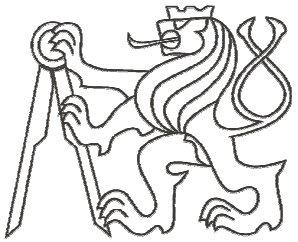
KONTAKT 2011



Mikrokvadrotor: Návrh, Modelování, Identifikace a Řízení

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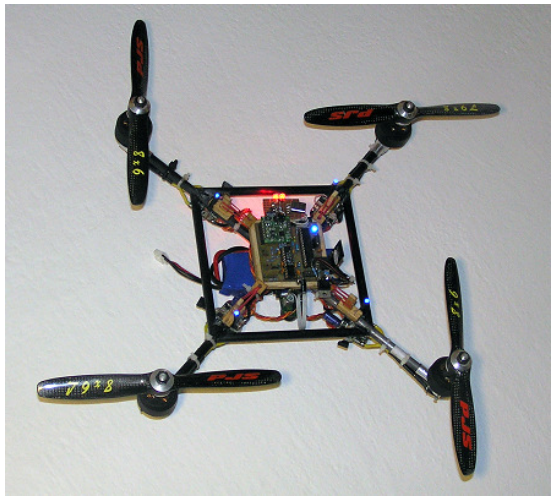
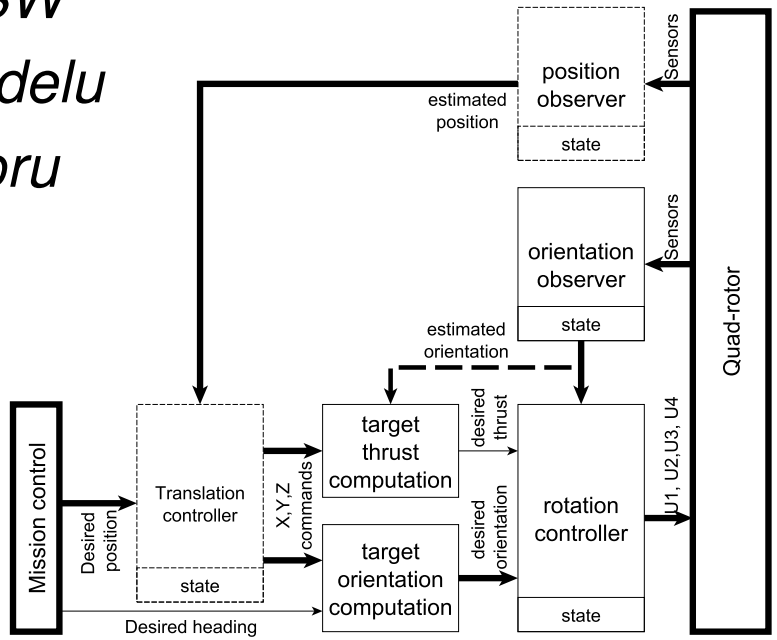
Vedoucí: Zdeněk Hurák (hurak@fel.cvut.cz)

Mikrokvadrotor: Návrh, Modelování, Identifikace a Řízení

- Projekt: **Postavit a řídit vlastní quadrotor**
  - ✓ *Realizace vlastního HW a SW*
  - ✓ *Odvození dynamického modelu*
  - ✓ *Návrh nelineárního regulátoru*
  - ✓ *Návrh inerciální jednotky*
  - ✓ *Identifikace*





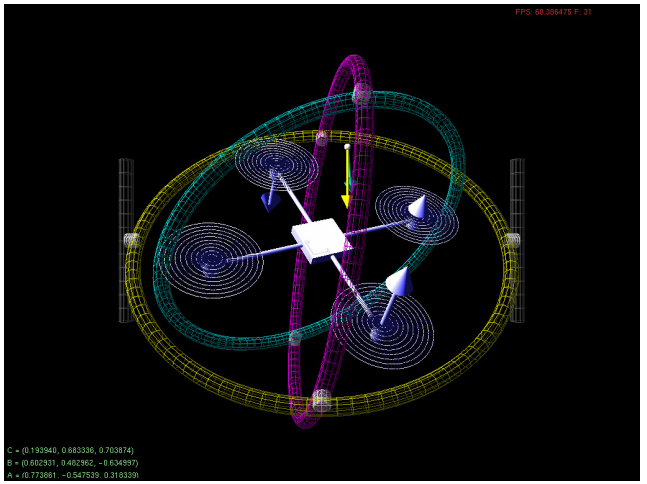
✓Zařízení je připraveno odstartovat

Diplomová práce se zaměřuje na modelování a řízení.

