Haptic Human-Robot Interfaces
MICRO-553

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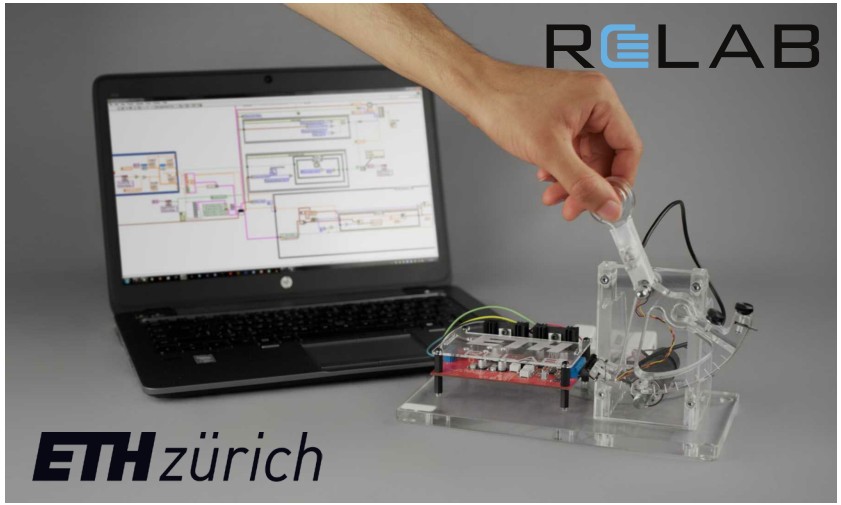
Haptic paddle - history

Okamura et al. (2002). Feeling is believing: Using a force-feedback joystick to teach dynamic systems. *Journal of Engineering Education*, *91*(3), 345-349.



