DIGITAL FILTERS

DIGITAL FILTERS

Digital Filters

- In this course you will learn:
- How to choose an appropriate filter response.
- Why Butterworth responses are maximally flat.
- Why Chebyshev and Elliptic responses are equiripple.
- When to choose an IIR and when an FIR filter

DIGITAL FILTERS

- How do you design FIR and IIR filters from specifications on amplitude performance?
- What are multirate systems and their properties? What is interpolation / Upsampling and Decimation / Downsampling?
- How do you design efficient Decimation and Interpolation systems?
- What are frequency transformations and how do you design these?
- How accurate is the DFT as a spectrum estimator?

DIGITAL FILTERS

- What are short FFT algorithms?
- How do you choose the required wordlength?
- What are Fast Convolutions and how are they realised?
- How do you deal with a DSP problem in practice?

Course content

Assumed DSP background

DSP Background folder

- 1-Introduction
- 2-z transform
- 3-transfer functions
- 4-Signal Flow Graphs
- 5-digital filters intro

Course content

2-Digital Filter Design

- 1-Digital Filters (FIR)
- 2-Digital Filters (IIR)

3-Multirate

1-Interpolation_Decimation

Course content

4-Tranforms

- 1-DFT
- 2-DFT_one2two
- 3-general transforms
- 4-Wavelets

5-Finite Wordlength

- 1-Finite Wordlength

Course content

6-Spectrum Estimation (Assumed background in Mathematical Background folder)

- 1-Fourier transform & DFT
- 2-FFT-based Power Spectrum Estimation
- 3-Modern Spectrum Estimation
- 4-Intro-Estimation
- 5-Eigen-based methods
- 6-A Prediction Problem

Course content

7-Adaptive Signal Processing

- 1-Adaptive Signal Processing

8-Applications

- 1-Applications
- 2-Applications

Digital Signal Processing & Digital Filters

BOOKS

- **Main Course text books:** Digital Signal Processing: A computer Based Approach, S K Mitra, McGraw Hill
- Mathematical Methods and Algorithms for Signal Processing, Todd Moon, Addison Wesley
- Other books:
- Digital Signal Processing, Roberts & Mullis, Addison Wesley
- Digital Filters, Antoniou, McGraw Hill

DIGITAL FILTERS

Analogue Vs Digital Signal Processing

Reliability:

Analogue system performance degrades due to:

- Long term drift (ageing)
- Short term drift (temperature?)
- Sensitivity to voltage instability.
- Batch-to-Batch component variation.
- High discrete component count

Interconnection failures

DIGITAL FILTERS

Digital Systems:

- No short or long term drifts.
- Relative immunity to minor power supply variations.
- Virtually identical components.
- IC's have > 15 year lifetime
- Development costs
- System changes at design/development stage only software changes.
- Digital system simulation is realistic.

DIGITAL FILTERS

Power aspects

- Size
- Dissipation

- DSP chips available as well as ASIC/FPGA realisations

Applications

Radar systems & Sonar systems

- Doppler filters.
- Clutter Suppression.
- Matched filters.
- Target tracking.

- Identification

DIGITAL FILTERS

Image Processing

- Image data compression.
- Image filtering.
- Image enhancement.
- Spectral Analysis.
- Scene Analysis / Pattern recognition.

DIGITAL FILTERS

Biomedical Signal Analysis

- Spatial image enhancement. (X-rays)
- Spectral Analysis.
- 3-D reconstruction from projections.
- Digital filtering and Data compression.

DIGITAL FILTERS

Music

- Music recording.
- Multi-track “mixing”.
- CD and DAT.
- Filtering / Synthesis / Special effects.

DIGITAL FILTERS

Seismic Signal Analysis

- Bandpass Filtering for S/N improvement.
- Predictive deconvolution to extract reverberation characteristics.
- Optimal filtering. (Wiener and Kalman.)

DIGITAL FILTERS

Telecommunications and Consumer Products

These are the largest and most pervasive applications of DSP and Digital Filtering

- Mobile Communications
- Digital Recording
- Digital Cameras
- Blue Tooth or similar