UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Processing and Coding of Multimedia Data

2021-3-E3101Q126

Aims

From the theoretical point of view, the student will learn the basics of the transition from analog and digital signal (sampling, quantization and coding) applied in the case of audio, image and video signals. From the practical point of view, during the practical activities the student will learn to manage and process the digital signals by means of linear time invariant systems and using frequency analysis.

Contents

The course offers an introduction to multimedia signals: images, video and audio, presenting the main methods of digitizing and encoding. The course is divided into two parts: the first part analyzes the analog to digital conversion in particular by introducing the concepts of sampling and quantization, and presents digital signal processing through linear time invariant systems.

The second part describes the main methods of lossy and lossless compression, applied in particular to audio, image and video signals.

Detailed program

1. Definition of one-dimensional signals, tw-dimensional signals, N-dimensional signals

- Analog signal

- Digital signal
- Media, variance, energy and power
- Noise

2. Signal in the transformed domain: Fourier Transform

- Fourier series for periodic signals
- Fourier transform for continuous signals
- Fourier transform for discrete time signals
- Discrete Fourier transform for discrete time signals
- Convolution theorem

3. Analog to digital conversion

- sampling theorem
- Filter Anti-Aliasing
- Quantization
- SNR quantization

4 Linear time invariant Systems (LTI)

- Definitions
- input / output equation
- Impulse response
- Equation differences

5. z-transform

- Convergence and convergence region.
- Relationship with the Fourier transform.

- Analysis of LTI systems with z-transform
- diagram poles-zeros, stability and physical feasibility of a LTI system.
- Design FIR and IIR systems through placement of poles and zeros

6. Audio signals, images and video: sampling and quantization, quantization SNR

7. multiresolution analysis

- Filter bank
- Wavelet Transform

8 Compression

- Main compression loss-less and lossy algorithms
- Audio Compression
- Image Compression (particularly JPEG)
- Video Compression (in particular MPEG)
- Main image Formats
- Analysis of signals quality

Prerequisites

No prerequisite. The knowledge of some basic concepts of Mathematical Analysis and Programming 1 is useful.

Teaching form

The course consists of lectures, classroom exercises, and practical activities. Several exercises will be carried out during the practical activities to verify the new expertise acquired. The course is taught in Italian.

In the Covid-19 emergency period, lessons and exercises will take place mainly via videoconference in remote synchronous mode, with any contributions recorded asynchronously. The laboratory will instead take place in asynchronous remote mode with synchronous videoconferencing events to clarify any doubts.

Textbook and teaching resource

Textbooks:

- M. Laddomada, M. Mondin, Elaborazione numerica dei segnali, Pearson, Prentice hall
- R.Gonzalez, R. Woods, Digital Image Processing, Pearson International Edition

Deeping texts:

- Mark S. Drew, Foundamentals of Multimedia, Pearson
- Video Processing and Communications, Yao Wang, Jorn Ostermann, Ya-QuinZhang.
- Introduction to Data Compression, K.Sayood

Slides projected during the lectures.

Text of exams and exercises

Semester

second semester

Assessment method

Examination:

• Written and oral exam + practical activities:

Evaluation Type:

• Final mark out of thirty

Written and oral exam:

The written exam consists of two parts. The first part of the written exam consists of exercises on digital signal processing, similar to those explained during the course.

The second part (writen or oral in case of Covid-19 Emergency) consists of open questions about digitalization and compression of multimedia signals. This part verifies the competencies acquired and it is based on what taught during the lessons, available on the slides and on the indicated text books.

It is also possible an oral verification of the expertise acquired. Maximum mark is 30/30.

The assignments carried out during the practical activities will provide further 2 points for the final exam. These points remain valid for the academic year in which the teaching is delivered. Four assignments are mandatory.

Two partial tests are scheduled

one at about half of the lessons, the second at the end of the course.

The first test is about exercises on digital signal processing and it has a maximum mark of 30/30

the second one consists of open questions about digitalization and compression of multimedia signals, and it has a maximum mark of 30/30.

The single test is considered passed if it has received a score >15. The final mark of the written exam is the average of the two parts (both of them >15). The exam is passed if this average is >=18.

The final mark is the sum of the mark of the written exam plus th eeventual extra point sfor the practical activities.

If one of the two parts is not carried out (absent or withdrawn student) or if it is not sufficient (<=15) it can be recovered during the first examination only.

Office hours

Friday from 11.00 to 12.00.