6-month Master Thesis project:

Motion planning for aerial dynamic grasping

At LAAS-CNRS - Toulouse, France

Context: In the field of unmanned and micro aerial vehicles (UAVs and MAVs) grasping, manipulation, and general physical interactive tasks are gaining an increasing importance and feasibility. UAVs and MAVs are changing from pure information gathering robots to interactive and manipulating robots, see, e.g., Figure 1, with deep implications both in research and industry. Compared to grasping from a fixed robot arm, aerial grasping faces additional problems like, e.g., underactuation of the aerial platform and non-negligible dynamic coupling between the UAV and the grasped object, non-balanced by ground reaction forces.

Fig. 1: Aerial manipulator of the ARCAS EU Project, a consortium including LAAS-CNRS.

Goal of the master thesis: The goal of this master thesis project is to conceive and develop a motion planning algorithm that is able to generate dynamic grasping trajectories for underactuated aerial systems. The dynamic grasping problem is completely different and much more challenging than its static counterpart. The motion-planning algorithm has to take into account the dynamic constraints of the system (e.g., underactuation, thruster saturations) and environment constraints (e.g., presence of obstacles). The planner has to generate motions that do not require the robot to stop while grasping. A major novelty of the thesis will be the tight combination of motion planning and control methodologies. The thesis will be divided in the following phases:

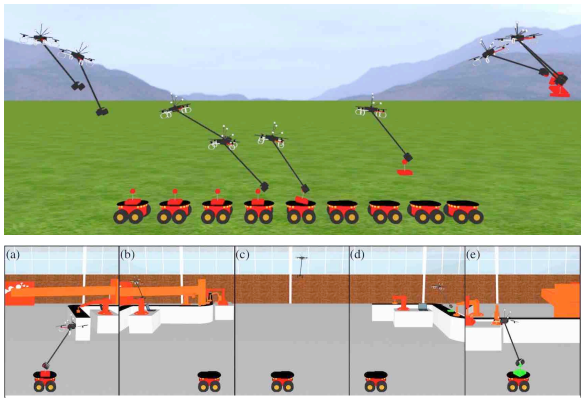

Figure 2: Top: stroboscopic view of the dynamic grasping. Below: a possible industrial application. Watch also the video at http://homepages.laas.fr/afranchi/robotics/?q=node/135.

- *Thorough modeling of the aerial grasping planning class of problems starting from [Spica et al, IROS 2012]*
- *Development of a novel approach to dynamic pick(&place) with aerial manipulators, possibly based on an extension of a geometric formulation using sampling-based algorithms [Simeon et al, IJRR 2004]*
- *Implementation and testing of the developed algorithm in a dynamic simulator*
- *Implementation of the method on the quadrotor –based aerial testbed of LAAS (optional)*

Requirements:

- Study in the field of computer science, engineering, physics, or mathematics
- Strong background in planning algorithms, automatic control, and robotics
- Programming skills in C++ and Matlab
- Motivation to work in an interdisciplinary project and international environment
- Good English skills

Practical Info: The expected duration of the project is six months. Preferred starting time is between January and March 2015. Duration and starting date can be tailored to the student needs. The intern will be paid according to the French regulation (436 Euros/month). A successful participation to the project will be favorably considered in the application for a subsequent PhD position on related topics at LAAS-CNRS.

Application: In order to apply, please send an e-mail to af-applicants@laas.fr including:
1) your **CV**; 2) your **Ms transcripts**, 3) your **Bs transcripts**, and
4) the tag **[mtp2015-PlanningAerialGrasping]** in the subject of the e-mail.

Lab and Advisors: LAAS/CNRS (https://www.laas.fr/public/en) is an interdisciplinary research institute located in the aeronautic/aerospace scientific area of Toulouse/France. LAAS is involved in the EU Project 'ARCAS', http://www.arcas-project.eu/, whose goal is the development and experimental validation of the first cooperative free-flying robot system for assembly and structure construction. The master thesis project will take place within the 'Robotics and Interactions'-group (www.laas.fr/public/en/ris) and will be supervised by Antonio Franchi http://homepages.laas.fr/afranchi/robotics/ and Juan Cortés http://homepages.laas.fr/jcortes/, both permanent scientist at CNRS active in the topics of aerial robot planning and control.