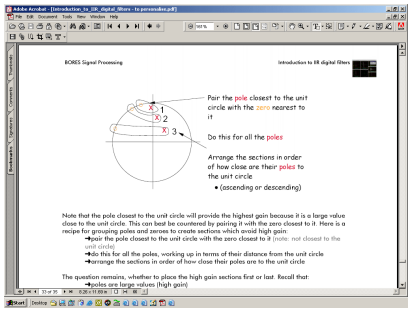
IIR digital filters

DSP eBook series

Benefits

IIR filters are prone to horrid failures. when implemented. This eBook focuses on implementation and explains how to avoid common pitfalls: You will understand:

- IIR design methods
- poles, zeroes and the z domain
- quantization and its feedback
- why different structures are used
- how to group coefficients and sections
- why many text books are misleading



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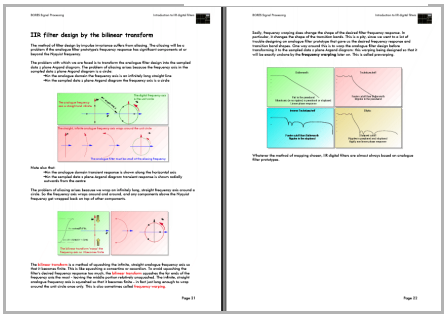

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What is an eBook?

This eBook is an electronic book in Adobe Acrobat™ file format. Clear explanations supported by color diagrams make it easy and helpful to read. You can view it on-screen or print sections to read away from the computer.

Contents

IIR filters are prone to really horrid failures. when implemented. Many texts ignore the problems of implementation, even though these can lead to catastrophic failure. In this very practically-oriented eBook we examine the reasons why IIR filters fail when implemented on real DSP hardware. We focus on the practical limitations and compromises that are forced on implementers by limited-precision hardware, and show useful practical ways to avoid the common pitfalls.

Understanding digital filters

We explain what filtering really is, how filters are specified, what we mean by the 'frequency domain', and why convolution comes into it.

- Filtering as frequency selection
- Digital filter specifications
- The frequency domain
- Convolution

IIR digital filters

We describe IIR digital filters and explain why they can be more efficient than the simpler FIR designs. We look into the meanings of the filter frequency and impulse responses, and see why the IIR response is called Infinite.

- The linear digital filter equation
- Filter frequency response
- Infinite impulse response

The meaning of z

An intuitive meaning for the 'z domain' is hard to come by. We explain the z transform and show how the z domain can be interpreted - including why filter diagrams have those little boxes with Z^{-1} in.

- The z transform and delays
- An intuitive interpretation of the z domain

Poles and zeroes

We explain how poles and zeroes determine the frequency and impulse responses, and show how to use the positions of poles and zeroes to estimate a filter's responses. We also show why IIR filters can become unstable, and why the position of poles relative to the unit circle determines stability.

- Poles and zeroes
- How poles determine stability
- Poles, zeroes and frequency response

IIR design methods

We show why IIR design is more art than science, explain how the main design methods work and outline their limitations

The impossibility of direct IIR design

- IIR filter design by impulse invariance
- Aliasing in impulse invariant designs
- IIR filter design by the bilinear transform

IIR implementation

The problems of implementation, especially of quantization noise being fed back to create unworkable filters, are crucial to good IIR design in practice. We explain why IIR filters are implemented as second-order sections, and how the different implementation structures try to limit quantization errors.

- A simple but unworkable IIR filter program
- Non-linear effects
- The failure of math in practice
- Why we use second order sections

Quantization problems

We explain how quantization, and its non-linear nature, makes math and IIR filters break down - and how to try to avoid this happening.

- Quantization in IIR filters
- DSP data formats
- Parallel and cascade IIR structures
- ordering sections & grouping coefficients
- Direct form I and II structures
- Why many texts are misleading

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Your credit card is charged in pounds Sterling: the credit card company will convert to your local currency at their exchange rate. For guidance, on 28th March 2002 £20 Sterling works out at about $28 or €33.

To book or find out more

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