Kickoff Digital Engineering Projects SwarmLab

Prof. Mostaghi, Christoph Steup
Chair of Intelligent Systems

Organization

- Time and location:
  - Start: 12.04.2017
  - End: 15.07.2017 ++
  - Time: 15:00 (3:00 pm)
  - Place: G29-035
- Contact:
  - Christoph Steup: steup@ovgu.de
  - Sebastian Mai: sebastian.mai@st.ovgu.de
- Meetings:
  - Individual meetings organized by periodically by Team Leader
- Web:
  - DE Project Overview
- Registration / Application
  - Form due by 13.04.2017 23:59

Teams

- Teams of max. 4 DE Students

- One leader (chosen by team) :

  – Organize project (sub-tasks, milestones, documentation)

  – Communication to staff

- Presentation by all members

- Prerequisites:

  – Courses: PKES, TI2, Swarm Intelligence, Control Theory

  – Programming: C++/C, Ocaml, Lua, Python, Latex …

  – Enthusiasm and Teamwork
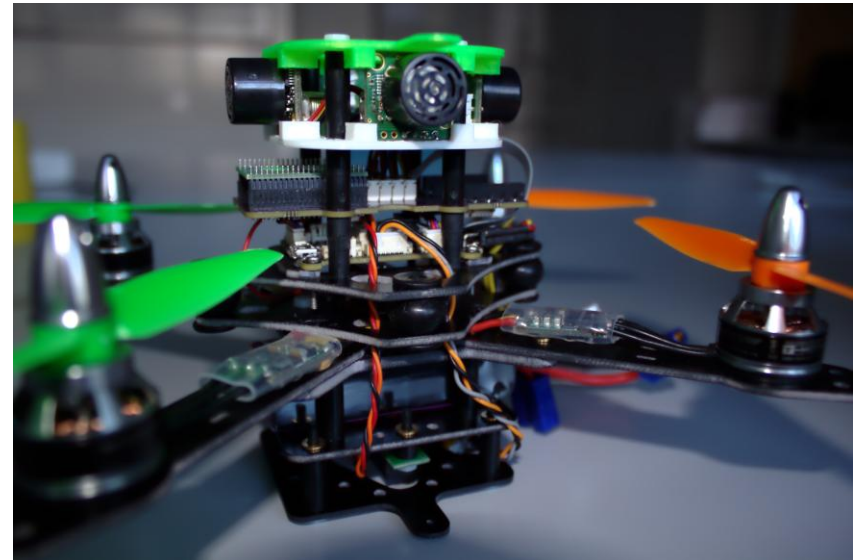
Evaluation

- You deliver:

  - Working Prototype

  - Code

  - Documentation

  - Project Management

  - A talk including video or demonstration

- We deliver:

  - Guidance

  - Introductory meetings to show you your way around the used systems

  - A (probably good) grade after everything is done

ROS – Interface to Copters

- Current Software Paparazzi

- ROS (Robot Operating System)

- Already running in lab

- Goal:
  - Provide Status Information
  - Enable Remote Control of Copter
  - Reliable connect and reconnect
  - Multiple Copters

- We have:
  - Positioning (ROS aware)
  - Telemetry (Up and Down)
 - ROS capable PC on Copter

Swarm Behaviour Estimation

- Copters shall follow different Swarm Behaviours

- Currently only simple Attraction - Repulsion

- More Swarm Behaviour necessary

- Evaluation of Swarm Behaviour in Realistic Dimensions

- Goal:
  - Extend Swarm Behaviour
  - Cohesion, PSO
  - Evaluate quality
  - Evaluate robustness

- Evaluation in Real World
- Development may be Simulation-based
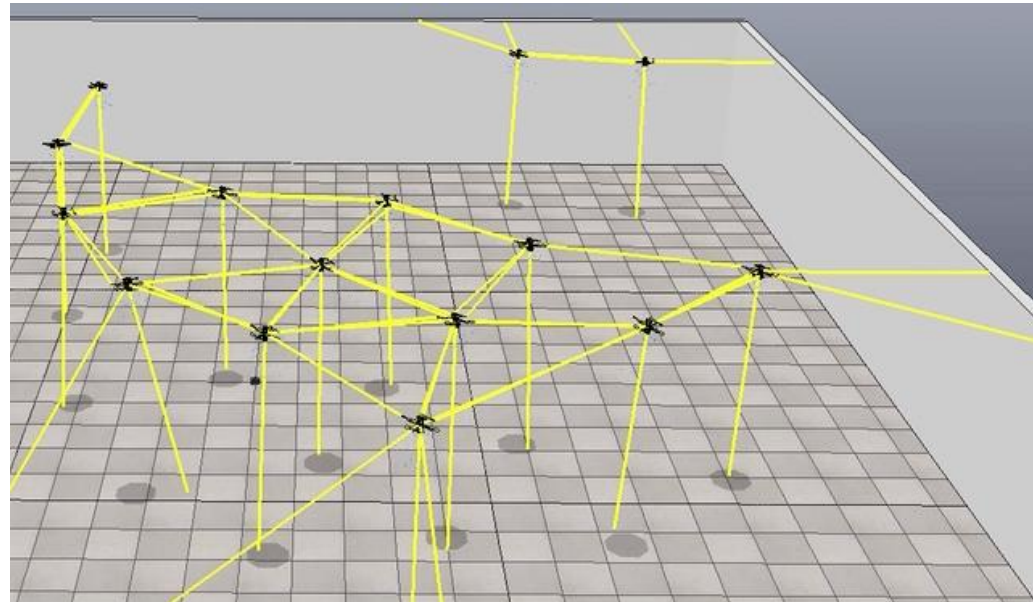
Vibration Compensation for IMUs

- Copters use internal IMU for attitude control

- IMU are MEMS-Sensors with high fidelity

- Motors induce large vibrations into copter frame

- Acceleration is dominated by vibrations of motors

- Good and trustworthy acceleration allows for dead-reckoning navigation

- Goal:
- Learned Acceleration Sensor Model
- Manually moved copter vs. flying copter
- Kalman filter to compensate vibration in acceleration

Prior knowledge of state $\rightarrow$ $\mathbf{P}_{k-1|k-1}$ $\hat{\mathbf{x}}_{k-1|k-1}$ $\rightarrow$ **Prediction step** Based on e.g. physical model

Next timestep $k \leftarrow k + 1$

$\mathbf{P}_{k|k-1}$ $\hat{\mathbf{x}}_{k|k-1}$

$\mathbf{P}_{k|k}$ $\hat{\mathbf{x}}_{k|k}$ $\leftarrow$ **Update step** Compare prediction to measurements $\leftarrow$ **Measurements** $\mathbf{y}_k$

Output estimate of state