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Control System for Unmanned Aerial Vehicles

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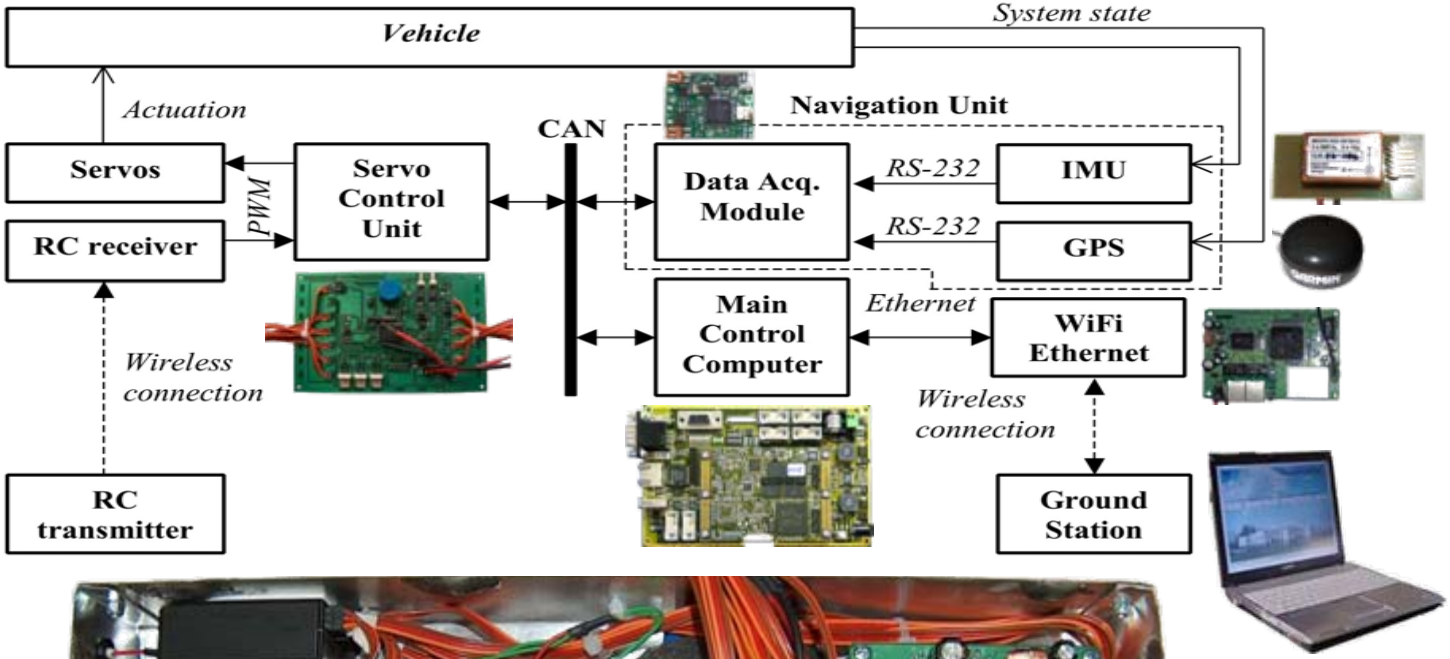
Motivation