https://relab.ethz.ch/downloads/open-hardware/haptic-paddle.html

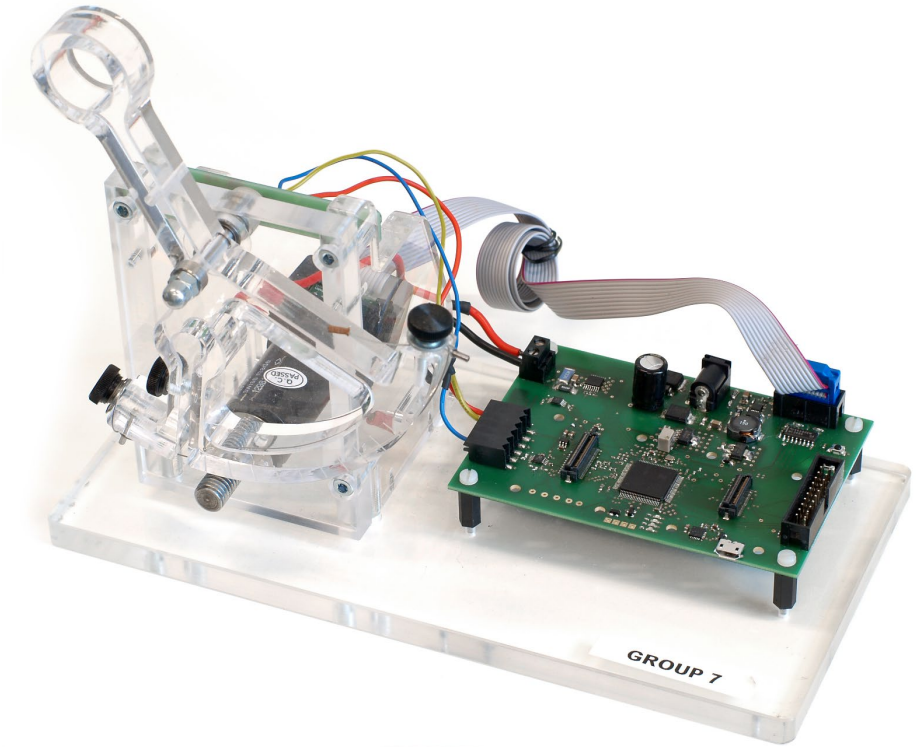
Haptic paddle – general description

Actuation

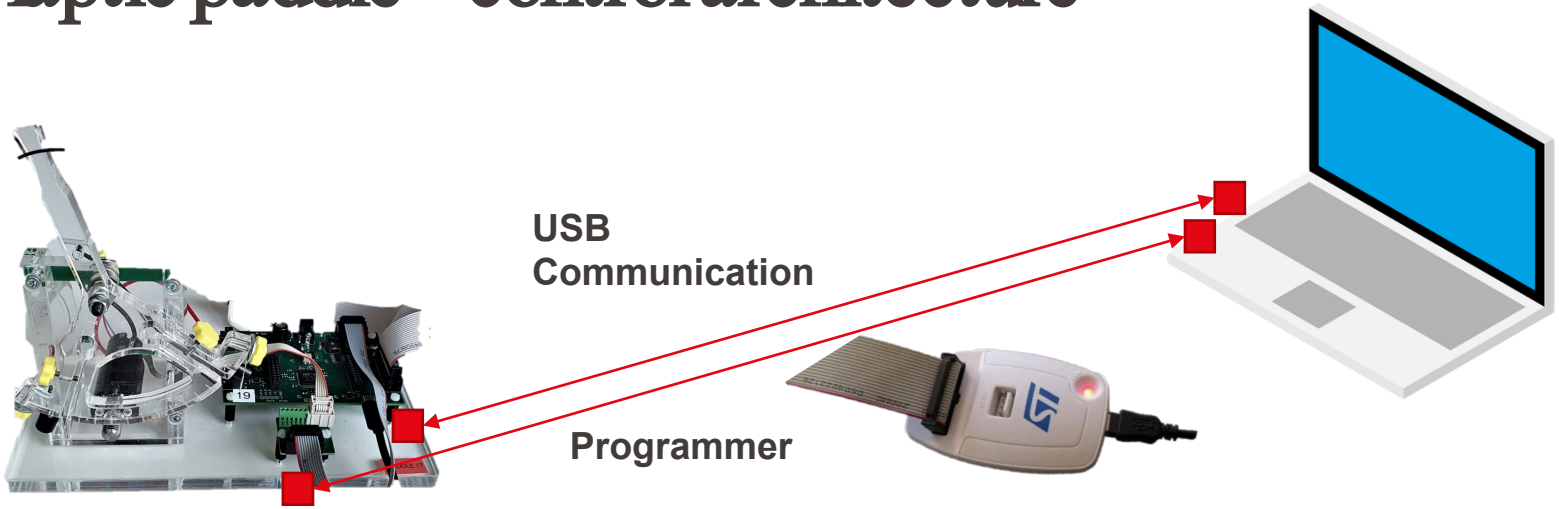
- Brushed DC motor
- Capstan cable transmission

Sensing

- Incremental encoder (motor shaft)
- Hall sensor (paddle shaft)
- Motor current sensing



Haptic paddle – control architecture



Paddle
-Motor
-Transmission
-Sensors

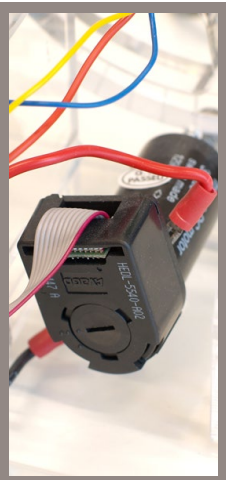
Embedded Electronics
-Microcontroller
-Motor driver
-Hall sensor input
-Encoder convertor
-Optional extension boards

PC
-Programming
-Graphical user interface (monitoring and setting)