Mikrokvadrotor: Návrh, Modelování, Identifikace a Řízení

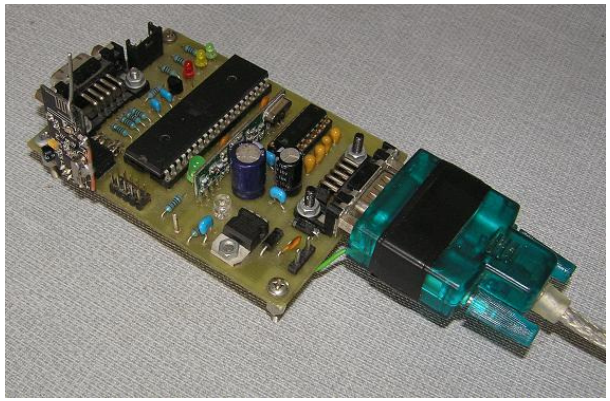
Přínosy práce

- Představen pokročilý, efektivní **regulátor rotace pomocí quaternionů.** (Článek pro *IEEE MSC 2011:* „Advanced Control of a Quadrotor using Eigenaxis Rotation“)

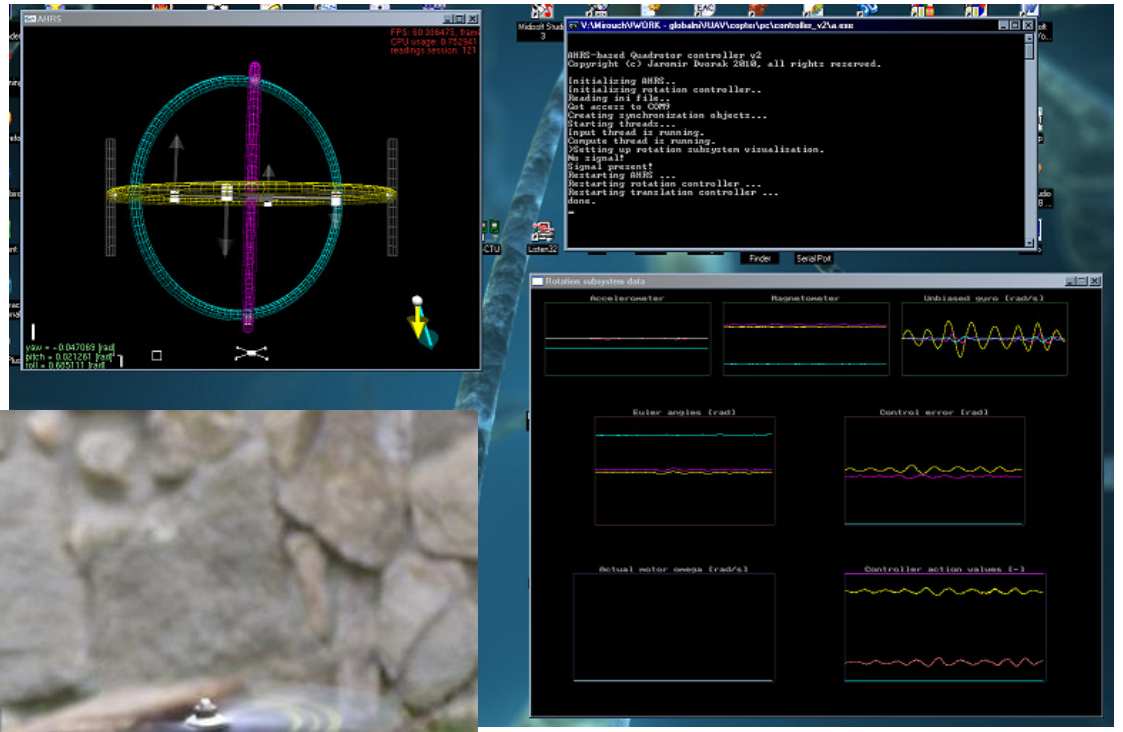


- Návrh **experimentálního inerciálního algoritmu odhadování orientace** pro quadrotory.

- Model je **řízen v reálném čase skrz rychlou bezdrátovou linku**. Regulátor je realizován na PC.



