PhD position on cobotic manipulation for microrobotics

Summary
This PhD project aims to develop an industrial grade desktop micromanipulation system. It is a joint project between Percipio Robotics and ISIR/UPMC and as such, it is expected to occur much closer to the industry. Its final objective is a product with a high maturity and market value. It builds on the previous developments and existing products of partners and as such requires precise engineering skills, great communication talents and creativity. The field of microrobotics is relatively new territory with very promising prospects, hence this PhD project maybe a valuable asset for an enterprising candidate.

Background
Microrobotics is a fast growing field as microsystems are in high demand in a wide spectrum of applications, such as automobile, IT peripherals, biomedicine, telecommunication, scientific research... Each year, tens of millions of microsystems are produced to meet this need, and this high demand is pushing the development of microrobotics.

Nowadays, small-batch production of microsystems is commonly handled by handmade process because the required flexibility and complexity cannot be tackled by existing robotic solutions. To address this blank market, the microrobotics team in the Institute for Intelligent Systems and Robotics of Pierre and Marie Curie University (ISIR, UPMC) in Paris, in collaboration with Percipio Robotics company, a spin-off from the Femto-ST institute, is developin a desktop Cobotic platform, Chronogrip, for flexible robotics micromanipulation.

The Chronogrip system is equipped with multi-DOFs positioning stages with submicron resolution and large motion range (cm); a vision system composed of multiple cameras; a high resolution micro-gripper (PiezoGripper); a user manipulation interface; and a central computational system.

To enhance flexibility, a human operator is supplied with various information, such as vision and haptics. Central challenge of a full Cobotic platform is the interaction between human operator and micro working environment. This interaction and the user interface are detrimental in the acceptance of the device by the end-users and hence is a decisive component of its success.
In this context, a PhD student position is proposed for highly motivated candidate with excellent academic record. The PhD program is funded for a period of 3 years and the PhD student will conduct her/his research activities in both ISIR, UPMC (Paris) and in Percipio Robotics (Besançon)

Research topics
This PhD program contains 3 research axis:

1. Design of a new generation of TeleTweez

Designed and prototyped by the PhD student and engineers in ISIR, UPMC, **TeleTweez** is the 1° robotic device which aims to achieve intuitive tweezers-based assisted micromanipulation. It can be used as conventional tweezers, as well as a haptic device for remote or virtual reality operation.

In bilateral micromanipulation, user holds the TeleTweez the same way as operating a conventional tweezers and it acts as a remote control to Chronogrip's end-effector. During pinching, the opening states of two levers are obtained upon various high resolution sensors (infrared pos. sensor, strain gauge, rotation encoder...) installed in the TeleTweez and transferred to the slave device, a piezo controlled microrobotic gripper. The contact information and force are measured by the slave device and sent back to the TeleTweez. Via the compact actuation system embedded in the TeleTweez, user is able to feel the feedback force, just like as she/he operates directly with target objects.

The PhD student will improve the design and performances of the current prototype to produce a compact and intuitive version with excellent qualities in haptic rendering. The objective is a commercially viable and production-ready version which will be finally integrated in the Chronogrip platform.
2. **Transparent bilateral coupling for micromanipulation**

In remote micromanipulation, the scaling ratios in position/velocity control and force feedback ratio are from $10^6$ to $10^9$. The quality of bilateral control strongly depends on the properties of haptic interface such as transparency (*how haptic sensations are faithfully rendered*), bandwidth (*the capability of frequency range for haptic signals*), and dynamic range (*the ratio between the max. and min. rendered haptic signal*). The PhD student will establish a bilateral control scheme by studying the dynamics and control aspects of the haptic interface and Cobotic platform which guarantees the stability, robustness and the transparency of the overall system.

3. **Evaluation on end-users experience & ergonomics**

In the last phase of the development of the Cobotic platform, the PhD student will finally conduct a series of rigorous user experiences to verify the level of intuitiveness and effectiveness for micromanipulation.

Concretely, the test will be dedicated to people in the target profession. For example, one application field of the TeleTweez is the high-end watchmaking industry. The PhD student will evaluate the effectiveness and intuitiveness of operations conducted by professional
watchmakers when using the Cobotic platform (with TeleTweez installed in the Chronogrip) in watchmaking scenario. Especially how haptic sensations facilitate micromanipulation when coupled with visual feedback, and furthermore, how to achieve the best quality of haptic feedback.

Fig. 4: User experience of TeleTweez in virtual environment application

**Prerequisites**
- Strong interest in microrobotics, high level of motivation and autonomy;
- M.Sc. in robotics, mechatronics, or other related fields;
- Excellent academic record;
- Knowledge of real-time systems and C/C++ programming is a plus.

**Starting date**
Autumn of 2016

**Contact**
To apply, please send a detailed CV in English or French to Sinan Haliyo sinan.haliyo@upmc.fr and Prof. Stéphane Régnier: stephaneregnier@upmc.fr