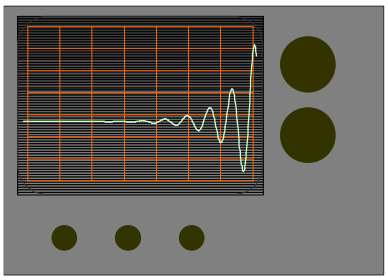
IIR digital filters

DSP foundation series

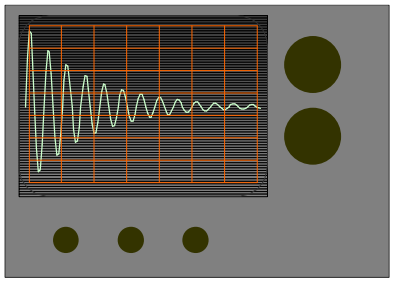
Benefits

Avoid the common disasters encountered by naive IIR filter designers, understand how IIR filters are designed, and learn to control problems when implementing on real hardware, through our clear and practical seminar presentation.

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. We focus on implementation issues, and explain how to avoid the common pitfalls.



From 'should' work...



...to would work

Contents

In this very practically-oriented seminar we examine the reasons why IIR filters fail so often and so catastrophically 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.

IIR filter basics

We review the basics of IIR digital filtering, especially with regard to practical effects.

- Linear IIR Filters
- Filtering to smooth a signal

Analysis of IIR filters

We explain how the IIR filter operation can be analysed, and show how the impulse and frequency responses are calculated.

- Fourier transforms
- Spectral analysis
- Fourier analysis of IIR filtering
- IIR frequency response

IIR filter design

The problem of IIR filter design is an inverse one - to design the coefficients, given a desired end result (the filter response). We explain why this problem has never been solved, and show how some compromises can be used to avoid solving the design problem. We also give some useful models for relating filter response to poles and zeroes.

- The z transform and the meaning of z
- Poles, zeroes and filter response
- Design by impulse invariance
- Limitations of impulse invariant designs
- Bilinear transform design

IIR filter programming

We present a simple program to implement an IIR filter, and (later) show how this must be modified in order to actually work.

- A simple IIR filter program

Practical limitations

We analyse and explain the limitations and compromises faced in practical design situations, especially the difficult problems posed by implementing on hardware with finite precision arithmetic.

- Finite precision and quantization noise
- Fixed and floating point formats
- Precision and dynamic range
- The advantage of floating point
- Why floating point is faster too
- The problems of quantization feedback
- Impracticality of high order filters

Design workarounds

We present ways to work around the practical limitations of implementing IIR filters, and show how the different implementation structures arise to address different problems.

- Why we use second order sections
- The effects of scaling and quantization
- Parallel and cascade structures

Rules of thumb

We present rules of thumb that help guide design choices such as: which pole/zero pairs to group in second order sections; how to arrange the sections in order; and which implementation structures to choose.

- How to group poles and zeros in sections
- How to order the sections
- Filters as block diagrams

Debunking nonsense

Some utter nonsense is talked regarding IIR filters. At least, it is nonsense from a practical viewpoint: many things would work if we had infinite precision hardware, but we don't, so they won't. We review some dangerous notions and help to dispel some myths.

- Cascade and transposed structures
- The non-equivalence of structures
- Why most IIR filters go wrong

Time and arrangements

The 'DSP foundation' 3-day seminar series gives a thorough grounding in DSP including fundamentals, FIR filters and IIR filters. It is presented 'on-site' by arrangement - the material can be adapted if you have specific needs (at extra cost). We recommend it be followed as a series, but individual 1-day seminars can be taken by arrangement if desired.

- on-site by arrangement
- contact: Chris Bore
- email: chris@bores.com

IIR digital filters seminar

- 1-day seminar presentation
- £330 (€550, $660) per person
- arrangements as above

DSP 'foundation' series

- 3-day seminar series
- £ 990 (€1,650: $ 1,980) per person
- arrangements as above

To book or find out more

Call us by 'phone or send email to book or to ask questions.

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DSP foundation seminars

The 'DSP foundation' is a 3-day series of seminars designed to give a thorough understanding of DSP including FIR and IIR filtering. The series can be followed as a 3-day session or as separate 1-day sessions, by arrangement.

- Introduction to DSP
- FIR digital filters
- IIR digital filters

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