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

MASTER THESIS PROPOSAL

Full time from April 2026 (it can start part time from February 2026)
Presentation date to be chosen: end of July or beginning of September 2026

Note: The main Master Thesis supervisor has to be a professor of the Master in Photonics program. One co-supervisor (internal or external) can be defined. Main Supervisor is responsible for the subject of the proposal and has to give continuous support to the student (research development, Report writing and presentation preparation). For external proposals a co-supervisor from the Master program and a collaboration agreement with UPC are needed.
You can find all information about the Master Thesis process in our webpage.

Laboratory:PLAT (Polarized Light Applications and Technologies)
Institution: Universitat de Barcelona
City, Country: Barcelona, Spain

Title of the master thesis: 3D reconstruction from a full-Stokes polarization camera using circular polarized illumination

Name and affiliation of the master thesis supervisor: Oriol Arteaga, Universitat de Barcelona
Name and affiliation of the co-supervisor (if any):
(for external proposals a co-supervisor chose among the Master Program professors and a collaboration agreement with UPC is needed)
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Keywords: polarimetry, brain, polarized light, biological tissue

1. **Summary of the subject (maximum 1 page):**

When light interacts with a surface or a scattering medium, its polarization state is modified in ways that carry rich information about geometry, texture, and microstructure. Our novel full-Stokes polarization cameras allows the measurement of the complete polarization state of light in a single shot, enabling fast, high-resolution analysis without sequential acquisitions.

This master thesis explores the use of **circularly polarized illumination combined with full-Stokes imaging** for the **3D reconstruction of surfaces and materials**. Circular polarization can

enhance sensitivity to surface orientation and curvature, making it a promising approach for photometric stereo, depth estimation, and shape retrieval.

The PLAT laboratory has strong expertise in advanced polarimetry, Mueller matrix optics, and polarization-based material characterization. This project will involve designing and implementing an experimental setup using our full-Stokes polarization camera, generating circular polarization states, and developing computational algorithms for 3D reconstruction from polarization cues. The work will bridge optical polarization and computational imaging, aiming to validate a novel method for non-contact 3D surface analysis.

Potential applications include material inspection, object recognition, and autonomous driving. The thesis will contribute to the understanding of how polarization—particularly circular polarization—can be used as a robust modality for shape and geometry recovery.

2. Objectives (maximum 1 page):

- **Implement circularly polarized illumination** and analyze its interaction with different surfaces and materials.

- **Develop a methodology for extracting 3D geometry information** (surface normals, depth maps, curvature) from Stokes-based measurements.

- **Design and test computational reconstruction algorithms**, integrating polarization cues with photometric or phase-based models.

- **Evaluate the influence of material properties** (e.g., birefringence, surface roughness, reflectivity) on 3D reconstruction under circular polarization.

- **Validate the technique experimentally**, comparing reconstruction results with ground-truth measurements or reference imaging systems.

- **Document all developments** and prepare the final thesis report and scientific presentation.

Additional information (if needed):
* Required skills:

- Familiarity with polarized light, polarimetry and imaging systems

- Programming skills (Laview, MATLAB, Python or similar)

- Interest in image processing

* Miscellaneous:
The project will be developed within the PLAT group at the Universitat de Barcelona, offering access to advanced optical instrumentation and interdisciplinary collaboration opportunities.