PhD position in Manipulation of Soft Bodies with Multiple Drones, the ARMEN team at LS2N in Nantes, France and the Rainbow team at Inria/IRISA in Rennes, France.

The ARMEN team at LS2N, Nantes, France:

http://ls2n.fr/equipe/armen/

and the Rainbow team at Inria/IRISA Rennes, France:

https://team.inria.fr/rainbow/

are looking for a PhD candidate in *Manipulation of Soft Bodies with Multiple Drones*

********** CONTEXT **********

The aerial manipulation is a robotics research field that proposes the integration of one or more robotic arms in multirotors, for allowing the manipulator(s) to perform certain operations in workspaces at high altitude or in areas out of the reach of standard fixed-based or mobile (but grounded) manipulator arms. Possible applications span many areas such as disaster response, maintenance of infrastructure, inspection of remote sites. However, aerial manipulation is a real challenge when considering that the gripping function is still one of the most complex to achieve even by classical robotic systems (e.g., fixed-base manipulators). In order to grasp an object of large dimension, instead of using a big-size drone equipped with a gripper, which is a very costly solution, an alternative is to create a big-size gripper attached to several drones. A new class of grippers is currently being developed for industrial robots: soft grippers, i.e. underactuated grippers composed of flexible bodies able to sustain very large deformations (also called soft bodies), which have the ability to adapt themselves to any shape of the objects, thus allowing for the possibility of designing universal grippers. This idea is of interest in the context of the aerial grasping: (a) soft bodies are very lightweight, thus having less impact on the drone autonomy than a standard gripper, (b) their low weight allows the design of grippers of bigger size, thus being able to grasp bigger size objects, and (c) they can adapt to any kind of objects and shapes, thus improving the robustness of the grasp in case inaccurate positioning of the drone occur.

********** PHD TOPIC **********

Robotic manipulation of soft bodies is a complex and challenging problem. There are many issues that need to be addressed in soft bodies manipulation with drones: modeling (of the soft body but also of the full system {drones+soft body}, which is necessary for the control of any aerial systems), estimation of the {drones+soft body} states (configurations, velocities), and controller design. Another problem is the grasping of the object. However, in the scope of this thesis, we will not work on this task and the bodies to be manipulated will be considered already grasped by the drones (they will be rigidly attached to them beforehand). The main objectives of the PhD will then be:

- Develop a dynamic model of the system (soft bodies attached to the drones) able to run in real time for being used in a control loop. Finding a good compromise for modelling the system (accuracy vs. computational time) will be crucial

- Observation of the internal state: estimation of the soft bodies deformation based on the developed model and external sensors (e.g., vision)

- Control of the soft bodies deformation using robust, adaptive or predictive strategies

- Experimental validation: the intended benchmark will consist of at least two drones manipulating a single soft rod with the aim of imposing a desired shape to the rod and to displace it to a desired location. The final experiment will represent a first concrete step towards the full grasping of an object with the system UAVs+soft body. For this, we are going to consider the following scenario: surrounding a vertical pole with the soft body as in the following illustration

********** CANDIDATE'S EXPECTED PROFILE **********

The candidate must be a proficient user of C/C++ and ROS. Familiarity with matlab/simulink is a plus. Scientific curiosity, large autonomy and ability to work independently are also expected.

A M.Sc. degree in computer science, robotics, engineering, applied mathematics (or related fields) is required.

The PhD aims at advancing the state-of-the-art from both the *methodological/theoretical* and *experimental* points of view. Therefore, the candidate is expected to have a strong passion (and attitude) towards problem solving on the methodological and experimental sides.

********** SALARY **********

The position is full-time for 3 years and will be paid according to the French salary regulations for PhD students.

********** ENVIRONMENT **********

The ARMEN team

http://ls2n.fr/equipe/armen/

is creating original research results in design, control and perception in the field of autonomous robots and of the control of their interactions with the environment. Designing and controlling systems able to address the two facets of the term environment (in the sense of the environment in which the robot evolves or in the ecological sense of the term) are two priority objectives of the team. The main issues addressed concern the control of the dynamics of robotic systems and their environment, the gain in

autonomy and the minimization of the environmental impact. The facilities available in the group include a fleet of autonomous industrial cars, a platform for prototyping industrial-size industrial and aerial robots, a fleet of quadrotor UAVs, and an indoor testing arena instrumented with Qualisys Motion Capture System.

The Rainbow team

https://team.inria.fr/rainbow/

is internationally recognized for its scientific activity as well as for technology transfer experience in the field of visual tracking, visual servoing, computer vision, shared control, haptics and sensor-based control for robotics applications. The facilities available in the group include three 6-dof industrial manipulator arms, a 6-dof torque-controlled backdrivable arm, two 7-dof torque-controlled robot arms (Franka), a pioneer indoor mobile robot, a humanoid robot (Pepper), a fleet of quadrotor UAVs, and an indoor testing arena instrumented with Vicon.

The candidate will be under the supervision of

Dr. S. Briot

https://pagesperso.ls2n.fr/~briot-s/

Dr. Paolo Robuffo Giordano

https://team.inria.fr/rainbow/team/prg/

and

Prof. A. Chriette

https://www.ls2n.fr/annuaire/Abdelhamid%20CHRIETTE/

and will work in close collaboration with other members of the ARMEN and Rainbow teams involved in the project.

********** HOW TO APPLY **********

Instructions on how to apply to each position can be found at:

https://team.inria.fr/rainbow/manip-soft-drone/

The position will remain open until a satisfactory candidate is found.