UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Adaptive Optics

2627-1-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.
Summary:

- Number of in-person lesson hours: 28;
- Number of interactive remote hours: 14.

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

ASSESSMENT TAKES PLACE THROUGHOUT THE ENTIRE COURSE.

ONGOING ASSESSMENT (maximum 12 points)
During the course, the instructor assigns **three problems** that students must complete and submit for evaluation. The following aspects will be assessed:
a. clarity of the exposition
b. correctness of the assumptions used to solve the problem
c. use of references from the literature to support the conclusions
d. analysis of limiting cases

Each problem is graded on a [0–4] point scale (1 point per item a-d), and the total will contribute to the final evaluation score.

FINAL ASSESSMENT (maximum, 18 points)

1. Submission, at least one week before the exam date, of a written report developed by the student on a topic assigned by the instructor and following an evaluation rubric provided by the instructor.
2. Oral discussion of the written report during the in?person exam.

The written report will receive a single grade out of eighteen (the “article grade”), obtained by summing the following scores:

- 0 to 3 points: Does the student clearly address the main topic of the assignment?
- 0 to 3 points: Does the student clearly describe the methodology?
- 0 to 3 points: Does the student correctly address the physical principles underlying the methodology?
- 0 to 3 points: Are the main results clearly summarized?
- 0 to 3 points: Are the graphical results interpreted correctly and clearly?
- 0 to 3 points: Is the terminology used in the report generally correct?

FINAL SCORE
The final score will be the sum of the numerical evaluation of the written report and the scores obtained from the three assigned problems.

Se vuoi, posso anche riformulare il testo in un inglese più formale, più sintetico, oppure in stile regolamento universitario.

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