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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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