Master in Photonics – "PHOTONICS BCN"
Master ERASMUS Mundus "EuroPhotonics"

MASTER THESIS PROPOSAL

Starting full time from April 2025
Presentation at the end of July or beginning of September 2025

Laboratory: Optical Metrology and Image Processing Laboratory
Institution: Universitat Autònoma de Barcelona
City, Country: Barcelona, Spain

Title of the master thesis: Melanoma histology analysis using Mueller matrix imaging polarimetry.

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Keywords: Polarization, Mueller matrix, imaging polarimetry, melanoma, cancer.

Summary of the subject (maximum 1 page):

Melanoma is the most fatal form of skin cancer, responsible for nearly 50,000 deaths annually worldwide. While identifying and characterizing cancerous tissues is crucial for effective treatment and prognosis, polarimetric imaging offers a promising approach for analyzing these tissues. It enhances contrast and can obtain additional information about the tissue microenvironment that traditional imaging techniques cannot capture, providing new insights into the microscopic features of tumours that are otherwise difficult to distinguish.

Analyzing the polarimetric response of cancerous tissues can help distinguish different types of structures and cellular components within the microenvironment by examining the properties of light as it interacts with the sample. Using Mueller matrix imaging polarimetry, the optical properties of melanoma histology slides are characterized, allowing for the identification of variations in cell organization and underlying structures. The choice of Mueller matrix imaging polarimetry is due to its ability to capture detailed optical properties of tissues, offering high sensitivity to subtle changes in tissue structure and composition. This makes it particularly effective for distinguishing cancerous tissues and analyzing tumor microenvironments.

This master's thesis focuses on developing a histological analysis method using a Mueller imaging polarimeter for melanoma samples. The student will measure optical parameters and analyze data to identify correlations between specific polarization signatures and histopathological characteristics,

providing valuable insights into differentiating tumor cell types and structural patterns in melanoma. This project has applications in medical diagnostics and biomedical research, enabling a deeper understanding of melanoma tissues, potentially contributing to the development of non-invasive diagnostic tools for skin cancer, reducing the need for invasive biopsy procedures and enabling real-time monitoring of disease progression and treatment efficacy.

Objectives:

- Optimize, calibrate, and implement a Mueller imaging polarimeter devised to analyse histological samples.
- Evaluate the ability of polarimetric parameters to discriminate between different types of structures in melanoma samples.
- Investigate the correlation between optical properties and histological characteristics of the samples.
- Implement enhanced vision of pathological structures through polarimetric imaging.

Additional information (if needed):

Required skills:

- Polarization theory: Stokes-Mueller Formalism.
- Experience with optical systems involving polarized light, image formation is fundamental.
- Image processing: Extracting relevant features from polarimetric images.
- Programming languages such as MATLAB for optical models' development.