INTERNSHIP: Modeling the evolution of Age-related Macular Degeneration using AI

Basic information

Required background: Ongoing M2 or ING3 in Image Processing, Artificial Intelligence, Machine Learning, Deep Learning

Place of internship: ISEP campus at Issy-Les-Moulineaux (Subway "Corentin Celton" on line 12). Occasional meetings at Paris 15-20 Hospital (Paris, 75012).

Internship beginning: February 2025

Internship duration: 5 to 6 months

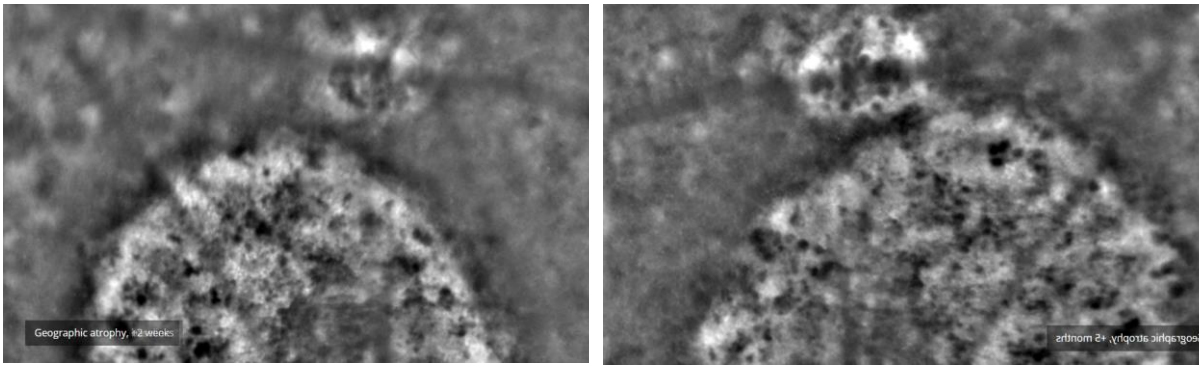
Salary: 440€/month (funded by Quinze-Vingts hospital)

Project

Age-related Macular Degeneration (ARMD) is a retinal disease that slowly causes the atrophy of the retinal pigment epithelium (PRE) causing the patients to ultimately go blind. The disease can be diagnosed and monitored using eye fundus images (cSLO in infra-red). However, the mechanisms of the expansion of the RPE atrophy remain unknown.

Our team has proposed a first method to process series of low resolution cSLO images in order to model the growth [1] of the RPE atrophy, commonly called geographic atrophy (GA). We have also explored unsupervised deep learning (DL) approaches to segment the GA [2] or its growth [3]. We want now to explore micro phenomena that occur at the border of the GA to better understand the mechanisms underlying the atrophy expansion. For that, we will rely on image series acquired at higher resolution, in adaptative optics (AO) and perform a timelapse analysis:

1. Fine detection of the GA boundary in series of AO images and modeling of the GA growth speed.
2. Segmentation and tracking of pigment spots in the neighborhood of the GA. A model of global motion will be inferred from the detected trajectories.
3. Detection of other spots that reveal global motions in the neighborhood of the GA



Example of a GA in AO images -See the animated gif here.

For task 1, we propose to investigate standard image segmentation approaches or deep learning, especially U-net models that are commonly used for image segmentation tasks. A colored speed map will be derived from the segmentation results for every series.

Tasks 2 and 3 are very challenging because of the low frame rate compared to the displacement amplitude, varying spot shapes and possible fusions. We propose to investigate DL approaches based on the combination of several neural networks, including recurrent neural networks, to perform spot detection / segmentation and motion estimation. Spot trajectories will be represented in color to reveal the detected motions and a global motion trend will be inferred.

References:

[1] F. Rossant, M. Paques, Normalization of series of fundus images to monitor the geographic atrophy growth in dry age-related macular degeneration, Computer Methods and Programs in Biomedicine, 2021.

[2] C. Royer, J. Sublime, F. Rossant, and M. Paques. Unsupervised Approaches for the Segmentation of Dry ARMD Lesions in Eye Fundus cSLO Images. Journal of Imaging 7, no. 8 (2021): 143.

[3] G. Dupont, E. Kalinicheva 1, J. Sublime, F. Rossant, M. Pâques, Analyzing Age-Related Macular Degeneration Progression in Patients with Geographic Atrophy Using Joint Autoencoders for Unsupervised Change Detection, Journal of Imaging, 2020, 6, 57.

Collaborations

This project relies on an active collaboration between ISEP and the Ophtalmology department of the Quinze-Vingts Hospital.

Application

Contact : Pr Florence Rossant florence.rossant@isep.fr

E-mail an application including CV, cover letter, M1 grades and, if possible, a letter of recommendation