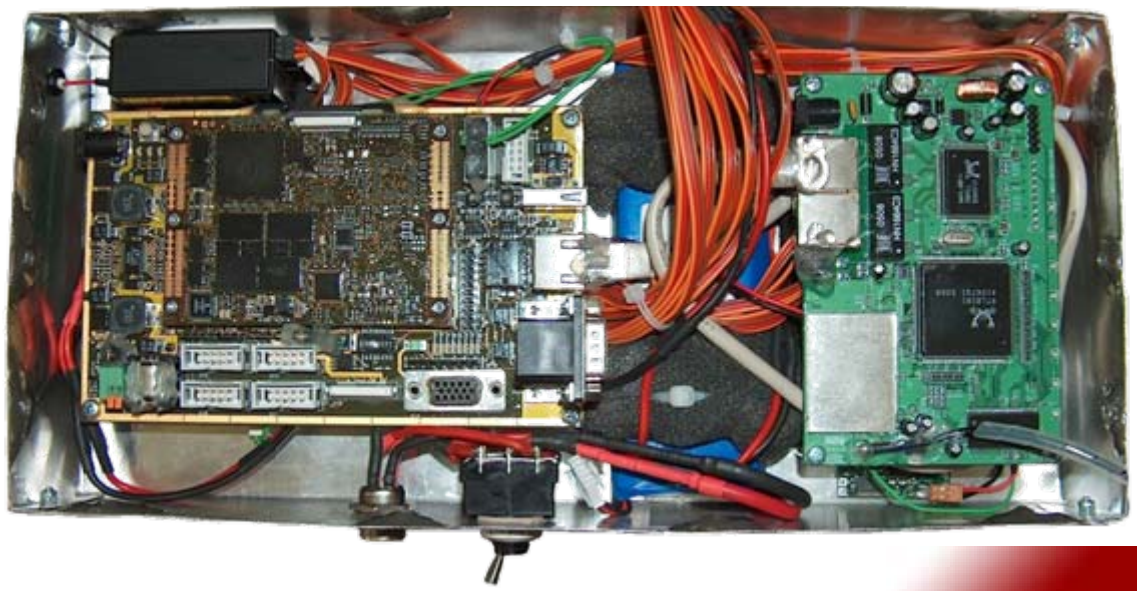
- UAV control is fresh and rapidly growing field
- A lot of possible applications
- Stock products are expensive – there is a lack of "open platform"
- Complex and challenging project

Control System Specifications

- Open, Easily Extendible
- Robust & Reliable
- Compact & Lightweight (330x160x65mm, 1.5kg)
- Low-Cost (≈ 2500 Eur)

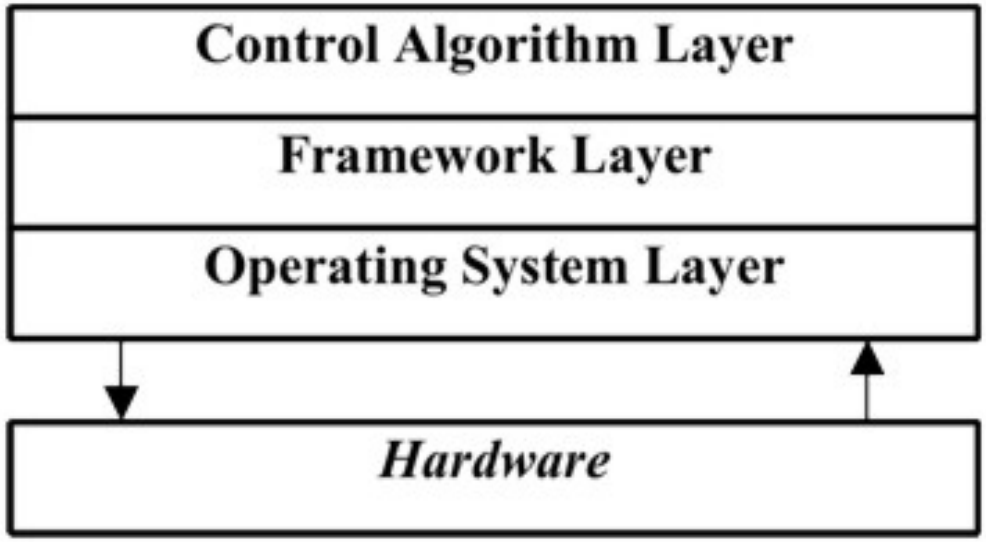
Control System Architecture





Control System Software

- Hierarchical structure
- Main Control Computer - Linux 2.6.14
- Modules - system less
- Remote SW updates



What is a helicopter?

