primary means of conveying the information. Nothing beats a few well written paragraphs supported by good illustrations.

Second, *complex numbers are treated as an advanced topic*, something to be learned after the fundamental principles are understood. Chapters 1-29 explain all the basic techniques using only algebra, and in rare cases, a small amount of elementary calculus. Chapters 30-33 show how complex math extends the power of DSP, presenting techniques that cannot be implemented with real numbers alone. Many would view this approach as heresy! Traditional DSP textbooks are full of complex math, often starting right from the first chapter.

Third, *very simple computer programs* are used. Most DSP programs are written in C, Fortran, or a similar language. However, *learning* DSP has different requirements than *using* DSP. The student needs to concentrate on the algorithms and techniques, without being distracted by the quirks of a particular language. Power and flexibility aren't important; simplicity is critical. The programs in this book are written to teach DSP in the most straightforward way, with all other factors being treated as secondary. Good programming style is disregarded if it makes the program logic more clear. For instance:

- a simplified version of BASIC is used
- line numbers are included
- the only control structure used is the FOR-NEXT loop
- there are no I/O statements

This is the simplest programming style I could find. Some may think that this book would be better if the programs had been written in C. I couldn't disagree more.

The Intended Audience

This book is primarily intended for a one year course in practical DSP, with the students being drawn from a wide variety of science and engineering fields. The suggested prerequisites are:

- A course in practical electronics: (op amps, RC circuits, etc.)
- A course in computer programming (Fortran or similar)
- One year of calculus

This book was also written with the practicing professional in mind. Many everyday DSP applications are discussed: digital filters, neural networks, data compression, audio and image processing, etc. As much as possible, these chapters stand on their own, not requiring the reader to review the entire book to solve a specific problem.

Support by Analog Devices

The Second Edition of this book includes two new chapters on *Digital Signal Processors*, microprocessors specifically designed to carry out DSP tasks. Much of the information for these chapters was generously provided by Analog Devices, Inc., a world leader in the development and manufacturing of electronic components for signal processing. ADI's encouragement and support has significantly expanded the scope of this book, showing that DSP algorithms are only useful in conjunction with the appropriate hardware.

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This book is now in the hands of the final reviewer, you. Please take the time to give me your comments and suggestions. This will allow future reprints and editions to serve your needs even better. All it takes is a two minute e-mail message to: Smith@DSPguide.com. Thanks; I hope you enjoy the book.

*Steve Smith
January 1999*