Flight Control Laboratory (FCL)
Kick-off meeting

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Overview

1. Presentation
   - Motivation
   - Organizational
2. Projects

What is the FCL?

Objectives

- Hands-on experience in control and/or estimation
- Working with a real and/or simulated aerial system
- YOU shall learn something / gain further insights
- A *working* project (A running demo)

You working crazy hours and getting frustrated is certainly NOT our goal!

Examples from previous Years

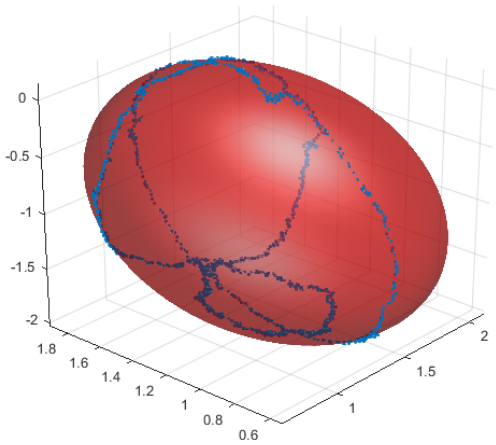


Figure: Magnetometer Calibration

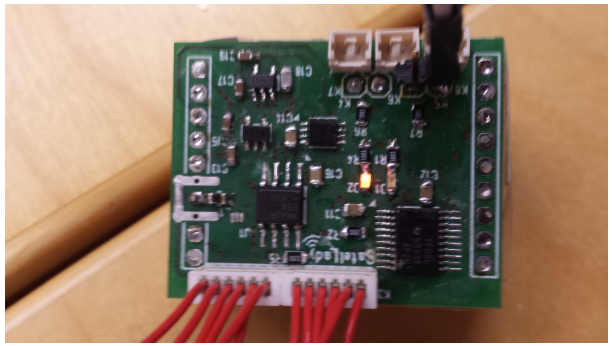


Figure: PCB development for a gps module

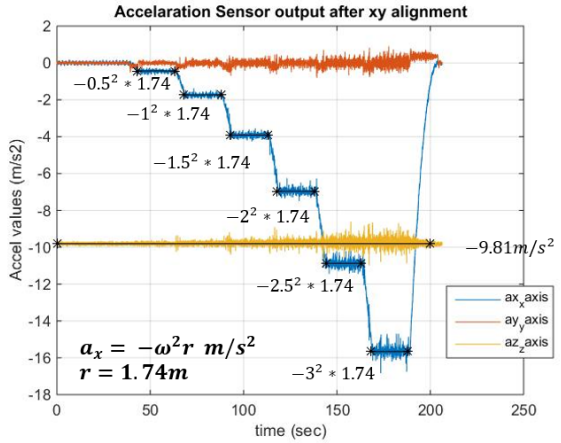


Figure: Accelerometer Calibration

Time-line

Deadlines and mandatory meetings:

- **Kick-off meeting** May 9, 2017
- **Project Proposal Presentation** (two weeks after Kick-off)
- **Mid-term Presentation** (second week of June)
- **Final Presentation** (last week of July) *graded!*
- **Final Report** *submission deadline* August 18th, 2017, 23:59

- **Weekly Report** *every* Monday, 23:59

Project Proposal Presentation

Project Proposal Presentation:

- 5-10 min each
- Present your Project:
  - Define goals
  - Identify approach(es)
  - Come up with detailed time line (plan for mistakes and detours!)
- make slides (with a software of your choice)

Afterwards:
(individual) discussion of project, approaches and time line

Mid-term Presentation

Mid-term Presentation (2nd week of June):

- work accomplished so far (including problems and taken approaches)
- current state
- planned work
- (updated) time line for remaining time
- NOT graded!

See this as a grand rehearsal for the final presentation.

Final Presentation

Final Presentation (last week of July):

- final state of your project
- Demo
- problems, approaches taken
- Prof. Diehl will be there!
- 20% of your grade

Final Report

General:

- Article in the SYSCOP wiki!
- *about* 1000 - 2000 words (quality over quantity)
- 60% of the grade

Contents:

- Explanatory graphics
- Problems, tried Approaches, lessons learned, . . .
- Point to code and Examples / Tutorial

Keep in mind while writing:
Other people will read (parts of) it when they want to use or build up on your work

Weekly Report & Meetings

What goes into the weekly report (deadline Monday 23:59)?

- Work accomplished in previous week, including Problems and state of lab
- Plans for the next week
- point to commits you have made

Questions, Problems, want to try your presentation, . . . ?

→ Send an email and ask for a meeting!

