Advanced Imaging for Biomedical Applications

In brief

Course langage: French, English

Presentation

Learning objectives

To know the basics of imaging for biomedical and biological applications, from the interaction between waves and matter to the processing of the images obtained.

To know different imaging techniques including both the acquisition and the restitution of the image at all scales of life, in vivo or in vitro for applications in biology or medicine.

Have an overview of the current and future problems and needs in the sector.

Description of the programme

Introduction: medical imaging:

- Spectral domains, image quality, image formation, x-ray imaging, nuclear imaging, optical imaging (the OCT), laser therapy

Basics of IT (Image Processing):

- Digital image, filtering, segmentation, restoration and inverse problems.

Tomography:

3D image reconstruction

Multidimensional image processing :

- machine learning and deep learning for classification

Geometric optics

basic notions of geometrical optics, application to microscopes

Physical principles of the organization of a living cell

- terms defining living organisms, the interactions involved, the notion of physico-chemical compartmentalization of the cell, its spatio-temporal organization dynamics.

- Understand the parameters describing the complexity of living organisms thanks to the instruments (electron microscopy and photonic microscopy)

Imaging biological systems :

- Cell imaging: The optical Microscope, Fluorescence microscopy, Vibrational microscopies, Superresolution techniques. Advanced optical microscopy techniques, applications

- Tissue imaging and biomedical applications: Introduction to biological tissue optics, contrasts, (absorption, fluorescence, scattering), Model of light propagation, Instrumentation and imaging/diagnostic setups examples

Biomedical ultrasound imaging

Basic principle of ultrasound, quantitative ultrasound imaging, tissue microstructures, principle of elastography, biomarkers, contrast imaging

Biophotonic sensors:

- Principle of surface and volume plasmon resonance - application to microfluidic imaging and pathogen detection

MRI: Magnetic Resonance Imaging

- Cerimed (visit)

- Basics of MRI: magnetic properties, polarization, resonance, relaxation, image reconstruction

- From theory to medical applications through equipment

Generic central skills and knowledge targeted in the discipline

- C1 (scientific and technical innovation): a good knowledge of the fundamentals of imaging for biomedical and biological purposes, combined with a perspective on the application and problems for physicians and/or biologists, will allow the potential of these techniques to be highlighted.

- C2 (mastering the complexity of systems): this course allows students to apply and complete the notions of physics and image processing in the case of living matter, which, by nature, is a complex system.

How knowledge is tested

CC1 = X written tests of one hour each = 45

CC2 = TP reports = 45

CC3 = Presentations = 10

Bibliography

[1] I.N. Bankman, Handbook of Medical Image Processing and Analysis (2009)

[2] Valery Tuchin, Tissue optics : Light scattering methods and instruments for medical diagnosis, 3e édition (2015)

[3] Marcel Locquin et Maurice Langeron, Handbook of Microscopy, 1re edition (1983)

Teaching team

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- Frédéric LEMARQUIS

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Total des heures		**100h**
CM	Master class	70h
TD	Directed work	12h
TP	Practical work	10h
PJ		8h

Useful info

Name responsible for EU

Lead Instructor

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