MASTER IN PHOTONICS – PHOTONICS BCN
EUROPHOTONICS-POESII MASTER COURSE

PROPOSAL FOR A MASTER THESIS

Dates: 2024-2025

Laboratory: Center for Sensors, Instruments and Systems Development (CD6)
Institution: Universitat Politècnica de Catalunya
City, Country: Terrassa

Title of the master thesis: Development and validation of a Visual Disturbances Simulator.

Name of the master thesis supervisors:
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Summary of the subject:

Objective: The objective of this master's project is to develop and validate a **Visual Disturbances Simulator** using Python, designed to aid ophthalmologists in evaluating visual disturbances (dysphotopsias) experienced by patients who have undergone cataract extraction and received multifocal or extended depth of focus (EDOF) intraocular lenses (IOLs) with a diffractive profile. This simulator will replicate the various visual disturbances—such as halos, glare, starbursts—experienced by patients due to specific optical properties of their IOLs, enabling better diagnosis, treatment planning, and patient education.
The system developed will be validated in a group of patients using different types of EDOF intraocular lenses.
Background: Cataract surgery, typically involving the removal of the natural lens and the implantation of an IOL, is one of the most common eye surgeries worldwide. However, certain IOL designs, particularly those with diffractive profiles (e.g., multifocal and extended depth-of-focus lenses), are often associated with visual disturbances known as **dysphotopsias** (Figure 1). These can significantly impact the quality of life for patients.

Figure 1. Main dysphotopsias present in patients implanted with a Diffractive Multifocal or EDOF intraocular lens.

Project Methodology: This project will use **Python** to simulate the visual distortions caused by IOLs, focusing on the dysphotopic phenomena. The key components of the simulator will include:

1. **Modelling Light Path and Reflections:** The simulator will model light entering the eye and interacting with the IOL to generate visual disturbances such as halos, starbursts, and glare.

2. **Graphical User Interface (GUI):** The Python-based interface will allow users (patients) to adjust variables such as light source type and intensity. The GUI will present simulated visual disturbances, enabling real-time visualization of how different combinations of visual disturbances affect vision.

3. **Extract Metrics:** The combination of different visual disturbances shall result in objective quality metrics that should enable clinicians to assess the 'amount' of visual disturbances a patient perceives at a given time.

Expected Outcomes: The expected outcome of the project is the creation of a robust, python-based, user-friendly simulator that can help ophthalmologists obtain objective metrics of the type and intensity of visual disturbances a patient perceives.

Significance: This simulator will provide a valuable resource for clinicians (ophthalmologists) by enhancing understanding of the complex visual effects associated with IOLs. It has the potential to improve patient outcomes through better preoperative counselling, more precise IOL selection, and effective management of post-surgical visual disturbances. Moreover, it can serve as a stepping stone for future advancements in the simulation of other ocular disorders, contributing to more personalized patient care in the field of ophthalmology.

* Required skills: Self-motivated, objective-driven, capable of autonomous working within a multidisciplinary team. Knowledge of Python.