Grading

Grading based on three components:

- 20% your final presentation
- 20% code and documentation
- 60% lab report (Wiki article)

Legal notice

Please note:

- Plagiarism or copyright violations will be rewarded with a 5.0 (you fail)
- Cite correctly! Wrong citations or missing citations are plagiarism.
- Indicate your source for any piece of intellectual property that is not yours (code, image, text), otherwise this is also plagiarism.
- Before you the intellectual property of somebody else make sure you have the right to do so, and that you are not violating any copyrights.

Organizational Questions?

Project Overview

Projects:

- Creation of a Quadcopter Model
- Quadcopter Optimal Control
- Generic Kalman Filter Framework
- Blackbox Modeling via a Neural Network

Special Projects:

- ACADOS Integration in OROCOS for NMPC
- Python Software Project

Project 1: Creation of a Quadcopter Model

- Design and implement a nonlinear quadcopter model (preferably in MatLab)

$$x = \begin{bmatrix} p \\ \dot{p} \\ q \\ \dot{q} \end{bmatrix} \qquad \dot{x} = [?]$$

- Verify its performance in simulation
- Linearize the model and apply a Linear Quadratic Regulator

$$u = -Kx$$

Project 2: Quadcopter Optimal Control

- Develop a 2D quadcopter model

$$x = \begin{bmatrix} p \\ \dot{p} \\ \phi \\ \dot{\phi} \end{bmatrix} \qquad \dot{x} = [?]$$

- Perform optimal control with constraints and external disturbances
- Extend the problem by adding obstacles

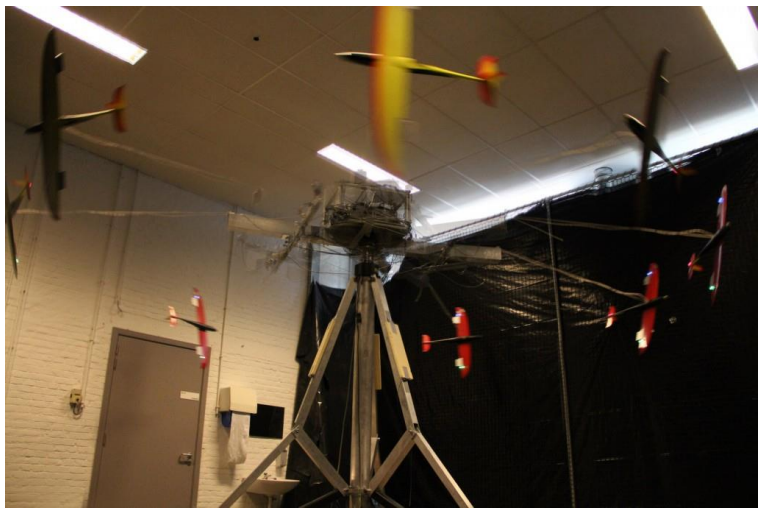
Project 3: Generic Kalman Filter Framework

- Implementation of a software framework for applying an (extended) Kalman filter to arbitrary models.
- The framework should be integrated in an OROCOS component.
- *Kalman Filter*: Join system knowledge with sensor data to create an estimate of the system state
- *OROCOS*: Open Robot Control Software, a framework for creating hard-realtime control applications

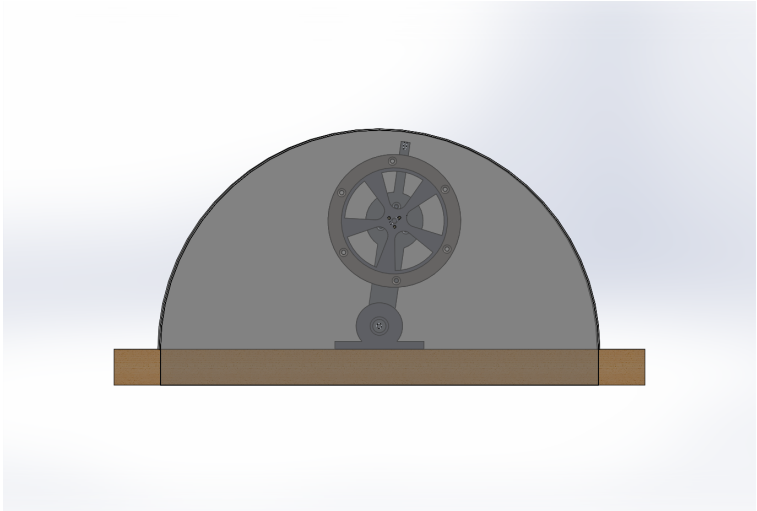
Project 4: Blackbox Modeling via a Machine Learning

For simulated scenarios and real measurement data:

- Design and train a neural network (with TensorFlow) (`https://www.tensorflow.org/`)
- Train a model with auto-sklearn (`https://github.com/automl/auto-sklearn`)
- Compare performances
- experience with Python & interest in Machine Learning required