Mikrokvadrotor: Návrh, Modelování, Identifikace a Řízení



Micro Quadrotor: Design, Modelling, Identification and Control

Author: Jaromír Dvořák (md@unicode.cz)

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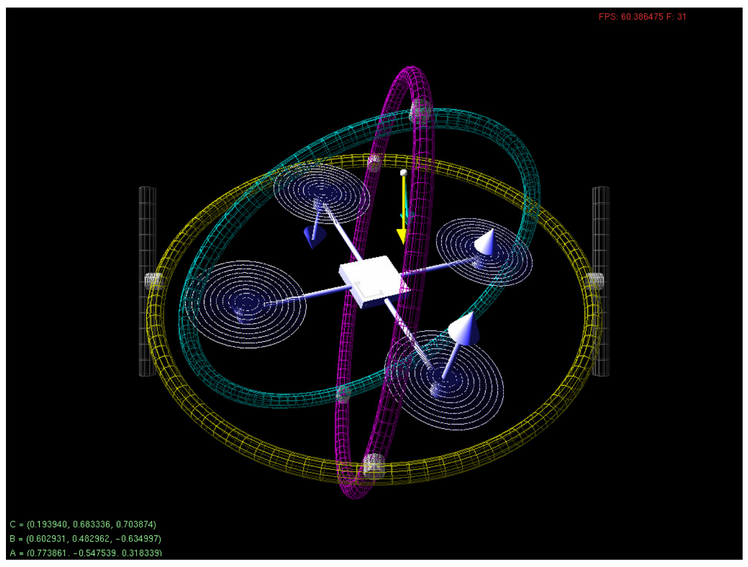
Abstract

This work shows development results of an existing quadrotor UAV project and focuses on the dynamic control. Apart from the construction, the work presents a complete strategy on how to design an advanced, structured flight controller for a quadrotor using alternative methods.

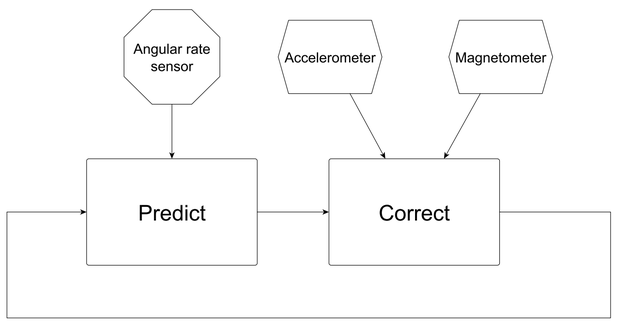
The work done

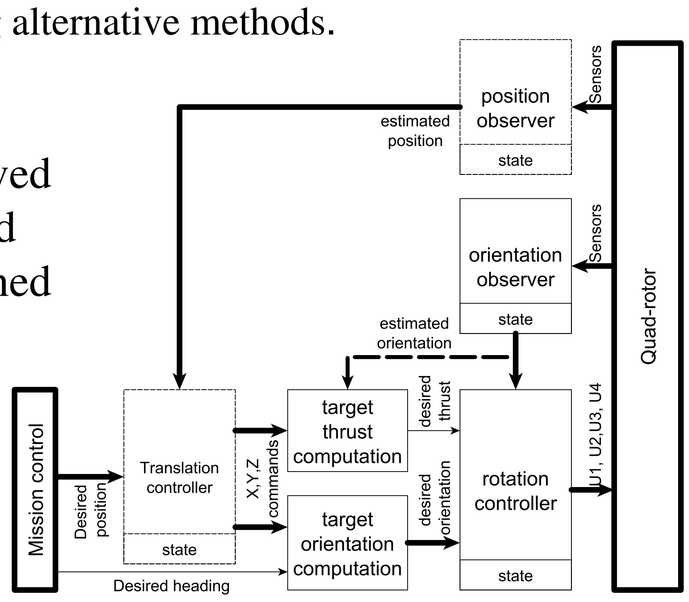
- ✓ A function sample of a quadrotor was built
- ✓ A complex quadrotor dynamic model was derived
- ✓ Advanced non-linear controller was synthesized
- ✓ Quadrotor-specific AHRS estimator was designed
- ✓ Identification procedures were developped
- ✓ The device is ready to take off with a pilot



Apart from vision-based systems that uses some external sensors to determine the quadrotor orientation/position, one of the goals of this work is to **discuss the posibilities of inertial *orientation an position observers* for the quadrotor concept**.

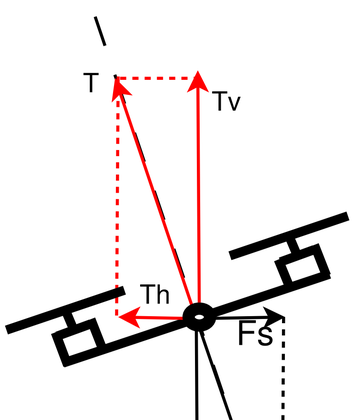
- ❑ Quadrotor onboard accelerometer phenomena, which generally complicates the inertial orientation estimation is discussed.
- ❑ A highly experimental approach of the quadrotor-specific inertial AHRS estimator is introduced.



