Control for Aerial Robotic Manipulation

short description

The aerial robotics group at the Autonomous Systems Lab is currently exploring the area of aerial manipulation. The goal of this thesis is to explore the control problem of aerial robotic manipulation and propose novel solutions that will allow increased dexterity along with maximum safety for the aerial vehicle. Apart from the capability to execute manipulation tasks via the floating-platform aerial robot, one particularly aspect of the goals of the project is to actively employ the dynamics of the Micro Aerial Vehicle to enable advanced manipulation capabilities.

This specific master thesis focuses on the modeling and control problem. Employing a physical simulation framework of the aerial robot, the manipulator and the physical world (through Gazebo) we aim to investigate multiple ideas and conclude on the approach that will be in a next step applied to the actual aerial robots (this goes beyond the time horizon of the specific thesis).

We are looking for an outstanding student with control background and knowledge who is also keen on implementing ideas and coding. This master thesis will be in the framework of the recently accepted AEROWORKS Horizon 2020 project which will further allow the student to get experience of the requirements of a large and collaborative research and development effort.

Type: Master Thesis
Period: 2015
Internal supervisor:
- Mina Kamel (mina.kamel@mavt.ethz.ch)
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Key words
Flying robots, Aerial manipulation, Control

Context
This project is a part of a larger remote inspection and maintenance project. Our goal is to establish the capability of aerial robotic work-task execution via single or collaborative aerial robots. Such systems should be capable of autonomously perceiving the environment, conducting high-fidelity inspection, damage detection and eventually maintenance work-task execution. This long-term goal also provides the ground for further research for exceptional students.

Work packages
- literature review on the problem of floating-platforms based manipulation
- literature review on the problem of aerial robotic manipulation
- Implementation and optimization of the simulation framework
- Modeling of single-robot aerial manipulation
- Investigation of different control approaches
- Complete implementation of the finally proposed control law
- Evaluation studies

Literature
tion with the environment", IEEE Robotics and Automation Magazine, 21 (3). pp. 41-50. ISSN 1070-9932


Formal Requirements

Work schedule: Please provide your supervisor a work schedule within two weeks after the start of the project. Generally, Bachelor and Semester projects last 14 weeks starting at the first day of the semester and end at the end of the semester. Master projects last 6 months and the starting date is agreed on with the supervisor.

Intermediate presentation: An informal intermediate presentation (about 10 minutes presentation/discussion) about your work will take place around mid-term. The goal of the presentation is to give a brief summary of the work done, to propose a plan for the continuation of the project, and to discuss about the main directions of the project.

Final presentation: The final presentation will take place at the end of the project. A test run is presented to and discussed with the supervisors 2–5 days before the public final presentation. Exact dates and times for the intermediate and final presentations will be arranged by the lab administration.

Report: A report has to be handed in to the responsible supervisor. The report has to describe the full work performed during the whole project. A preliminary version has to be handed in one week after the final presentation or as determined with the supervisor. The preliminary version of the report is discussed with the supervisors. The final report has to be handed over to the responsible supervisor in 3 paper copies. All documents and files, including the report (original data and as a PDF-file) and the final presentation, have to be saved on a CD/DVD and handed in together with the final report.

Evaluation: The project is assessed according to the ASL evaluation sheet and the “Merkblatt für Studierende zum Thema Plagiate” of ETH Zurich. The responsible supervisor hands both of them out at project start. The final presentation is evaluated based on the public final presentation. The report is evaluated based on the preliminary version with the requirement that the remarks are incorporated in the final report.

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<tr>
<th>Responsible Professor</th>
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<td>Roland Siegwart</td>
<td>Mina Kamel, Kostas Alexis</td>
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Zurich, December 2, 2014

Notes

The internet provides abounded information about how to write a scientific report and how to make a presentation. The report and presentation should be done according these common guidelines and the instructions from your supervisors. We recommend reading the following instructions before you start with your work:

Writing Guidelines for Engineering and Science Students
http://www.writing.eng.vt.edu/

Prof. Bernstein’s Student Guides
http://aerospace.engin.umich.edu/people/faculty/bernstein/guide.html

Style and format of your report should follow common practice and according the instructions of your supervisors. However, the ETH template is used preferably for the presentation.

We recommend you to use Microsoft Office, OpenOffice or LaTeX to create your report and presentation.

Report:

Latex Editor http://www.toolscenter.org/ or http://www.lyx.org/

Presentation:  
http://www.wired.com/wired/archive/11.09/ppt2.html

The LaTeX Beamer Class  
http://latex-beamer.sourceforge.net/