TECHNISCHE UNIVERSITÄT WIEN

ILSB Institute of Lightweight Design and Structural Biomechanics

Computational Bionics
Project Exercise 1

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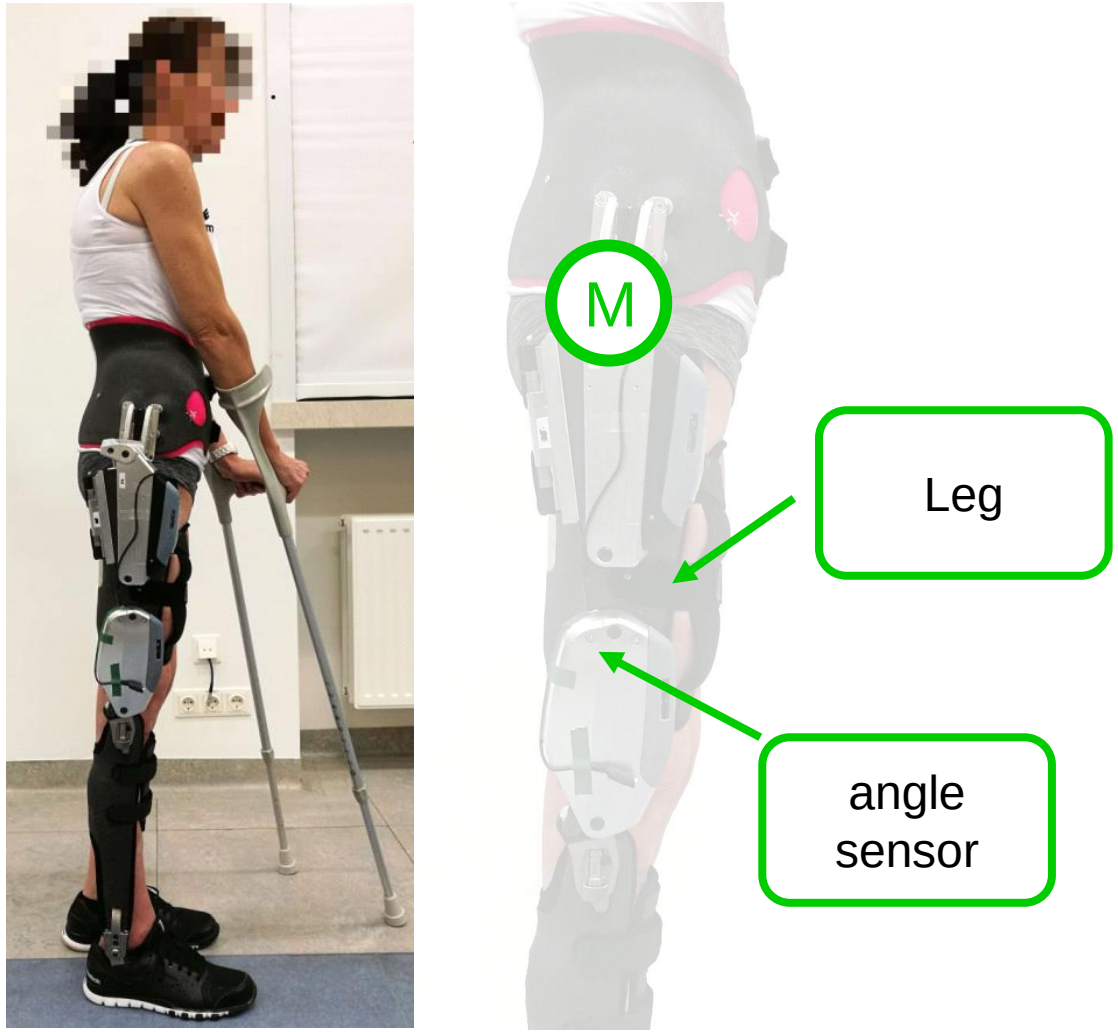
Our mission



Spinal cord injury (SCI) is a common cause of paralysis, according to WHO global incidence is 250.000 – 500.000 cases a year.

Our mission is to get as many people out of the wheelchair as possible. You will be modeling some subcomponents of an exoskeleton to push its development.

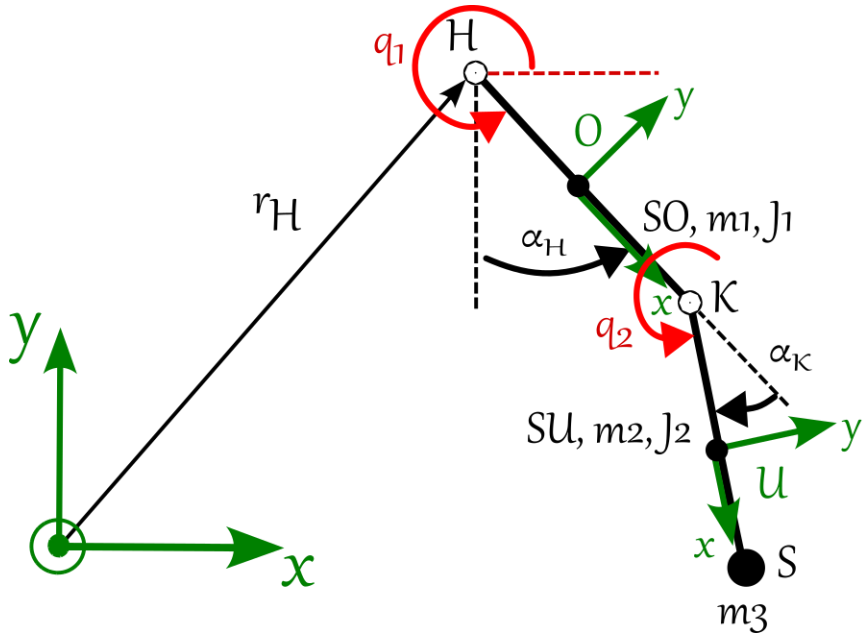
Subcomponents:

- leg
- hip drive
- knee angel sensor

The following slides provide you with information to build up your models. If you are missing information, make a reasonable assumptions and document it.

Modeling the leg (15 points)

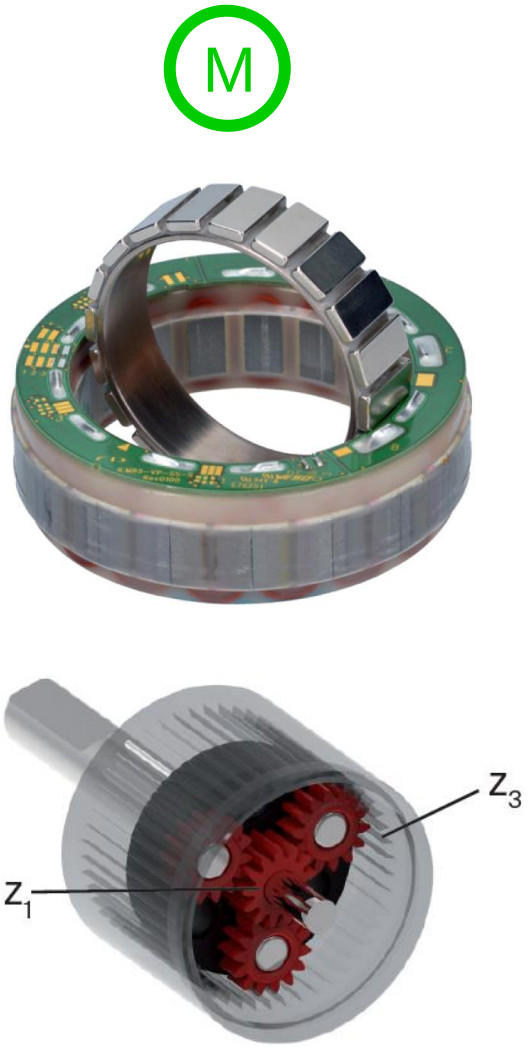
- Make a model of the leg (ODE model , states: q_1,ω_1,q_2,ω_2)
- Chose a mass of 100 kg for our test person
- Compute the mass of the leg segments according to the table
- Assume the segment mass as point mass in the middle of each segment
- Draw a simplified box model with your in and outputs and the equation system in the box
- Design a setting with reasonable input variables to verify your model. You can us the provided gait data.
- If you use gait data as provided, check the angles and torques and convert them to the mathematical angles and directions if necessary.
- Run the simulation and discuss the result



segment	mass in kg
thight	0.09 bodyweight + 0.73 = 9.73
shank	0.055 bodyweight - 0.43 = 5.07
foot	0.001 bodyweight + 0.34 = 0.44

Modeling the drive (10 points)

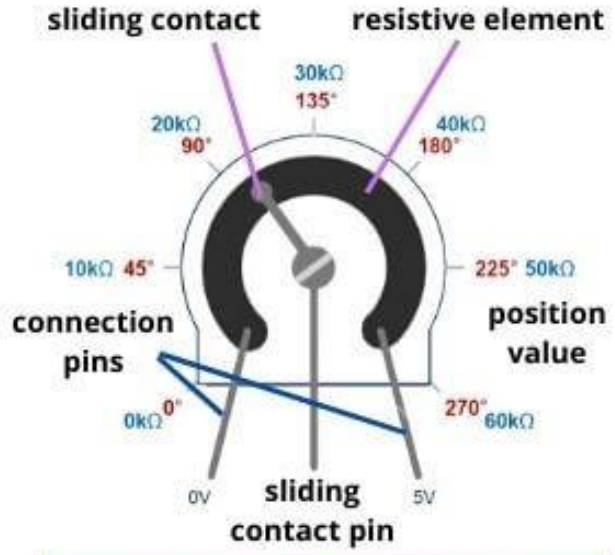
- Make a dynamic model of the drive (ODE model , states: I, M)
- Chose the ILM 50x08 motor from TQ systems
- Look um the necessary parameter in the provided datasheet
- Assume this brushless drive operates in star parallel configuration and operates like a brushed DC motor
- They're for you can approximate the speed constant by the no load speed over the rated voltage.
- Chose a motor voltage of 16 V
- Choose a gearbox with a gear ratio of 60 and an efficiency of 0.85.
- Draw a simplified box model with your in and outputs and the equation system in the box
- Design a setting with reasonable input variables to verify your model.
- Run the simulation and discuss the result



Modeling the angle sensor (10 points)

- Make a model of an angle sensor for the knee (algebraic model)
- Chose a potentiometer like displayed
- Chose the desired measurement range for the angle sensor according to the range auf motion in the knee (gait data)
- The supply voltage of the sensor is 5V
- The sensor has an integrated microcontroller
- The maximum voltage input range of the microcontroller is 3V
- The microcontroller has 8 bit ADC (analog digital converter)
- Draw a simplified box model with your in and outputs and the equation system in the box
- Design a setting with reasonable input variables to verify your model.
- Run the simulation and discuss the result

angle sensor



potentiometer design

What to submit

- Submit your exercise solutions in groups of 1 to 3 students.
- There is no group registration, just write the names of the group members on the protocol.
- Submit a jupyther notebook with the code for all three models. Provide it in the *.ipynb and *.pdf format.
- Write your notebook as a protocol (use markdown cells).
- Explain short how you derive your models, discuss the verification and the results.
- Prepare the protocol so that you can use it for the 15-minute group presentation.