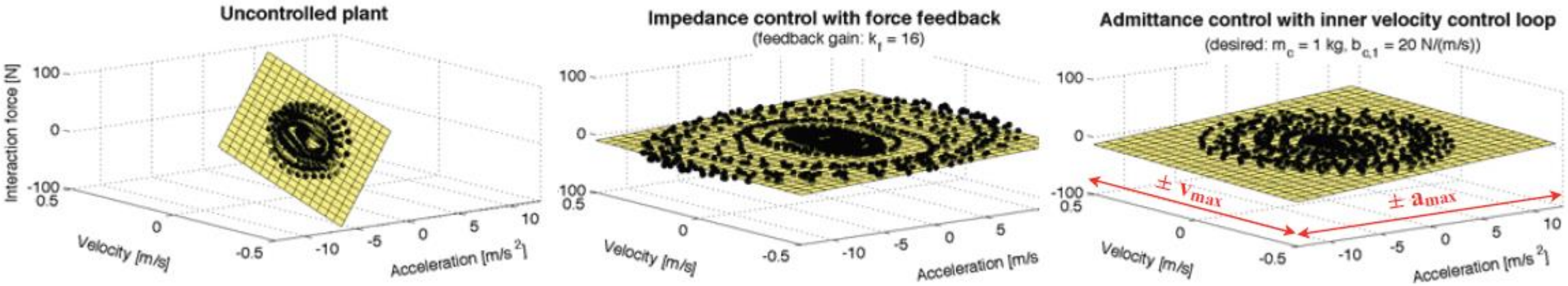



# COMPARING THE TRANSPARENCY OF THE HAPTIC PADDLE USING DIFFERENT INTERACTION CONTROLLERS

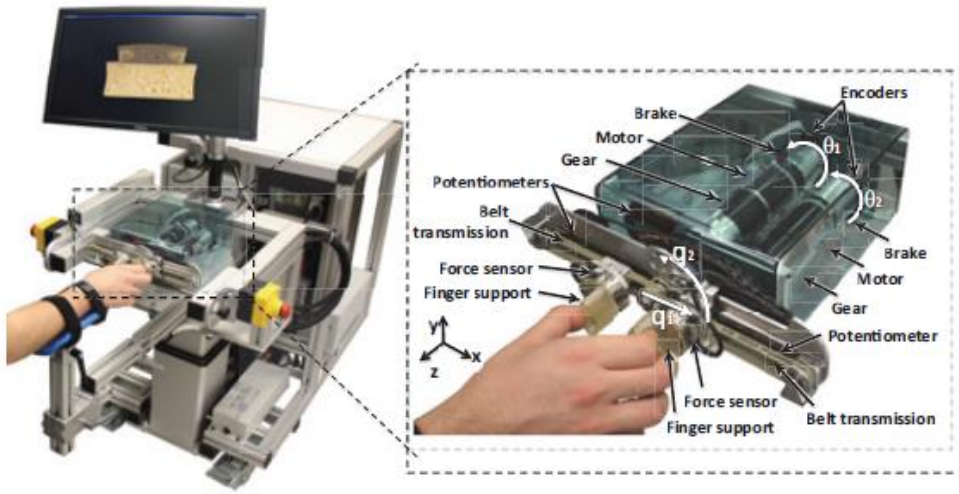
pHRI specialization project 07 -2021

Supervisor: Jan Dittli

# Motivation

How to implement a fully transparent environment into the haptic paddle?

Useful for rehabilitation applications (a stroke patients with weakness can interact with a robot when it's transparent)



# Goal

- The most appropriate controller for human-robot interaction is the impedance controller. Impedance controllers are well suited for achieving a transparent behavior, especially in combination with force feedback, in order to compensate for the device dynamics.
- During the exercises, all groups implement and evaluate a simple impedance controller with friction feedforward on the Haptic Paddle.
- In this project, you will improve your feedforward controller by using force sensor data and additionally implement an impedance controller with force feedback. You will compare the lower apparent impedance boundaries of different interaction controllers (e.g., uncontrolled, impedance control with friction feedforward, and impedance control with force feedback) by rendering transparency planes and by estimating the apparent inertia and damping felt by the user during human-robot interaction.