- Unstable, under-actuated non-linear system
- 6 DOF, 4 inputs (main and tail rotor collective pitch, longitudinal and lateral cyclic control)

Differences between miniature and full-scale helicopters

- Weight-to-thrust ratio
- Rotor head construction
- Blade stiffness

Helicopter Mathematical Models

Miniature Helicopter (Gavrilets)

- 17 State variables
- ≈ 50 Parameters
- Rigid body dynamics with external forces and moments acting on it
- Takes blades and flybar flapping, fuselage and fin drag into account

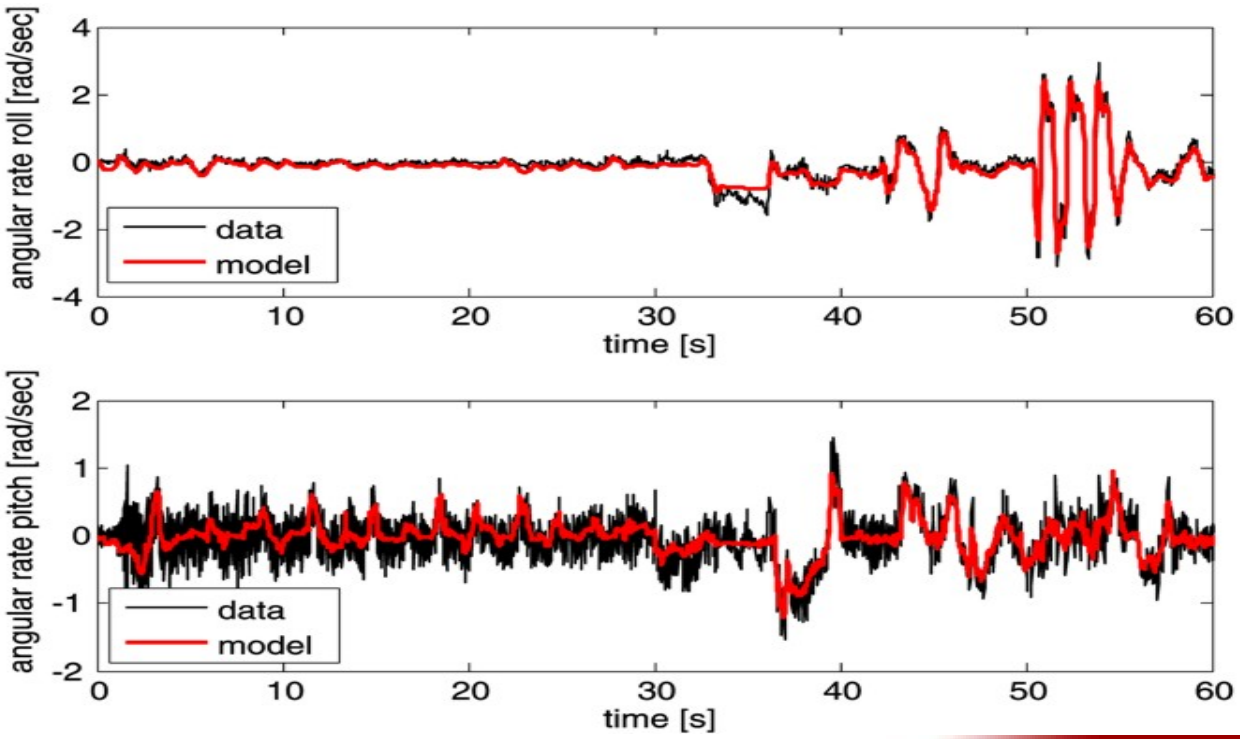
Full Scale Helicopter (Bramwell)

