**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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