Introduction to signal & image processing

Crédits ECTS
3 crédits

En bref

Langue de cours: Anglais

Présentation

Prérequis

Basic knowledge in mathematics and physics

Objectifs d'apprentissage

At the end of this course, students will be able to:

- Understand the role of biomedical signals and medical imaging in healthcare and diagnosis
- Identify the main biomedical signals and imaging modalities (EEG, ECG, MRI, ultrasound, X-ray, nuclear imaging, etc.)
- Describe the principles of signal acquisition, sampling, quantization, and digital representation
- Apply basic signal processing techniques such as filtering, convolution, and frequency analysis
- Understand the fundamentals of image processing and restoration methods
- Use Fourier and Wavelet transforms for biomedical signal and image analysis
- Extract relevant information and features from biomedical data
- Interpret and manipulate biomedical signals and images using MATLAB-based practical applications
- Develop basic analytical skills for biomedical engineering applications and medical data processing

Description du programme

This course provides an introduction to biomedical signal and image processing, with a focus on the fundamental techniques used for the acquisition, analysis, processing, and interpretation of biomedical data. Through theoretical lectures and practical MATLAB illustrations, students discover how signal and image processing methods contribute to modern medical diagnosis and healthcare technologies.

Introduction to signal & image processing

The course begins with an overview of biomedical signals and images, emphasizing their importance in medicine and diagnostic assistance. Students are introduced to the main categories of physiological signals and medical imaging systems.

A second part presents the principles of medical imaging modalities. Topics include sensors, image digitization, and digital image quality. The course then explores imaging techniques based on ionizing radiation, such as X-ray and gamma-ray imaging, as well as non-ionizing modalities including EEG, ECG, magnetic resonance imaging (MRI), and ultrasound imaging.

The signal processing section introduces the representation of analog and digital signals, sampling and quantization principles, random variables and functions, and basic statistical tools. Students then study essential processing methods including convolution, filtering, frequency-domain representation, and one-dimensional system identification. Different filtering approaches are discussed, such as low-pass, high-pass, band-pass, Wiener, and optimal filtering. Practical laboratory sessions illustrate digital image representation, histogram analysis, signal transformations, and feature extraction techniques.

The image processing section focuses on two-dimensional signal analysis techniques. Fourier transform concepts are introduced in both one-dimensional and two-dimensional forms. Students then study image restoration and enhancement methods, including contrast enhancement, histogram equalization, bit-level slicing, spatial filtering, and frequency-domain filtering. The final part of the course introduces wavelet transforms, including continuous and discrete wavelet transforms in one and two dimensions, with applications to biomedical image filtering and denoising.

The course includes practical MATLAB demonstrations throughout the semester, as well as a comprehensive final laboratory session integrating the main concepts covered in the course. Continuous assessment is based on practical work and multiple-choice quizzes.

Bibliographie

Biomedical Signal and Image Processing, Kayvan Najarian, Robert Splinter, CRC Press, 2012.

Equipe pédagogique

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Total des heures		**24h**
CM	Cours Magistral	16h
TD	Travaux Dirigés	8h

Infos pratiques

Nom responsable UE

Responsable pédagogique

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