Setup rotational takeoff



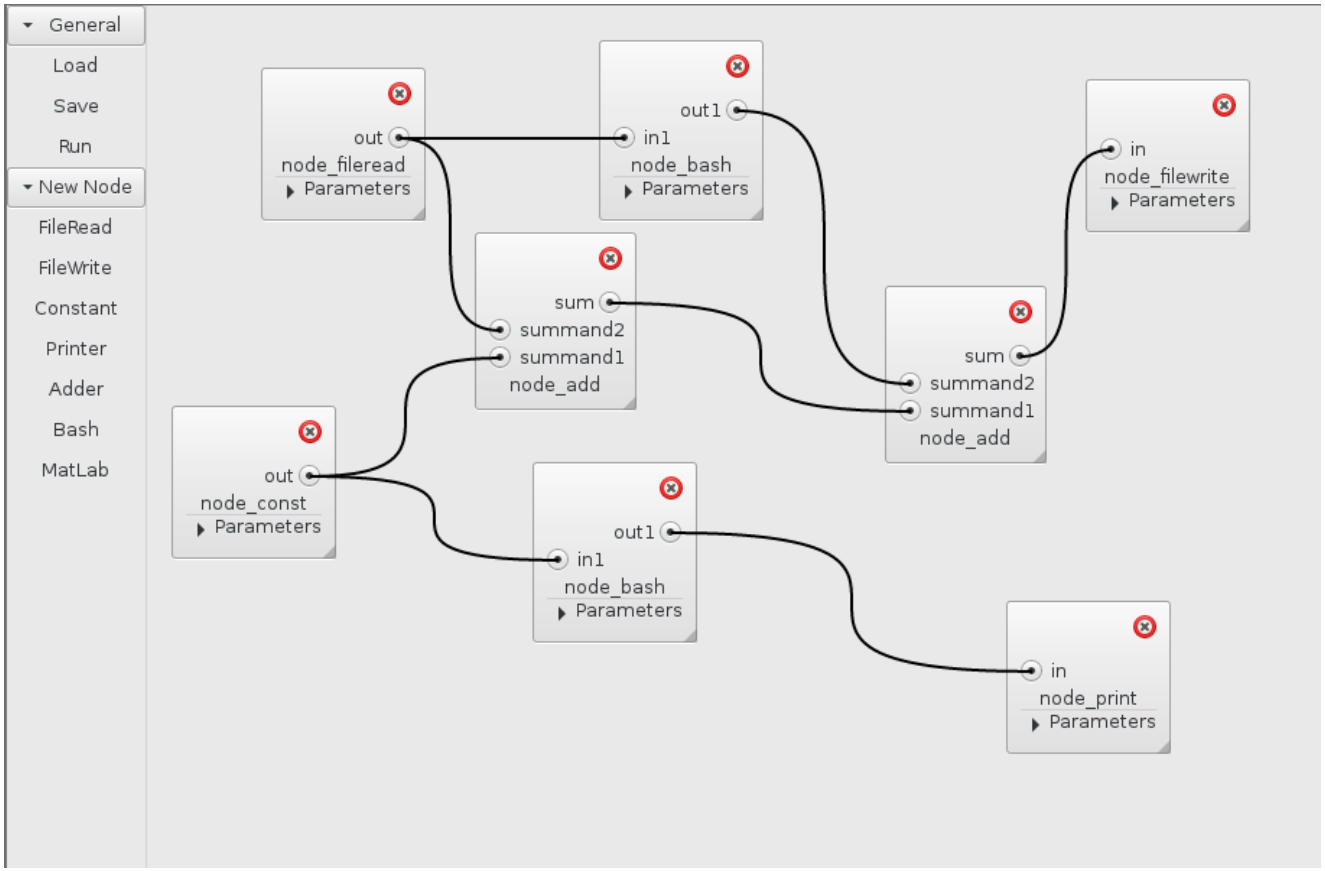
Inverted Pendulum

Project 5: ACADOS Integration in OROCOS for NMPC

- ACADOS is a framework for creating fast optimal control problem solvers developed at the SYSCOP Lab.
- Nonlinear model predictive control (NMPC) is a powerful control strategy for difficult control problems
- Help porting it to embedded platforms!

Project 6: Python Software Project

Help developing a new graph-based data processing tool



Personal Projects: Your Project Ideas

If have an idea for a project you would like to do:

- Please discuss your idea with us during the next week.
- Make sure it fits the time frame (about 180 hours workload).
- Identify possible approaches and goals
- Make sure all materials, tools, hardware, software, ... you need is available.

Please note, that projects have to be accepted by us **prior** to the Project Proposal Presentation!

Project Discussion