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Departamento de Engenharia Electrotécnica e de Computadores

Multimedia Systems

M.EEC057
Master degree in Electrotechnical and Computing Engineering 2023-2024

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Multimedia Field of Study

- even if still considered as secondary, multimedia is becoming an important field of study within the electrical and computing engineering domain
- technically speaking, what exactly is about the multimedia field of study?

understanding human perception of audiovisual signals + the nature and physical characteristics of real-world media signals

combined with

knowledge on media processing and encoding approaches

methods for managing trade-offs between competing resources

techniques for evaluating the efficiency of alternatives

knowledge on user-centered approaches

to deliver

practical solutions for the problem of optimising the use of resources to be integrated in real-world multimedia applications and services and meeting user expectations

General description of the CU

- Title: Multimedia Systems
- falls under the Multimedia technological field of study and therefore its goals and outcomes can be seen as a subset of the objectives and aspects addressed in this field of study

Major goals

- To provide an overall technological perspective of the multimedia field of study
- To create knowledge and competencies to enable identifying and selecting technological solutions to design, implement and manage multimedia applications and systems according to different requirements and purposes and under distinct resources availability
- To provide solid knowledge on the analysis of media signals with an emphasis on sound/audio
- To bring awareness to the challenges that arise and, simultaneously, to let know approaches and solutions that exist, to efficiently create and distribute multimedia content, i.e., to build multimedia systems
- Students should acquire knowledge and competencies useful for building intelligent, context-aware networked multimedia systems
    - which is a complex and interdisciplinary field that encompasses various aspects of electrotechnical and computer engineering, as well as computer science and multimedia technology

Major competencies

- Identify and use different types and tools of media analysis techniques with a focus on Music Content Analysis
- Identify and use technologies and protocols for compressing and transmitting media signals
- Apply conceptual modeling in the design of multimedia applications, prototyping principles and usability
- Adopt formal methodologies for planning and designing multimedia applications
- Identify and select standards and protocols for building multimedia systems
- Identify and apply multimodal alternatives for establishing interaction

Major Learning Outcomes

- describe the fundamental concepts of multimedia systems
- identify the most relevant physical characteristics of real-world media signals and distinguish signals based on those characteristics
- understand how to use media processing techniques to automatically analyse media content with an emphasis on music content
- understand the practical implementation of commonly used media processing and compression techniques and their role within a multimedia application
- Explain the various steps of a user-centred and iterative approach for developing multimedia applications
- Understand the formal process of conceiving multimedia applications
- Describe alternatives for multimodal interaction in multimedia systems with a focus on the use of the auditory sense
- identify the different currently used standards for efficient media transmission
- identify requirements of multimedia applications and design corresponding systems
- understand how to use sensor data and intelligent techniques to build context-aware applications

Teaching methodology

- Lectures
  - exposing knowledge and examples
  - visualisation of short videos during lectures
  - raising questions, discussing and replying to quizzes/activities
- Laboratories
  - Presentation of techniques and tools
  - Work group for experimenting audio processing algorithms and related individual assignment for summative purposes
  - Work group for specifying and developing a multimedia system with multimodal interfaces
- Formula for calculating the final classification (provisional)
  - Labs 35% MM application 35% mini-exam 30%
- teachers
  - António Sá Pinto (labs) - Maria Teresa Andrade (lectures)

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Lectures Syllabus

- Introduction
  - What is “multimedia”?; …
  - Overview on the generation and perception of media signals
    - Characterisation of media signals in the real-world and their digital representation; perception of media signals: the Human AudioVisual System; …
- User-centered design, modeling of multimedia applications; principles of prototyping and usability
- Formal design of multimedia systems in UML (use cases, collaboration diagrams, class diagrams, …)
- Overview of media compression
  - compression principles, standards and proprietary encoders; evaluation of quality and performance
- Networked multimedia applications
  - challenges and emergent solutions for networked multimedia applications;
  - Multimedia streaming protocols and technologies
  - Quality of Experience and Quality of Service
- Context-awareness and intelligent interaction

Laboratory Syllabus

- Introduction to Music Content Analysis: What is it; the different modes and representations, applications, research topics and tasks
- Sound and Music Analysis: DFT (Discrete Fourier Transform), FFT (Fast-Fourier Transform) and STFT (Short-Time Fourier Transform) in audio signal processing
- Description of musical content in terms of abstraction levels, temporal contexts and musical aspects; Computation of low-level descriptors
- Scientific challenges in Music Content Retrieval (MIR)
  - tone description; Clustering and classification
  - pitch determination; Extraction of chroma, chords and tonality
  - novelty detection; rhythm analysis and beat and downbeat detection
  - quality assessment

What will you learn?

- identify and select representation and compression formats of media signals
- how to measure and manage quality of media signals
- the principles and technologies necessary to develop user-centred multimedia systems, supported in the analysis of and access to Music Content
- what are the main representations and analysis techniques of audio musical signals
- how to use music content analysis tools
  - grasp specific software for audio signals
    - Jupyter Notebooks (Python)
    - Sonic Visualizer
- how to identify and apply principles of usability and quality of experience
- how to apply formal design principles for conceiving multimedia applications
- different possibilities to enable context-awareness and interaction

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Welcome to the course!

Hope you'll enjoy it!

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