Biomedical Optics

Semester
Fall

In brief

Course langage: French

Presentation

Prerequisites

Basics of wave physics and electromagnetism.

Basics of geometrical optics and wave optics

Learning objectives

Imaging of living organisms includes all the techniques used for the acquisition and restitution of images at all scales of living organisms, in vivo or in vitro, for applications in biology or medicine. The goal of imaging is to create a visual representation of the information that we want to study. It is a field that lies at the intersection of disciplines such as biology, medicine, optics/photonics and signal processing.

Imaging -- and more generally optics -- for biomedical purposes refers to techniques that aim to probe and observe organs. In this context, we can approach the physical notions and the modelling related to the interaction between tissues (scattering and/or absorbing) with light. The objective here is to show how from a measurement related to the interaction between a wave and a tissue, we can build an image (modeling, reconstruction...).

In this context, optical techniques have the advantage of being non-invasive, non-ionizing (and therefore not dangerous for the patient), and of using inexpensive instruments (compared to other very heavy equipment) that are often miniaturizable (endoscopes, optical fibers...).

Here we will discuss high resolution imaging techniques to probe and observe at the cell level or beyond. Optical microscopy is a widely used technique for the observation of cellular mechanisms, which can be enriched with many modalities to increase sensitivity, contrast, specificity, and resolution. One of the objectives of this course is to present some of the advanced techniques

used in biophotonics (fluorescence microscopy, which is one of the reference techniques for marking precise cellular structures and thus studying particular biological functions, non-linear microscopy, which allows the generation of new contrasts, etc.).

We will also mention other imaging techniques on a larger scale, such as optical coherence tomography (OCT), as well as tissue imaging methods using diffuse optical tomography approaches. The use of polarimetry for tissue imaging will also be discussed as well as the use of light in thermotherapy applications.

This rapidly expanding field is based on consortiums that bring together hospitals, start-ups, large groups and research laboratories. Engineers working in this field must master the issues and problems of biology and medicine, and have advanced skills in imaging sciences and technologies.

Description of the programme

- General introduction

- Reminders of electromagnetism in matter

- Optical properties of tissues

- Microscopy: basic principle, contrast modalities, fluorescence microscopy and advanced techniques

- Optical Coherence Tomography (OCT): principle and applications

- Diffuse optical tomography: scattering modeling, introduction to tomography and inverse problem reconstruction

- Laser-biological matter interaction, introduction to phototherapy

How knowledge is tested

Continuous assessment, including two grades:

- an individual mark for the written test. Duration of the test 1h30, with authorized documents. (The modalities of the test are subject to change) (75% max. of the total UE grade)

- an individual mark for autonomous work (25% min. of the total UE mark) evaluated on the documentary report.

Teaching team

Julien FADE

Sustainable Development Goal

Biomedical Optics

Access to health

Life on land

Life below water

Quality education

Total des heures **0h**

Useful info

Name responsible for EU

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