MASTER'S THESIS INTERNSHIP OFFER

DESCRIPTION

Title : Development of deep learning architectures for the analysis of massive hyperspectral CARS data - Application to bioimaging (Deep'nCars)

Hosting organizations: Universities of Limoges and Poitiers

Lab: XLIM

Research teams: Fibre Photonics and Coherent Sources | Image Synthesis and Analysis (ASALI)

Scientific poles: Photonics | Mathematics, Computer Science, Image

Starting date (month/date): 1er mars 2024

Short description of the internship offer (up to 5 sentences):

This offer falls within the scope of a broader project involving the Photonics and ASALI groups of XLIM institute, aiming at implementing a complete chain of acquisition, processing and analysis of CARS (coherent anti-Stokes Raman scattering) spectroscopic data for applications in biology and health.

In this frame, the Deep'nCars project is mainly devoted to the development of new numerical methods for the unsupervised analysis of massive hyperspectral CARS data, based on multivariate approaches and artificial intelligence (AI).

Objectives (up to 5 sentences):

- To design multivariate and AI-based numerical methods taking the full CARS physical phenomenon into account

- To apply these methods to the analysis of bioimaging datasets (possibility for the intern to participate to measurement campaigns conducted within a linked project)

- To provide a complete algorithm ready for the automatic analysis and visualization of biological data

Description of the internship offer:

This offer falls within the scope of a broader project involving the Photonics and ASALI groups of XLIM institute, aiming at implementing a complete chain of acquisition, processing and analysis of CARS (coherent anti-Stokes Raman scattering) spectroscopic data for applications in biology and health. In this frame, the Deep'nCars project is mainly devoted to the **development of new approaches to unsupervised CARS hyperspectral data analysis**, in the continuity of a primary work done by D. Boildieu [1,2].

To go beyond this preliminary study, Deep'nCars proposes to integrate the complete modeling of the physical phenomenon involved in the generation of the hyperspectral vibrational signal, in order to obtain an extraction of chemical/biological signatures of superior quality. Of course, this finer analysis leads to an increased complexity in the design of the data processing algorithm, a major challenge that currently does not find any convincing solution within the community.

The project is based on the development of techniques originating from **multivariate analysis** and **artificial intelligence** (AI) in order to make the best use of the data collected by such innovative photonic devices (data mining). From a methodological point of view, it is a question, on one hand, of reformulating the decomposition by multivariate approach, and, on the other hand, of further developing the autoencoder (AE) structure, which has not been optimally used in the specific context of CARS microspectroscopy up to now. Namely, the two blocks of projection and reconstruction composing the AE have to be customized according to the nature of the signal acquired. This problem being complex, an adaptive complexity framework should be required to solve it.

References

[1] Boildieu *et al.*, Front. Cell Dev. Biol., 2022 | Article link

[2] Boildieu *et al.*, Computational Imaging Conference, IS&T Electronic Imaging, 2023 | Article link

Photo (optional)

