8001202 SYSTEM LEVEL DSP ALGORITHMS

- Lectures: Tapio Saramäki, ts@cs.tut.fi
- Thursday and Friday 12–14, TB215
- First lecture 10.3, no lectures 17-18.3
- Exercises: Mikko Koivuluoma, k73210@cs.tut.fi
- Wednesday 12–14, TC407

PURPOSE OF THE COURCE

- System-level design of DSP algorithms for varoius applications.
- Special emphasis is on the optimization of these algorithms for VLSI and signal processor implementations.
- We do not consider actual VLSI and processor implementaions since there are separate cources for these purposes.
- However, we try to act as a team with the implementation specialists such that they tell us what is crucial to take into account when optimizing the algorithms at the system level.

CONTENTS

DIVISION OF THE COURSE INTO SUBTOPICS

PART I: Why there is a need for developing algorithms at the system level

PART II: Design of digital filters using identical subfilters as basic building blocks

PART III: Design of various kinds of digital filters meeting the same criteria

PART IV: Finite wordlength effects

Part V: Some elegant designs based on the use of recursive running sum filters

Part VI: Design of digital filters and filter banks by optimization: Applications

Part VII: Ant research

HOW TO PASS THE COURSE?

- Final examination.
- Three homeworks will be given out of which two must be done. For the remaining homework, extra points will be given which are added to the points obtained from the final examination.

COURSE MATERIAL

- Lecture notes and copies of some articles

PART I: Why there is a need for developing algorithms at the system level

- This part serves as an introduction to the course.

PART II: Design of digital filters using identical subfilters as basic building blocks

- This part is very long since the lecturer has been studied intensively these filter structures.
- It is not worth trying to remember all the details by heart. For the examination, it is important to understand the basic ideas.
- The key idea behind the filter structures to be considered lies in the fact that we are able to design filters in such a way that no general multipliers are needed.
- Filters of this kind are very attractive for VLSI implementations where a general multiplier element is very costly.
- We start by considering results. Then, we concentrate on how to generate these results.

PART III: Design of various kinds of digital filters meeting the same criteria

- This part shows how the same filter criteria can be met by various kinds of digital filters.
- Futhermore, it is shown that after proper reasoning we are able to end up filters with a drastically reduced complexity.

PART IV: Finite wordlength effects

- This part can be divided inro the following three topics:
- How to easily quantize the coefficients of direct-form FIR filters.
- How to easily quantize the coefficients of IIR filters implemented as a cascade of second- and first order blocks.
- How to easily quantize the coefficients of IIR filters being implementable as a parallel connection of two allpass filters.
- Validity of the quantization noise model.

Part V: Some elegant designs based on the use of recursive running sum filters

- This pile contains two articles on how generate elegant products with the aid of running sum filter.
- What to read for the examination: Why the recursive structures in these articles are so effective? When do they work in a proper manner? That is all folks!

Part VI: Design of digital filters and filter banks by optimization: Applications

- The purpose of this part is to give a rough idea on how to use linear and nonlinear optimization for synthesizing DSP algorithms.

- There are sets of transparencies of two talks as well as one long article.

- What to read for the examination: Why the two-step procedure described in the two talks as well as in the article are very useful in the cases it can be applied.

- Please do not read all the details!!

- Note that the first set of transparencies concentrates on the use of the Dutta-Vidyasagar algorithm that has been implemted in FORTRAN. The file fminimax.m in the MATLAB OPTIMIZATION TOOLBOX can be used equally well for the same purpose. Please do not hesitate to contact the lecture if you like to use this file.

Part VII: Ant research

- This is the most crucial part of the course. Please read very carefully!!