- 100 State variables
- ≈ 500 Parameters

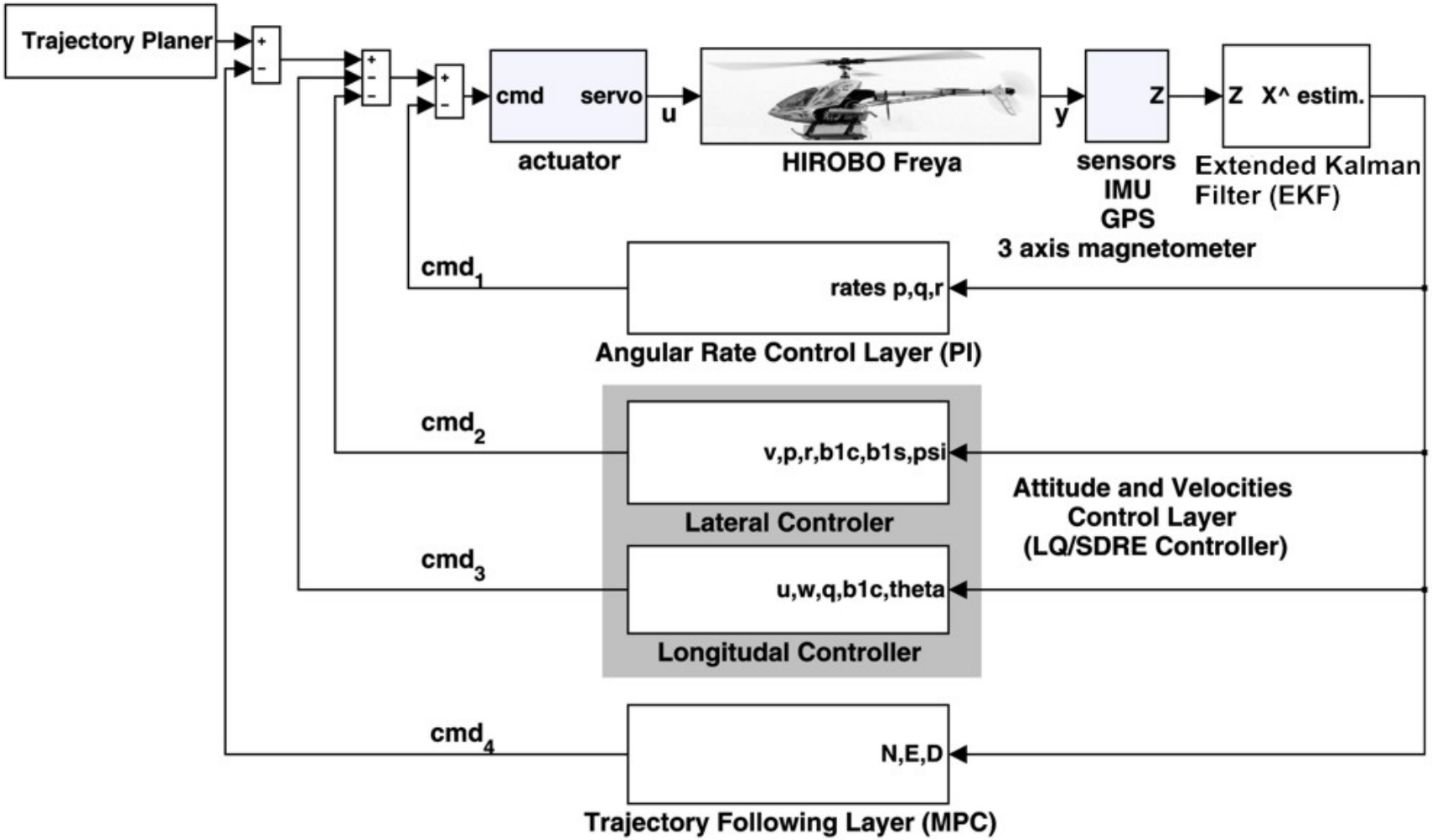
Mathematical Model Identification

Measured Variables

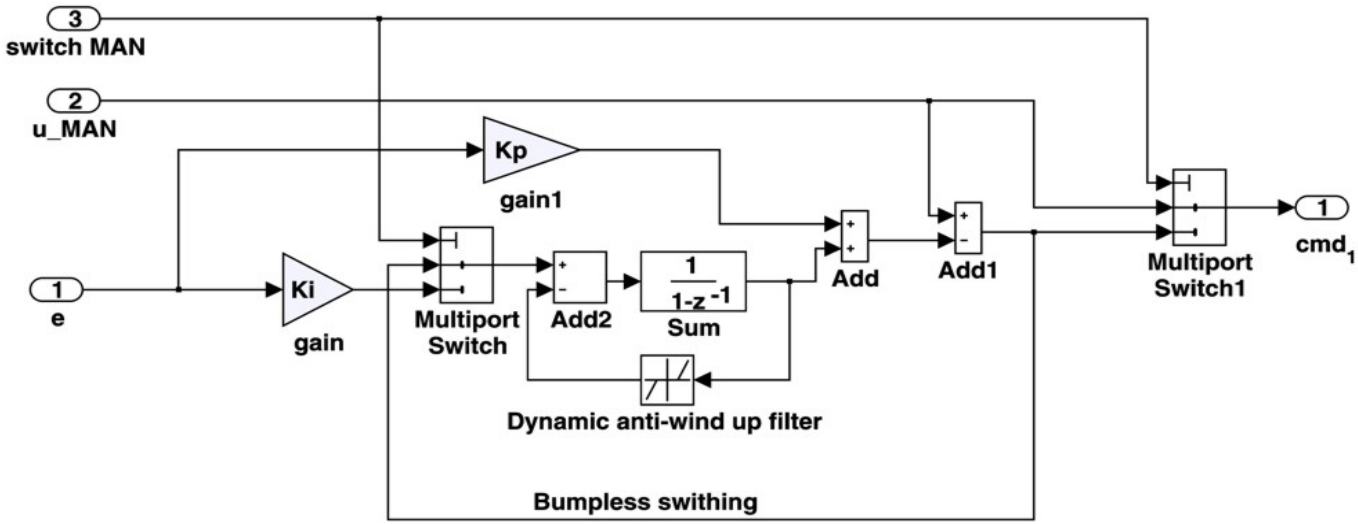
- Roll, Pitch & Yaw angular rates (rad/s) @ 32Hz
- X, Y, Z accelerations (m/s^2) @ 32Hz
- Geographical position & altitude @ 1Hz

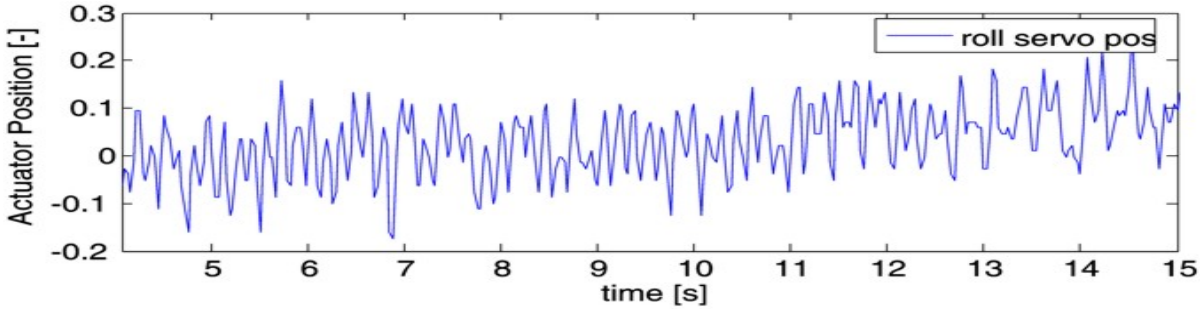


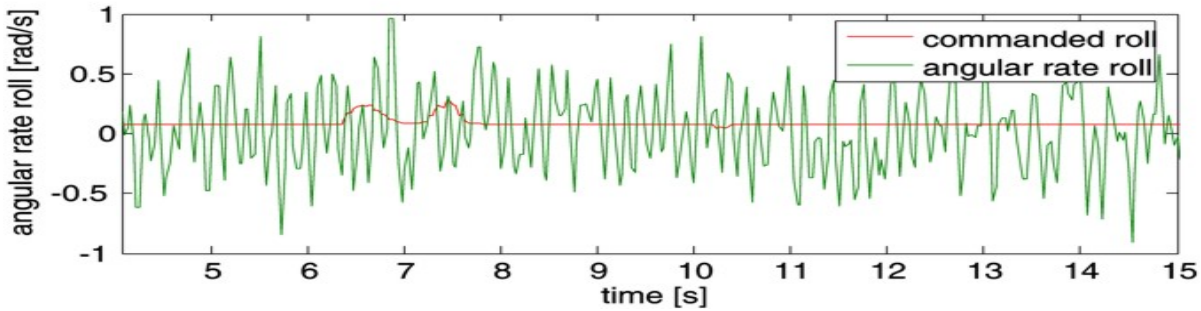
Autopilot Hierarchical Structure



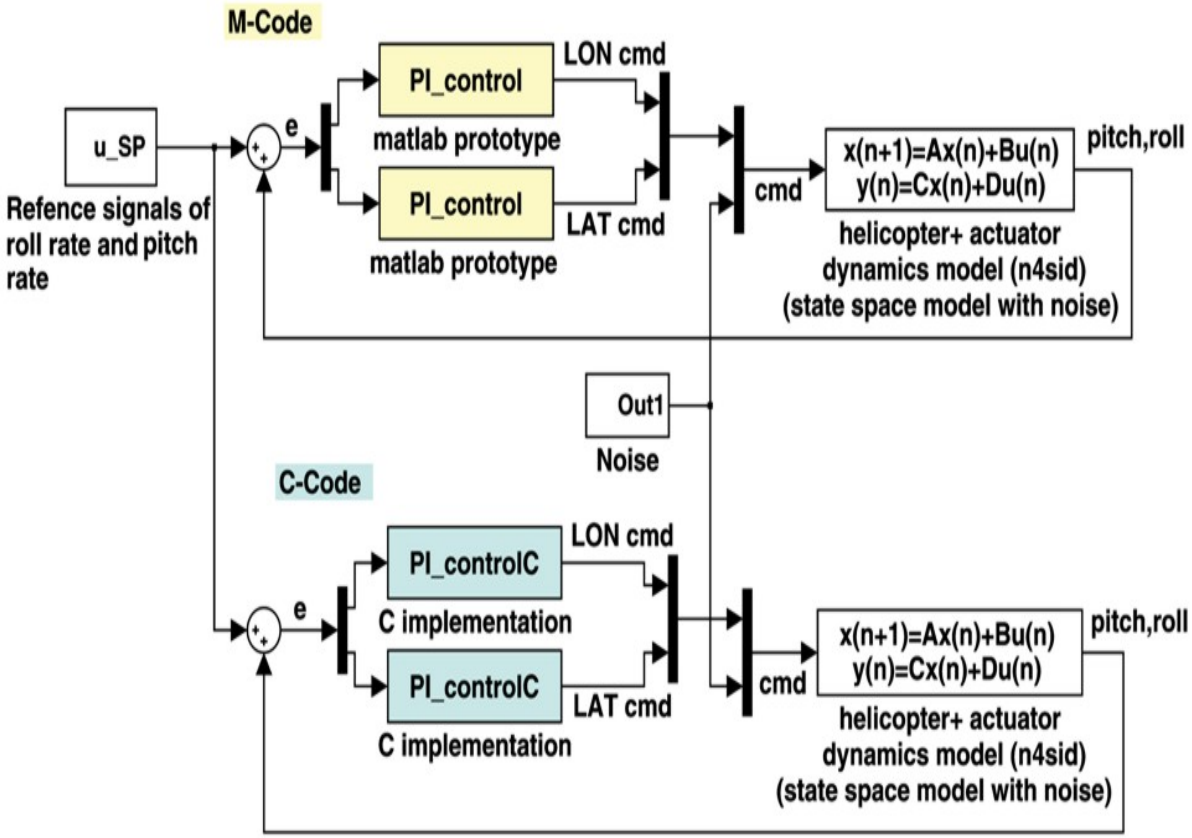
Angular Rate Stabilizers







Controller Implementation Testing



"...and we can save 700 lira by not taking soil tests."

Conclusion & Future Work

- HW & System SW ready and running
- Basic mathematical model identified
- Angular stabilization flight-tested
- Integration of 3-axis magnetometer
- SDRE attitude and velocities controller
- Trajectory following (MPC ?)

Discussion

http://rtime.felk.cvut.cz/helicopter