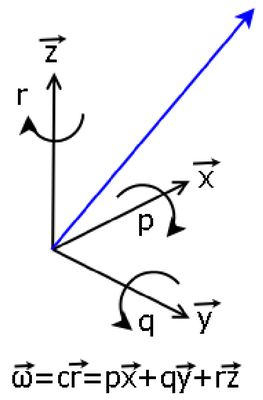


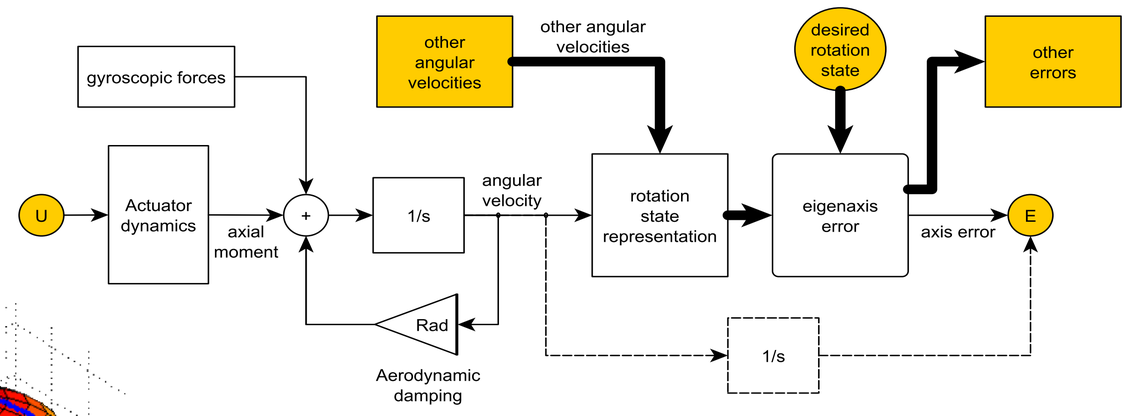
Euler angles have been sucessfully used for control of fixed-wing aircraft as natural representation of errors from straightforward flight. Nevertheless, for an omnidirectional aircraft, non-linearities arise when moving far from the zero orientation state. **Quaternions offer a significant advantage in terms of mathematical robustness and not suffering from singularities**.

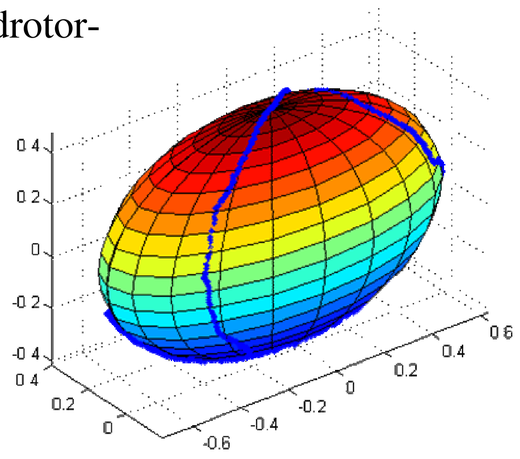
Together with the overall control structure, the work introduces a non-linear rotation controller, operating in *entire rotation space,* able to handle large maneuvers:



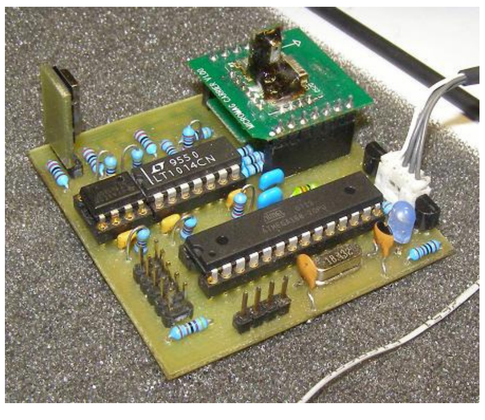
- ❑ LQ-optimal design combined with **quaternion feedback** and various non-linear extensions, such as gyroscopic compensator
- ❑ Paper was sent (and accepted) to *IEEE Multiconference on Systems and Control, 2011* **„Advanced Control of a Quadrotor using Eigenaxis Rotation“**







The project involves design and construction of the function sample, aiming to utilize the potential of currently available parts and come through the competition with another similar projects. **From the special features of the design:**



- **Custom-made BLDC motor drives** allowing RPM measurement for usage as state variable inside the controller and special PWM strategy for faster dynamic responses
- **Real-time control over 2.4GHz very-low-latency wireless datalink** allowing comfortable way of designing the real-time controller on a PC, demonstration, education and much more.