UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Adaptive Optics

2425-1-F1702Q010

Aims

It provides specialized training in advanced optical techniques to enhance the diagnosis and treatment of eye diseases. The course will cover the principles and applications of adaptive optics, focusing on how these technologies can improve the resolution and accuracy of ophthalmic imaging. Topics include wavefront sensing and correction, retinal imaging, and the integration of adaptive optics into clinical practice. The goal is to equip optometrists and specialists in vision science with the knowledge and skills to leverage adaptive optics for better patient outcomes.

Contents

• Basics of Physical Optics: the propagators (Fresnel, Fraunhofer, Angular spectrum)
• Examples in Fourier Optics: the holographic algorithm to generate visual stimuli
• Description of optical aberrations: first order Seidel aberrations
• Adaptive optics tools I: deformable mirrors.
• Adaptive optics tools II: spatial light modulators (the Gerchberg-Saxton algorithm)
• Corrections of optical aberrations and Zernike description.
• Applications of adaptive optics for vision testing: retina imaging (https://www.imagine-eyes.com/)
• Role of adaptive optics to study accommodation, how to assess the vision improvement.
• Learning about vision at the scale of single photoreceptors.

Detailed program

**introduction to Adaptive Optics. **
Description of optical aberrations: first order Seidel and second order aberrations with geometrical optics.

Analysis of the first order aberrations with the wave propagation.

** **Methods for the correction of the optical aberrations**:
• Adaptive optics tools I: deformable mirrors.
• Adaptive optics tools II: spatial light modulators (the Gerchberg-Saxton algorithm)
**
• **Methods to describe the optical aberrations** (with particular care to the Zernike description).
• Applications of adaptive optics for vision testing. Analysis of two main AO opthalmoscopes and their applications to retina imaging (https://www.imagine-eyes.com/)
• Role of adaptive optics to study accommodation, in particular: understanding accommodation, vision Improvement Assessment, applications in Clinical Practice.
• How to exploit high resolution imaging assisted by AO to diagnose vision defects at the scale of single photoreceptors.

Prerequisites

Algebra and geometry
introdcutory calcolus, derivatives and integrals
basics of Python or MatLab coding.

Teaching form

Lectures with proposition of problems in the classroom. Assignment of problems at home tha go to make an exam pre-evaluation.
Use of numerical simulatons and animations. Proposition of real world cases. Lectures, problem-solving, and simulations will be integrated.
Student Participation is encourage through the problem solving.

Textbook and teaching resource

Optical Imaging and Aberrrations, Virendra Mahajan, SPIE press, 1998.
Adaptive Optics for Vision Science: Principles, Practices, Design, and Applications.
Edited by Jason Porter, Hope M. Queener, Julianna E. Lin, Karen Thorn, And Abdul Awwal
Wiley Scientific, 2006.

Semester

second

Assessment method

Homework on the solution of a specific problem-oriented exercise.
Oral examination.
The student will prepare a specific topic, expanding one of the aspect of the syllabus, and prepare a presentation in pptx. This will be the basis for the oral examination. In addition, basic knowledge on a list of syllabus points (provided at the beginning of the course and revised at the end of the course) will be required.

Office hours

through the webex page
https://unimib.webex.com/meet/giuseppe.chirico
Every Monday, 13.00-14.00.

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING