
Master 2 Internship

Title: Segmentation of label-free living cell images

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PhD funding (if any): not secured yet

Project:

Label-free microscopy techniques are very attractive for live cell imaging because they do not require any treatment or staining of the sample, however, due to the transparency and sometimes low contrast of cells in their original media, methods for enhancing their contrast is often required. Enhancing the contrast with linear algorithms is often not sufficient to facilitate the segmentation of these objects from their surrounding media. When non linear transformations are used, for instance to suppress image artifacts such as observed in phase contrast –PC- (halo, shade-offs), differential image contrast –DIC- (shadow), quantitative phase imaging –QPI- (background phase distortion), the result of the segmentation procedure often lead to divergent morphological informations. The project team in LOMA is presently working on different organisms, adherent mammalian cells (multicellular organism) for application to cancer and microorganisms (single cells such as yeasts with different shapes). For these two systems the scales of the cells are quite different, their structure, composition and motility are also very different. The question of segmentation of transparent objects has stimulated a tremendous number of approaches during the past two decades, nevertheless this issue was not completely solved, probably because the microscopy imaging techniques are not strictly equivalent, introducing a confusion in the interpretation of the images.

This internship will be '*segmented*' in two parts, a first part devoted to a literature analysis of the different strategies and corresponding algorithms developed for transparent object segmentation. Both traditional and learning-based segmentation methods will be surveyed, comparing their domain of application and performance. The second part will be more practical, from a set of label-free images collected on the different microscopes in operation in LOMA, a selection of a few algorithms belonging to traditional and learning-based methods will be performed from quantitative criteria provided by the type of images, the cell shapes, contrast and their statistics. The algorithms will be developed and tested under MATLAB software. To evaluate the performance of the segmentation method, a detection score will be defined for each microscopy method, and morphological parameters of the identified objects will also be extracted and compared.

For this internship, the master student should have a priori knowledge of phase imaging techniques and their operation modes, both experimentally and theoretically. She/he should also have facilities with computing methods (matricial and vectorial transformations, learning-based methods) which are used for image processing.

This study will be performed in collaboration with two laboratories of the University of Bordeaux, the Institut de Biochimie et de Génétique Cellulaire (IBGC, collaboration with A. Devin and S. Duvezin) and the laboratory : Chimie et Biologie des Membranes et Nanoobjets (CBMN, collaboration with A. Bouter).