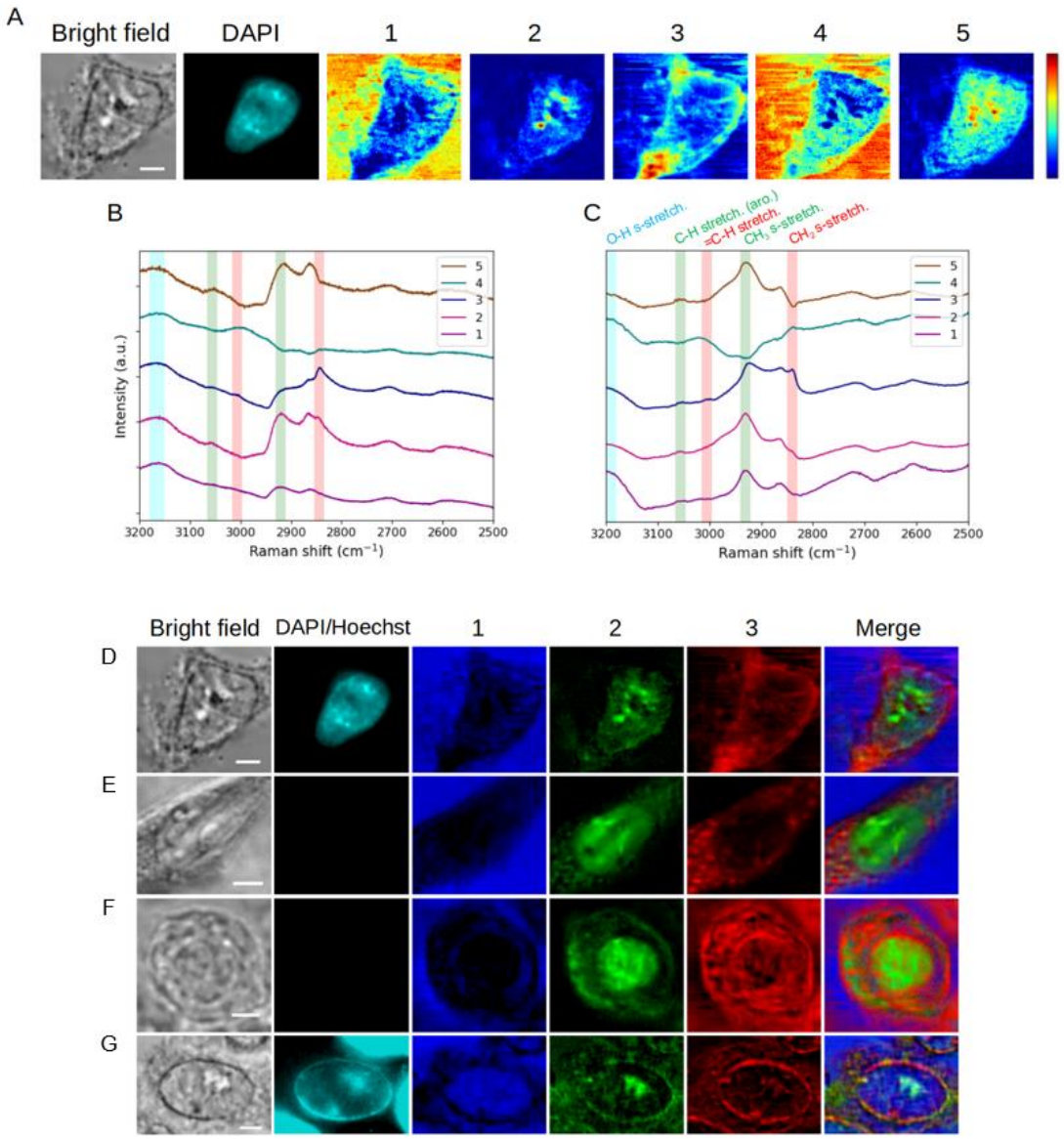

Figure adapted from reference [1]

Description of the research team:

Our research team includes PhD students and researchers from the **Photonics and ASALI groups of XLIM institute**. It also extends to the **Bioceramics group of IRCER institute** regarding biomedical applications (bone repair surgery), and to **Leukos company** for accessing the last advances in CARS microscopy technology. Lastly, the work within Deep'nCars will be strongly connected to our long-term partnership with **Kyushu University in Japan**, bringing a recognized expertise in biospectroscopy to the project.

The present internship will thus be performed in a multidisciplinary context.

SKILLS

Expected skills of the applicant:

- Knowledge and use of programming environments
- Very good knowledge of English language
- Ability to work both independently and within a team
- Interest for multidisciplinary research and biomedical applications

Educational Profile of Applicant:

Being enrolled in second year of a master's program (or equivalent) in physics/photonics or informatics/data science.

PHD THESIS OPPORTUNITIES

PhD thesis opportunity after the Master course:

☒ Yes ☐ No

If yes, financing already obtained:

☒ Yes ☐ No

If yes, what kind of funds: XLIM CASI + NA Region

CONTACT & APPLICATION

Surname and first name of the internship supervisor(s):

Philippe LEPROUX - David HELBERT - Philippe CARRE

Email of the supervisor(s): philippe.leproux@unilim.fr - david.helbert@univ-poitiers.fr - philippe.carre@univ-poitiers.fr

Phone number of the supervisor(s): 05 55 45 74 16 (PL) - 05 49 49 65 80 (DH)

The application shall be sent to the email: all addresses above

Closing date for applications: Cliquez ou appuyez ici pour entrer une date.