# Literature (1)

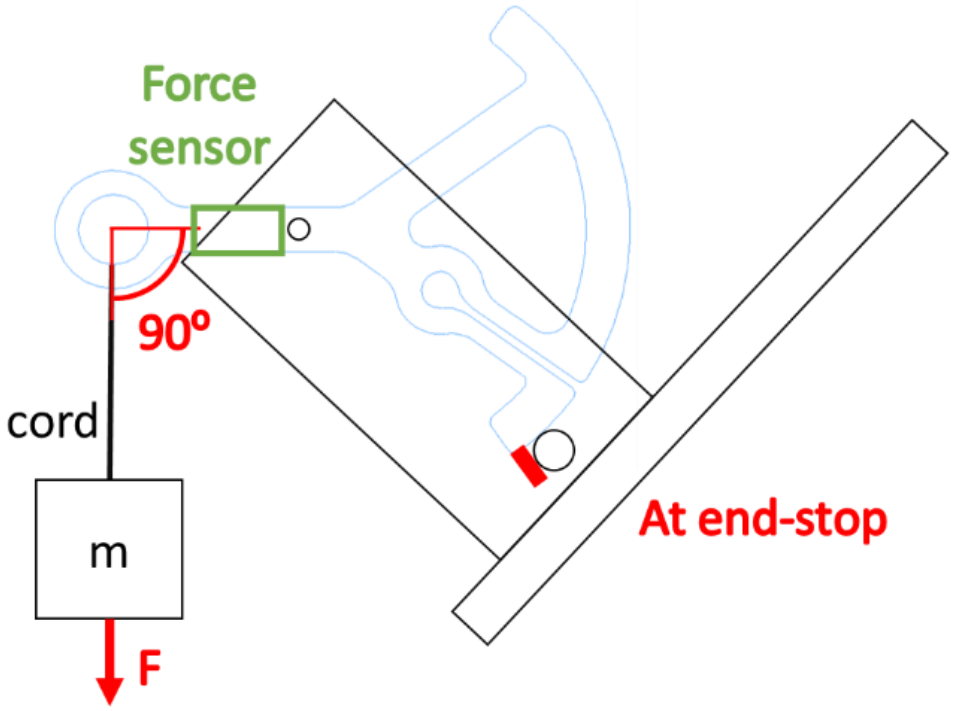
- Metzger J.-C., Lambercy O., Gassert R., (2015) Performance Comparison of Interaction Control Strategies on a Hand Rehabilitation Robot. Proceedings of the IEEE International Conference on Rehabilitation Robotics (ICORR), Singapore, 846-51
  - Implementation of transparency into ReHapticKnob
  - Useful explanation of transparency planes

# Literature (2)

- Tagliamonte NL., Scocia M., Formica D., Campolo D., Guglielmelli E. (2011) Effects of Impedance Reduction of a Robot for Wrist Rehabilitation on Human Motor Strategies in Healthy Subjects during Pointing Tasks, Advances in Robotics, 25:5, 537-562.
  - You will also find the use of transparency planes here

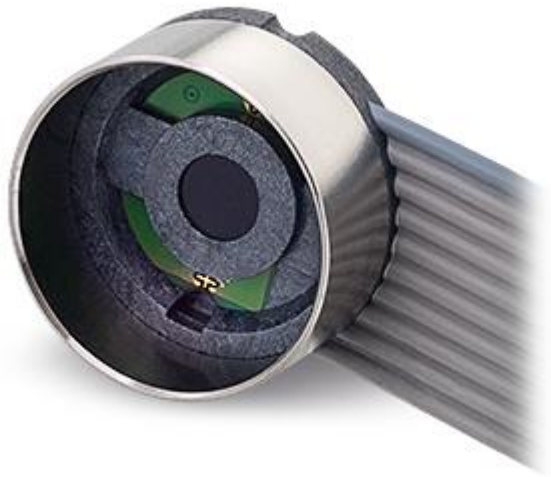
# Additional hardware

- Force sensor
  - *Sensor* → *Amplifier board* should be already connected (check!)
  - Connect *Amplifier board* → *NI USB 6008* via blue wire as AI
  - Determine TF of sensor according to provided guideline



# Additional hardware

- Tachometer
  - Works without amplifier
  - Connect *Tachometer* → *NI USB 6008* (GND – GND, SIG – AI pin)



# LabVIEW Tips

- LabVIEW can’t read multiple threads simultaneously
  - Read out multiple channels on same thread
  - Take subset of resulting array for individual read-outs of interest
  - More details: https://knowledge.ni.com/KnowledgeArticleDetails?id=kA00Z000000P8b1SAC&l=de-CH
- SubVIs and comments in code can make your life much easier… ☺

# Topics for lab 1

- **Familiarization with the project and force sensor**
  - Read literature
  - Calibrate force sensor
  - Implement force sensor readouts
  - Revisit impedance control from previous lab sessions
  - Plan your time

# Topics for lab 2

- **Implementation and experiments**
  - Implement different impedance controller strategies
  - Compare impedance control strategies using transparency planes

# Topics for lab 3

- **Presentation**
  - Introduce motivation for impedance control
  - Give a brief overview of your different impedance control strategies
  - Compare them using transparency planes
  - Discuss with respect to literature

- Feel free to send me your slides in advance for feedback!

# Strategy for support

- You can decide yourself when and where you work on the specialization project
- Try to work as independently as possible

- If you run into issues/have questions:
  - Official time for physical meetings with supervisors in lab sessions at NO on Thursday morning
  - Email supervisor anytime describing your problems/questions
    - Answer directly via email or via Zoom
    - Additional physical meetings possible if necessarily required