UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Processing and Coding of Multimedia Data

2425-3-E3101Q126

Aims

From the theoretical point of view, the student will learn the basics of the transition from analog to digital signal (sampling, quantization and coding) applied in the case of multimedia signals (audio, image and video) as well as in the case of signals acquired using wearable devices (physiological and electrophysiological signals, such as PPG, skin conductance, elctromyography, electroencephalography). 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), and signals coming from wearable devices, presenting the main methods of acquisition, 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 focuses on specific aspects: the use of physical and physiological signals coming from werable devices in human machine interaction applications, and intelligent systems, and 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. Physical and physiological signals applied in human machine interaction and intelligent system applications (affective computing, ambient assisted living, biometrics).

- photopletismography
- electroencefalography,
- respiration
- skin conductance
- elettromyography

9. Compression

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

Prerequisites

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

Teaching form

The course consists of 48 hours of lectures and 24 hours of laboratory activities where theoretical concepts will be translated into practical exercises.
Of the 48 face-to-face hours, 36 hours will be of didactic teaching and 12 hours of interactive teaching, with exercises, examples and case studies discussed with the students.

The 24 laboratory hours will all be interactive teaching. During the laboratory activities, some exercises using matlab will be presented and carried out together with the students. Assignments, explained and guided during the laboratory lectures, will be scheduled duringthe course.

Lectures and exercises are given in Italian and in presence.

Textbook and teaching resource

Textbooks:

- R.Gonzalez, R. Woods, Digital Image Processing, Pearson International Edition
- Fabrizio Argenti, Lorenzo Mucchi, Enrico Del Re, Elaborazione numerica dei segnali. Teoria, esercizi ed esempi al calcolatore, McGraw-Hill Education.

Deeping texts:

- Proakis & Manolakis, Digital Signal Processing.
- 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 exam consists of two parts. The first part is a written exam. It consists of exercises on digital signal processing, similar to those explained during the course.
The second part (oral) consists of open questions about digitalization and compression of multimedia signals and applications of phisical and physiological 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.

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**.

Final score
The maximum cumulative score of the written and oral parts is 30/30.
The single part is considered passed if it received a score >=15.
The final grade is the average grade when both parts (written and oral) are passed (both >=15) and the exam is passed if the average is >=18.
The final grade is the sum of the grade obtained from the average of written and oral parts plus any points from the lab tests.

Two partial tests are scheduled
The first partial test is scheduled 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 is oral, and it consists of open questions about digitalization and compression of multimedia signals, and applications of physiological and physical 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 is the average of the two parts (both of them >=15). This part of the exam is passed if this average is >=18.

The final mark is the average of the marks of the written and oral exam plus the eventual extra points for the practical activities.
If one of the two parts is not carried out (absent or withdrawn student) or if it is not sufficient (

Office hours

Friday from 11.00 to 12.00.

Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE