4 The Main Task

4.1. Cargo transportation with a helicopter

The main idea of the challenge is inspired by a cargo transport of a real helicopter like it is shown in Figure 4.1.

Figure 4.1.: A helicopter transporting cargo.

The cargo transport is thus the Main Task of the lab course. This is illustrated in Figure 4.2. The requested flight route is as follows. The helicopter has to

- start at point 1,
- fly to point 2 and pick up the cargo,
- fly to point 3 and deposit the cargo,
- and finally fly back to starting point 1 where it has to land safely.

For a safe flight, the helicopter[1] has to travel above a minimal altitude. Further, the helicopter is not allowed to fly through the gray shaded regions. The **whole task should be performed automatically**, i.e. you are only allowed to push a start button and not allowed to intervene during the flight.

[1] For this purpose, we neglected the geometry of the helicopter and only consider its center.

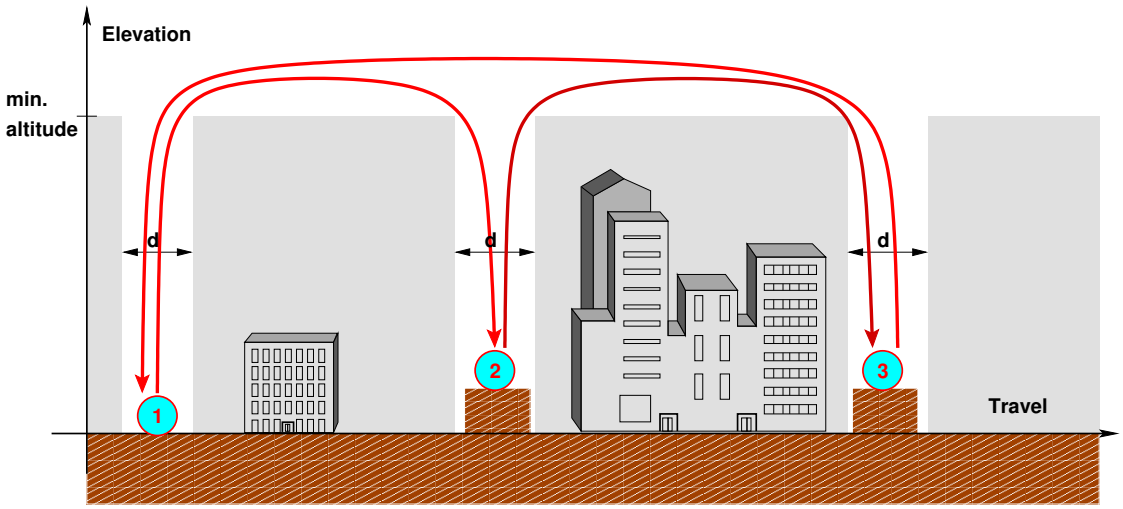

Figure 4.2.: Main Task of the labcourse: cargo transportation.

To formally define the Main Task, we introduce the coordinate system given in Figure 4.3. Therein, the coordinates "travel angle", "elevation angle" and "pitch angle" are polar coordinates. The origin of this coordinate system is given by the starting point (travel angle), horizontal orientation of the main arm (elevation angle) and the point where both motors are on the same level (pitch angle). Within this coordinate system, the desired minimal altitude of the helicopter for travel is at elevation $-7.5°$. Further, the width d of the corridor for starting and landing is $d = 15°$. Finally, the exact position of the points 1, 2 and 3 are given in Table 4.1.

Table 4.1.: Coordinates of the Main Task.

Subtask	Point	Travel α	Elevation β
Start	1	$0°$	approx. $-27°$
Cargo pick-up	2	$90°$	approx. $-22°$
Cargo deposition	3	$450°$	approx. $-22°$
Finish (landing)	1	$0°$	approx. $-27°$

You should only use the given coordinate system in your work. Further, in your protocols as well as in Simulink and Matlab files you should use the following terms and symbols. When documenting in German use *Schwenkwinkel*, *Steigwinkel* and *Nickwinkel* for travel, elevation and pitch. In your model and your working files use the symbols α, β and γ for travel, elevation and pitch. Use for the corresponding axis the symbols x, y and z, respectively. Symbols referring to the motors should use the indices F and B for front and back motor, respectively, e.g. the voltage at the front motor and back motor is U_F and U_B, respectively. An overview of the described terms and symbols is given in Table 4.2 and Table 4.3. **Do not use terms and symbols which are inconsistent with those given in Table 4.2 and Table 4.3.**

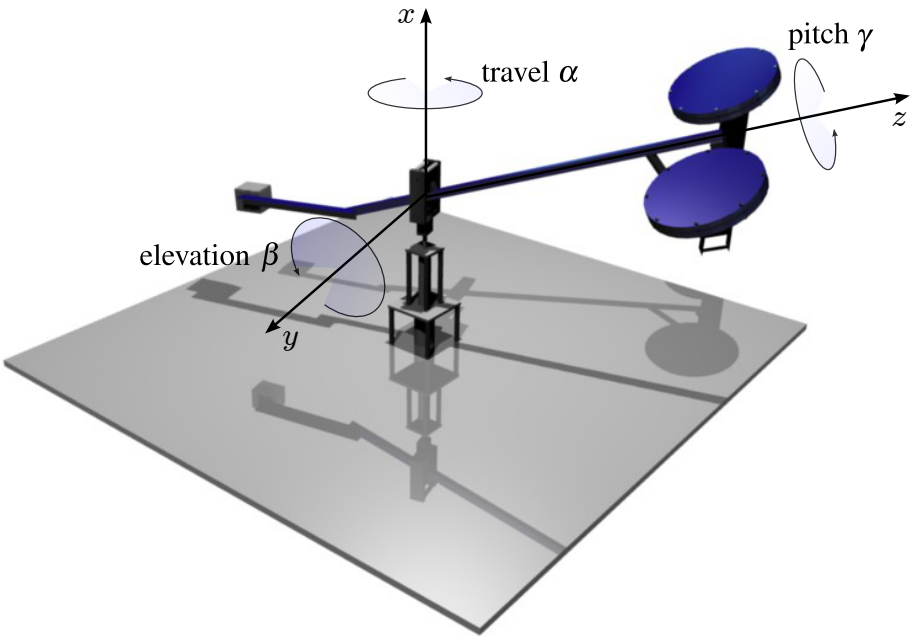

Figure 4.3.: Coordinate system.

Table 4.2.: Overview on coordinates.

Coordinate	German term	Symbol	origin of coordinate	corresponding axis
travel angle	Schwenkwinkel	α	starting position	x
elevation angle	Steigwinkel	β	horizontal position of the arm	y
pitch angle	Nickwinkel	γ	horizontal position of the helicopter	z

Table 4.3.: Overview on actuators.

Actuator	German term	Symbol for applied voltage
front motor	Frontmotor	U_F
back motor	Heckmotor	U_B