

Automation

Steering and Automation





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Time scope: 1-3h



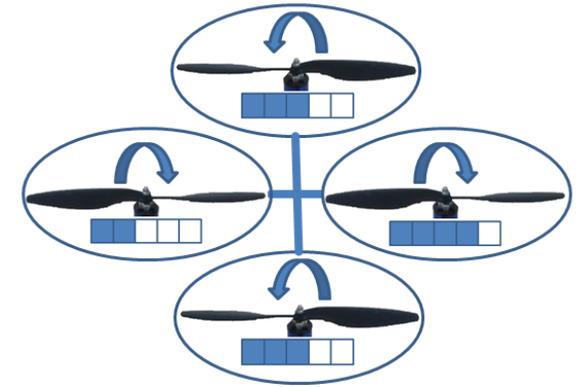
Steering a quadrotor

Steering a quadrotor:

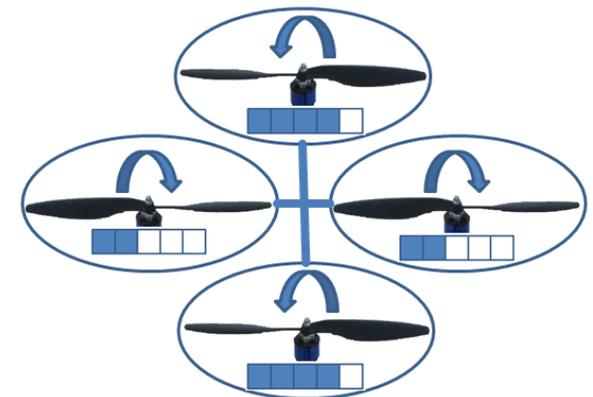
- Based on the three controllers, it is now possible to steer the quadrotor over the roll, pitch and yaw axes.
- By tilting the roll axis the quadrotor can manipulate its sideways position (strafe).
- By tilting the pitch axis controls the forward / backward position.
- Since the quadrotor can move in all directions with these two controllers, manipulating the yaw angle is not absolutely necessary.

Exceptions are:

- The quadrotor has a preferred orientation, e.g. to focus with a camera onto a certain spot.
- The quadrotor wants to save its energy in curve flight for higher energy efficiency / flight time.



Principle: Rolling



Principle: Pitching

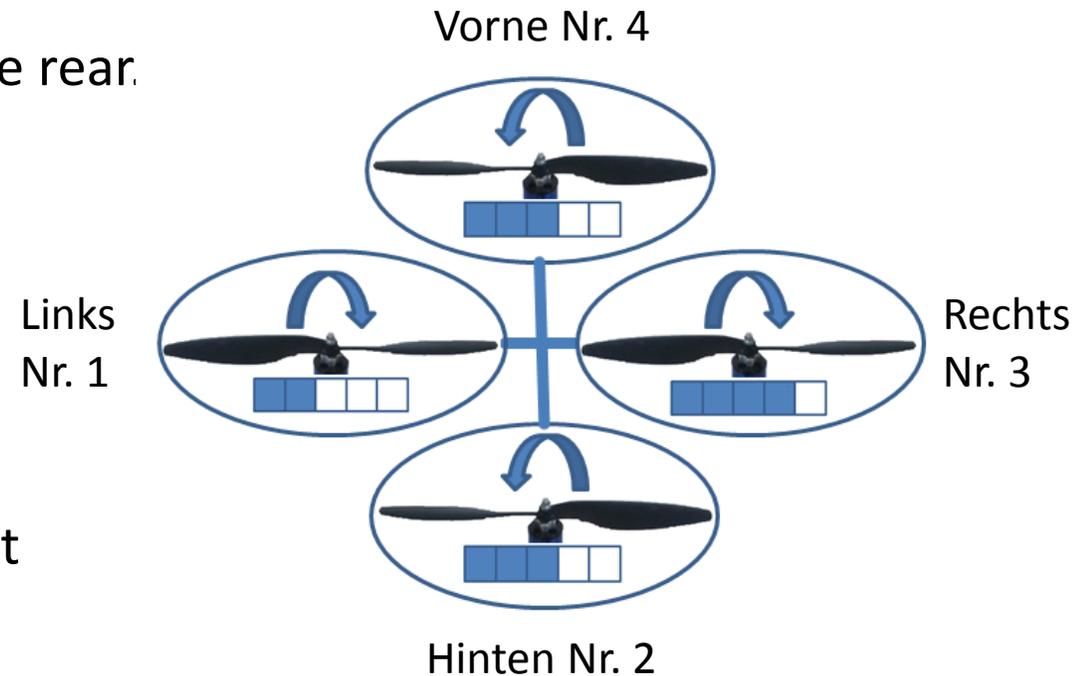
Steering a quadrotor

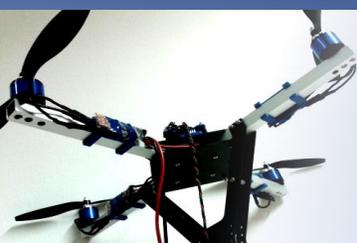
Steering a quadrotor (Back and Forth):

