Research projects (Master's, Ph.D. candidate, Post-doc)

Conception and implementation of the robotization of a high throughput screening microscope

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Prof. Marquet's Laboratory, within the framework of Canada Excellence Research Chair Program (https://www.cerc.gc.ca), has launched a strong program aiming at modeling the neurodevelopment component of major psychiatric diseases including schizophrenia, bipolar disorders and major depression disorder, using patient-derived induced pluripotent stem cells (iPSCs). The main goal of this research is to obtain a better understanding of the pathogenesis of these debilitating diseases for which there are only palliative treatments. Prof. Marquet's Laboratory is located at the CERVO Brain Research Centre, one of Canada's leading neuroscience and mental health centers, focusing on the root causes of brain diseases. The center brings together some sixty researchers in charge of research teams with more than 400 people, offering multidisciplinary expertise, ranging from membrane biophysics to social intervention, and the psychology of cognition (https://cervo.ulaval.ca)

Project Description

The project involves the design and implementation of the robotization of an internally developed high-throughput screening microscope and the management of its massive data in order to build a dedicated cellular phenotyping platform. identification of biomarkers of various diseases of the nervous system. The main objective is to meet the requirements of the complex and diversified experimental protocols that will have to be realized on the phenotyping platform using hardware and software solutions. In addition, sound and efficient management of the massive data produced by the high throughput screening microscope will need to be developed.

The heart of the high throughput screening platform is a digital holographic microscope (DHM), a device that allows for quantitative phase measurements on transparent or semi-transparent samples, without the use of contrast media with a very low lighting power. The integration of external components and their automation is however necessary to obtain a configuration and a geometry adapted to the study of the living cells. A super-continuum laser, a sample displacement stage, a temperature-controlled environmental chamber, an imaging chamber governing the gases, an infusion system, a fluorescence module, and an electrophysiology system will be integrated into one and even functional system. The student will have to design and implement a system of synchronization and control of all these elements. The project will involve a microcontroller or an acquisition card to manage the electronics of the trigger signals and a synchronization software to orchestrate all the tasks. This software will allow users to easily design, test and use several complex and diverse experimental protocols. In addition to the synchronization software, real-time image processing software will be developed to allow users to visualize biological phenomena recorded during acquisition. Also, a procedure for the sound and efficient management of the massive data produced by the high throughput screening microscope will need to be developed. Finally, the project includes a validation facet of the proposed solution to the laboratory through close collaboration with the various users of the phenotyping platform.

Under the supervision of the researcher, the student will have to perform the following tasks among others:

- Design and implement the electronics of the trigger signals
- Program a microcontroller and control an acquisition card
- Synchronize different highspeed video streams
- Work with various communication protocols
- Design and program synchronization software to control all components
- Design and program real-time image processing software
- Create protocols to use a combination of cascading external components
- Test integration of all components by demonstrating evidence of principles in cellular imaging
- Design and deploy a massive data management procedure

Required qualifications: Bachelor's degree in physics, physics engineering, or electrical engineering. Any relevant degree will be considered
Start date: To be discussed

Interested candidates may send their cover letter, resume and transcript to: lrnp-pnrl@cervo.ulaval.ca