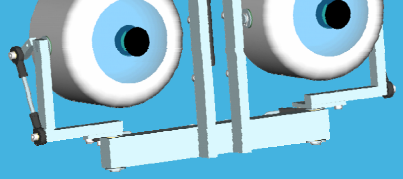
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

AUTONOMOUS SYSTEMS LAB



muFly: Fully Autonomous Micro-Helicopter

Motivation

- The scientific challenges of micro helicopter design and control for cluttered environments.
- The wide field of possible applications (search, surveillance, communication relay, etc.).
- The lack of the actual solutions.

Objectives

- Development and implementation of the first fully autonomous micro helicopter comparable in size and weight to a small bird.
- Optimal integration of cutting-edge technologies including: Aerodynamics, control, computer-vision, data-fusion, fuel-cell, etc. in a micro flying system.

muFly @ ETHZ

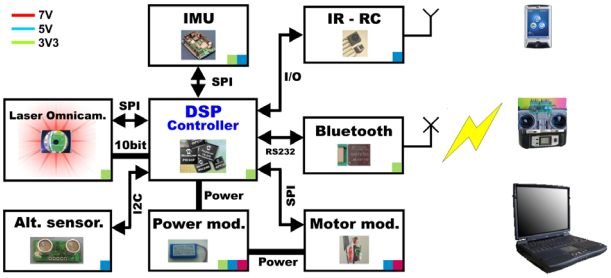
- **Overall systems design**
  - *Conceptual design:* Selection of the appropriate concept (quadrotor, coaxial, etc.), and evaluation of variants.
  - *Modeling:* Analytical models for optimization and simulation.
  - *Aerodynamics:* Innovation and optimization in propeller design.
  - *Communication:* Low power communication module.
  - Prototype design.
- **Control and Navigation**
  - *Control:* Hybrid active-passive attitude control, sonar-based altitude control, autonomous take-off and landing.
- **System integration**
  - *Integration weeks:* Key project engineers meet at one location for system integration and validation.

Project Organization

- **muFly** is a STREP project under the Sixth Framework Program of the European Commission.
- The consortium comprises six partners:
  - **ETHZ (CH)**
    System design and integration (leading partner)
  - **Berlin University of Technology (DE)**
    Power source (battery + fuel-cell)
  - **University of Freiburg (DE)**
    Navigation algorithms
  - **CSEM (CH)**
    Vision sensor
  - **Xsens (NL)**
    Miniature inertial sensor
  - **CEDRAT technology (FR)**
    Actuators

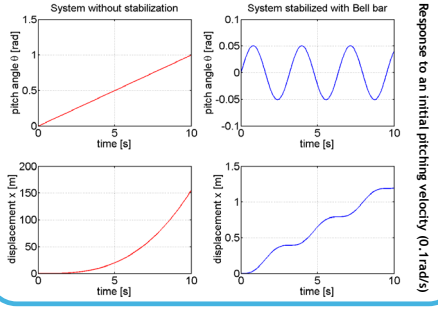
Platform

Mass:	30-50 g
Height:	100 mm
Rotor diam.:	100 mm
Endurance:	10 min
Motor:	Brushless
Control:	Passive-Active
Sensors:	IMU + Omnicam
Battery:	Lithium-Polymer
	Fuel-Cell



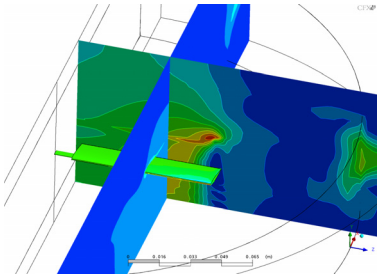
Dynamics

- Current work focuses on the investigation of the **passive stability** of the system. This would bring less control intervention, reducing computational effort and actuator power consumption.
- The goal is to identify design parameter dependencies of the **stability behavior**.



Aerodynamics

- Low Re and Ma numbers (different from full scale).
- The goal is to maximize the thrust to power ratio.
- Task decomposed in three parts:
  - 3D and Quasi 3D-Simulation: Blade Element Momentum Theory **X-Foil** and **CFX-5**.
  - Experiments: Measurement of torques and forces on the dedicated test-bench.



Milestones

- muFly project started in **July 2006**
- Preliminary concept ready (+6 months)
- First prototype ready (+12 months)
- Concept of Final Prototype Ready (+20 months)
- Final Prototype Ready (+35 months)

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