- Example forward flight: The copter tilts towards the front.
-> motor #4 turns slower and #2 stronger
- Example backwards flight: The copter tilts towards the rear.
-> motor #2 turns slower and #4 stronger

Steering a quadrotor (Left and Right)

- Example strafe right: The copter tilts towards the right
-> motor #3 turns slower and #1 stronger
- Example strafe left: The copter tilts towards the left
-> motor #1 turns slower and #3 stronger





Safety instructions

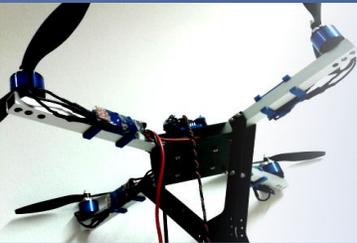
Safety instructions:

- Check the system and retighten all parts (screws/propellers/motors/arms/joints/bolts/nuts) if necessary before every start!
- Only connect and start the motors under the supervision of your teacher!
- Keep a safety distance of at least 50cm to any propeller.
- Take care for your neighbor and yourself! Be ready to turn the system off immediately in case of emergency!



Emergency Stop:

- Unplug / Shut down Power
- Unplug TWI Cable
- Shut down MCU



Exercises

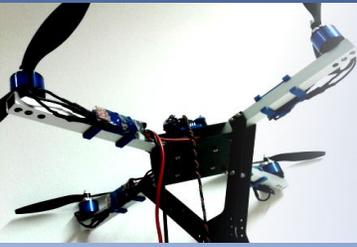
Required hardware:

- EVK1100
- Micro USB cable for power and flashing
- QCS in 3DOF Control Mode

Required software:

- AVR Studio 32 (with Tool Chain and FLIP Driver)
- EMQ Framework (Code)
- Documents:
 - EMQ_Framework.pdf

Exercises



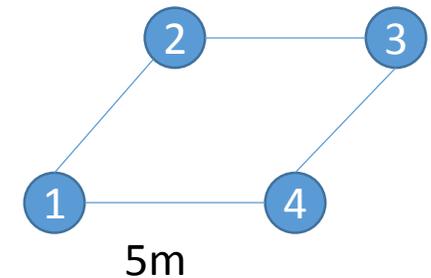
Exercise 1a:

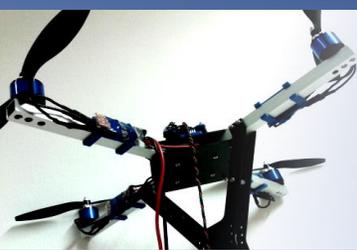
Now, the quadrotor shall “fly” a certain trajectory automatically on command. We simulate the flight using the QCS. For this we assume a 12° tilt causes an acceleration of the system of 2 m/s^2 (accelerated movement). We assume further, that after acceleration the quadrotor keeps flying with a constant speed when (back) in horizontal position without air friction until breaking. Delays of the acceleration until the desired angle of 12° is reached can be neglected.

The quadrotor shall fly a rhombus defined by the points P_1 , P_2 , P_3 and P_4 (see figure) with a maximum speed of 1 m/s .

$$P_1 = \langle 0\text{m}, 0\text{m} \rangle \quad P_2 = \langle 3\text{m}, 4\text{m} \rangle \quad P_3 = \langle 8\text{m}, 4\text{m} \rangle \quad P_4 = \langle 5\text{m}, 0\text{m} \rangle$$

The quadrotor is **not to be rotated around the z-axes** for this exercise (-> no yaw control). Calculate the required rotatory maneuvers and their timings first. Remember that the system has to accelerate and slow down at each corner! Diagonal movements are to be vectorial super positioned. Keep the maximum speed at any time!





Exercises

Exercise 2a:

Now, the quadrotor shall fly analogously to exercise 1 in a square with 5m edge length. In this exercise the quadrotor shall always fly towards the corners with the front first -> It has to control the yaw! Besides this, use the same preconditions as for exercise 1.

Hint: Take care that the wires do not wind up!

Exercise 2b:

In both cases the quadrotor will not fly the shapes exactly. Explain and discuss the possible reasons for this and think about a better solution.

