INSTITUT DES SYSTEMES INTELLIGENTS ET DE ROBOTIQUE
**JOB OFFER**

## Intership sheet

**Subject: Visual servoed auto-focusing in automated cell manipulation**

**Project language is ENGLISH**

Supervisors: Ferhat Sadak et Sinan Haliyo

Starting date of the internship: February 2023

Duration of the internship: 4 to 6 months

Desired level of study: Master 2 or equivalent

Host laboratory: ISIR (*Institut des Systèmes Intelligents et de Robotique*), Campus Pierre et Marie Curie, 4 place Jussieu, 75005 Paris.

## Contact person

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**You are required to contact the supervisors BEFORE applying for the projet.**

Send your application by email, with [internship subject] in the subject line, a CV and a cover letter.

## Description of the internship

**Abstract**:

Intracytoplasmic sperm injection (ICSI) is an assisted reproductive technology in which a single sperm cell is being injected into the oocyte using sharp glass needle [1]. Automated micro-manipulation systems has been attracted by the researchers and progressively advanced, particularly in the last 10 years [4]. The main reason for the development of automated micromaniopulation systems are to eliminate the human error in manual operations and increase system efficiency. Auto-focusing of an oocyte before micro-injection procedure is an essential operation for performing automated biological cell manipulation tasks. As shown in Figure 1, The holding pipette (on the left) should be aligned with the oocyte prior to injection.

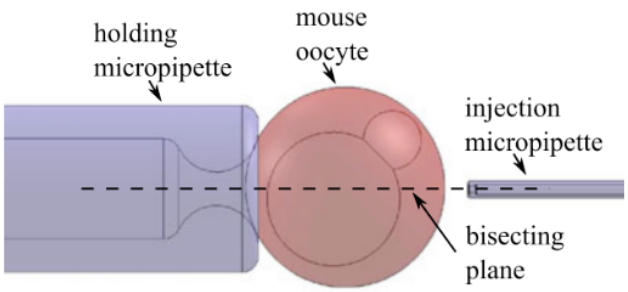


*Figure 1: Injection micropipette tip must be positioned in the bisecting plane (or the same focal plane as the cell's) to perform the injection. [2] Note: The polar body is out of the image plane.*

There is not much effort has been made toward auto-focusing of the micro objects that are used during ICSI procedure [2], except analysis of conventional focus measurement algorithms, such as Brenner gradient or Energy of gradint etc toward general micro manipulation applications [3].This project aims to automatically focus on the holding pipette and oocyte. This operation can benefit from the computational power and robustness of deep learning techniques. Subsequently, the obtained corresponding positions will be used to drive the motorised stages in a visual-servoing manner where one of them is placed underneath of the petri-dish and the other motorised stage is directly linked to the holding pipette. Overall, the project will investigate the potential of deep learning techniques to precisely autofocusing on the holding pipette and oocyte under various environmental disturbance to unlock and contribute to the fully automated ICSI system.

**Internship Objectives**:
The aim of this project is to precisely auto-focusing on the oocyte and holding pipette in ICSI operation using deep learning.

The main objectives of the projects are as follows:
- Collection and labelling of training data for oocyte and holding pipette
- Development of a deep learning based auto-focusing framework for both holding pipette and oocyte
- Driving the respective motorised stage in focal axes for both holding pipette and oocyte)
- Design of experiment to test the developed algorithm and conduct statistical error analysis
- Full experimental auto-focusing demonstration for both holding pipette and oocyte.

**References:**
[1] Yasuyuki Kimura and R Yanagimachi. "Intracytoplasmic sperm injection in the mouse". In: Biology of repro- duction 52.4 (1995), pp. 709–720.
[2] Zenan Wang et al. "Autofocusing and polar body detection in automated cell manipulation". In: IEEE Transactions on Biomedical Engineering 64.5 (2016), pp. 1099–1105.
[3] Meng Ying Yu et al. "Autofocusing algorithm comparison in bright field microscopy for automatic vision aided cell micromanipulation". In: 2010 IEEE International Conference on Nano/Molecular Medicine and Engineering. IEEE. 2010, pp. 88–92.
[4] Zhuoran Zhang et al. "Robotic micromanipulation: Fundamentals and applications". In: Annual Review of Control, Robotics, and Autonomous Systems 2.1 (2019), pp. 181–203.