EE-555 **Systems and architectures for signal processing**

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Cursus	Sem.	Type
Electrical and Electronical Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Oral
Workload	90h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

Study of the essential components and implementation technologies of digital signal processing and communication systems from the theoretical, algorithmic and system implementation point of view.

Content

Multimedia algorithms and architectures
Introduction of basic and advanced elements of compression theory (coding models and entropy coders), with applications to digital video processing, including the essential elements of acquisition, rendering, transport, standard and non-standard algorithms. MPEG algorithms and systems architectures, new trends in video and multimedia processing. Introduction of algorithms for the compression and indexing in the compression domain of genomic sequencing data.
Digital integrated systems
Overview of the state of the art of the system components architectures for video and signal processing. System behavior of different types of memories, relation with algorithmic requirements. Features and limits of current and next generation deep-submicron technologies. New challenges of CMOS based processing architectures: low power, many and multi-core platforms.
Practical design case studies
Specification and modeling of simple components of a video system communication component, analysis, optimization of the algorithmic behavior and analysis of the system implementation challenges. Study and analysis of compression system with indexing capabilities for data retrieval.

Keywords

signal processing systems, video compression systems, communication systems, genomic data compression

Learning Prerequisites

Recommended courses

Signal processing; Programming II; Information, Computation, Communication.

Important concepts to start the course

Basic theory of digital signal processing, C/C++ or java programming, basics of digital electronics.

Learning Outcomes

By the end of the course, the student must be able to:

- Assess / Evaluate the function and the behavior of the processing components of a video processing and communication system/application

- Formulate the basic theory of coding
- Use the basic theory of multi-dimensional signal processing for the understanding of acquisition and display of video signals
- Recognize the underlying theoretical (algorithmic) and implementation components that define its performance
- Detect the possible improvements and optimizations on both algorithmic and implementation sides
- Deduce the implementation challenges of an application design case in terms of processing, synchronization, real-time performance
- Investigate trade-offs between performance and implementation complexity
- Specify the essential behaviors and technological limitations of main types of memories that define systems implementation performance
- Quantify memory system bandwidth requirements of specified algorithms

Transversal skills

- Use a work methodology appropriate to the task.
- Assess progress against the plan, and adapt the plan as appropriate.
- Use both general and domain specific IT resources and tools
- Write a scientific or technical report.
- Continue to work through difficulties or initial failure to find optimal solutions.

Teaching methods

Lectures and projects

Expected student activities

Attendance at lectures, reading written material, doing a practical project.

Assessment methods

Written examination assessing theoretical knowledge acquired, evaluation of the project developed in terms of comprehension of the problem and quality of the developed solution (correctness and effectiveness).

Resources

Bibliography

C. Shannon, W. Weaver. *The Mathematical Theory of Communication.* Univ of Illinois Press, 1949. ISBN 0-252-72548-4.
J. Rissanen, G. G. Langdon: "Universal modeling and coding", IEEE Trans. Inform. Theor, 1981.
Leonardo Chiariglione ed. "The MPEG representation of digital media", Springer, 2012.
V. Sze, M. Budagavi, G. J. Sullivan: "High Efficiency video coding (HEVC)" Springer 2014, http//www.springer.com/series/7236
P.A. Sarginson: "MPEG-2 Overview of the systems layer", BBC RD 1996/2.

Ressources en bibliothèque

- The Mathematical Theory of Communication / Shannon
- Universal modeling and coding / Rissanen
- The MPEG representation of digital media / Chiariglione
- High Efficiency video coding (HEVC) / Sze, Budagavi, Sullivan
- MPEG-2 Overview of the systems layer / Sarginson, BBC RD 1996/2.

Notes/Handbook

pdf of ex-cathedra slides are available on a web site at each lesson of the course

Prerequisite for

"Information technology" orientation