Advanced biomedical signal and image processing

Master: Plasturgy & Biomedical Engineering

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Faculté de Science Meknes

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Course Syllabus

Advanced biomedical signal and image processing

Lectures	Tutorials (TDs)	Labs (TPs)
26 hours	10 hours	10 hours

Total Hours: 46 hours

Assessment:
Quizzes and problem-solving tests
Laboratory reports
Course project
Final exam

Course Syllabus

Advanced biomedical signal and image processing

The aim of the module is to provide master's students with

- a comprehensive understanding of the principles and techniques used in the processing of biomedical signals and images.
- equip students with essential skills in digital signal and image processing, enabling them to
  - analyze
  - interpret complex biomedical data.
- Students will utilize Python programming
  - in the PyCharm environment
  - libraries such as OpenCV,

Course Syllabus

Advanced biomedical signal and image processing

- MATLAB for practical applications. Through in-depth exploration of specific biomedical signals, such as
  - electrocardiograms (ECG)
  - electroencephalograms (EEG)
  - electromyograms (EMG)
- as well as various imaging modalities like
  - computed tomography (CT)
  - magnetic resonance imaging (MRI)
  - Ultrasound
  - positron emission tomography (PET)
  - Nuclear Medicine

Course Syllabus

Advanced biomedical signal and image processing

- students will be prepared to contribute effectively to
  - advancements in healthcare
  - medical imaging technologies
- Ultimately, the module aims to foster
  - the development of innovative solutions
  - enhance diagnostic capabilities
  - improve patient outcomes.

Course Syllabus

You will be advise for tests exams and lab test in advanced. A final exam might be scheduled independently.

Students are asked to respect their engagement such as:

Cell phones should be muted or turned off during course sessions tutorials and labs.

You can get off the class any time for any urgent matter

You will be allowed to return on class afterward

You are allowed to snacks and beverage in class

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The Advanced Biomedical Signal and Image Processing module will cover the following three main sections:

General introduction

Section 1 : Introduction to Digital Signal and Image Processing

Section 2 : Processing of Biomedical Signals

Section 3 : Processing of Biomedical Images

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Section 2 : Processing of Biomedical Signals

Electric Activities of the Cell

Electrocardiogram (ECG)

Electroencephalogram (EEG)

Electromyogram (EMG)

Other Biomedical Signals

CONTENTS

General introduction

Digital Signal and Image Processing (DSIP) is a critical area :

- In engineering
- Computer science
- Manipulation, analysis of signals and images using digital techniques.

Wide-ranging applications in various domains:

- Telecommunications
- Medical imaging
- Multimedia
- Computer vision.

General introduction

Digital Signal Processing (DSP)

- Digital Signal Processing involves
  - representation
  - Transformation
  - analysis of signals that are in a digital format.
- Signals can be
  - Audio
  - Speech
  - Video
  - any measurable physical quantity.

General introduction

Concepts

- **Sampling**: The process of converting a continuous signal into a discrete signal by measuring its amplitude at uniform intervals.
- **Quantization**: The process of mapping a continuous range of values into a finite range, which introduces quantization error.
- **Discrete Fourier Transform (DFT)**: A mathematical technique used to analyze the frequency components of a discrete signal.

General introduction

Common Techniques

- **Filtering**: Removing unwanted components from a signal (e.g., noise reduction).
- **Compression**: Reducing the amount of data required to represent a signal (e.g., MP3 for audio).
- **Modulation**: Modifying a signal to encode information for transmission (e.g., AM, FM).

General introduction

Digital Image Processing (DIP)

refers to

- the manipulation of digital images through a digital computer
- It encompasses a variety of techniques to
  - Enhance
  - Analyze
  - compress images.

General introduction

Concepts

- **Image Representation**
  - as matrices of pixel values
  - each pixel corresponds to a specific color or intensity.
- **Spatial and Frequency Domain**
  - Images can be processed in the spatial domain (direct pixel manipulation)
  - frequency domain (using transforms like the Fourier Transform)

General introduction

Common Techniques

- **Image Enhancement**: Improving the visual appearance of an image (e.g., contrast adjustment, sharpening).
- **Image Restoration**: Recovering an image that has been degraded (e.g., removing blurriness).
- **Image Segmentation**: Dividing an image into meaningful regions (e.g., separating objects from the background).
- **Feature Extraction**: Identifying and isolating significant features in an image for further analysis (e.g., edges, textures).

General introduction

Applications of DSP and DIP

- **Digital Signal Processing Applications**
- **Audio Processing**: Noise cancellation, speech recognition, and music synthesis.
- **Telecommunications**: Signal modulation and demodulation, error detection and correction.
- **Biomedical Applications**: ECG and EEG signal analysis for diagnostic purposes.
- **Digital Image Processing Applications**
- **Medical Imaging**: MRI, CT scans, and X-ray image enhancement for better diagnosis.
- **Computer Vision**: Object detection, facial recognition, and autonomous vehicle navigation.
- **Remote Sensing**: Analyzing satellite images for environmental monitoring and urban planning.

General introduction

Challenges in DSP and DIP

- **Noise and Artifacts**: Signals and images often contain noise, which can affect processing accuracy.
- **Computational Complexity**: Many algorithms require significant computational resources, especially for real-time applications.
- **Data Storage**: High-resolution images and long audio signals require substantial storage capacity.
- Digital Signal and Image Processing is a vital area of study that combines mathematical techniques with practical applications. As technology continues to advance, the methods and tools in this field evolve, leading to new opportunities for innovation in various industries.

END