Haptic paddle – sensors

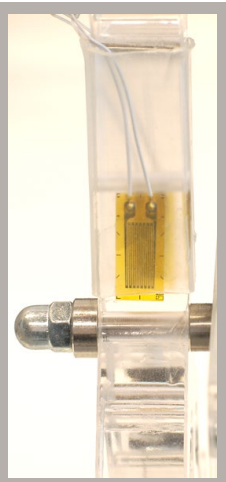
Standard sensors

Hall-effect sensor



Encoder

Optional sensors



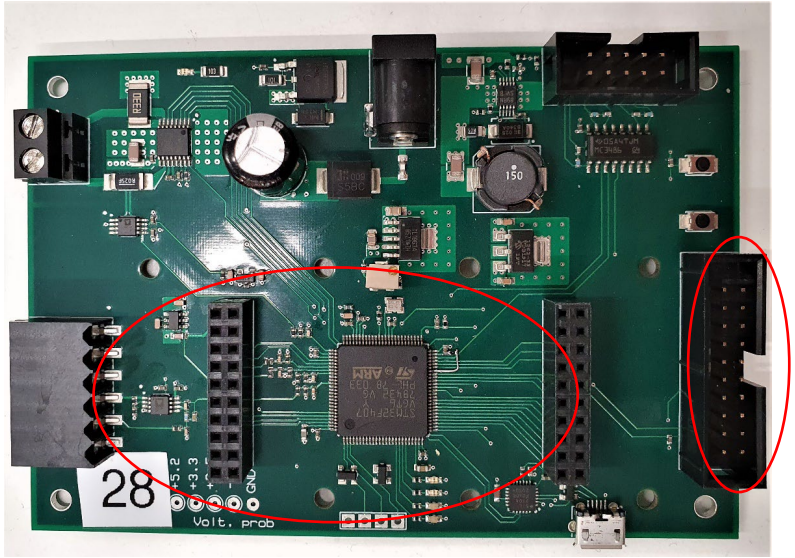
Strain gauges

Inertial measurement unit

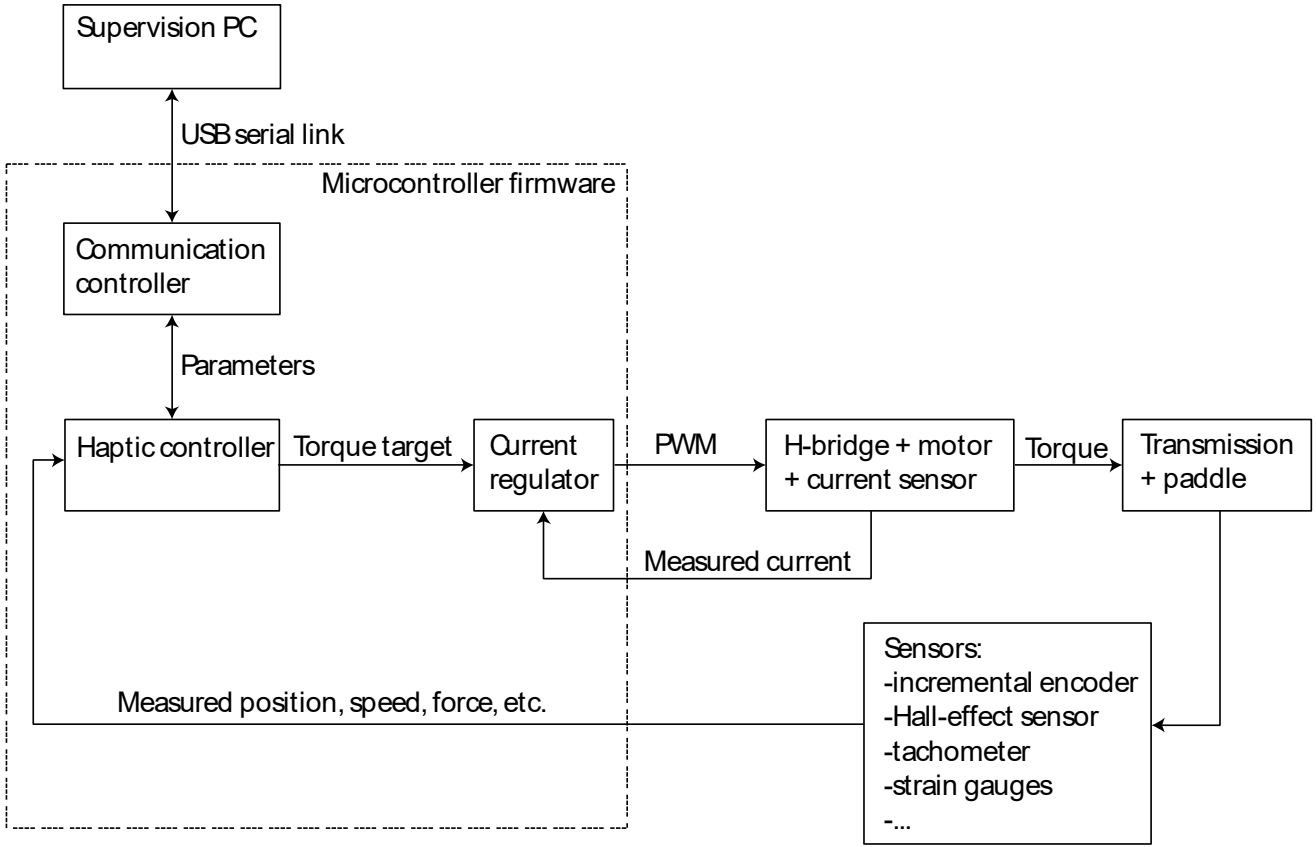
Electronics – recommendations

- Please connect the power supply to the board before connecting it to the mains.

- Be careful with electro-static discharge! Try not to touch the pins.



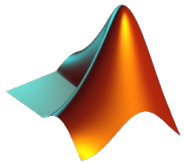
Software – structure



Software – PC

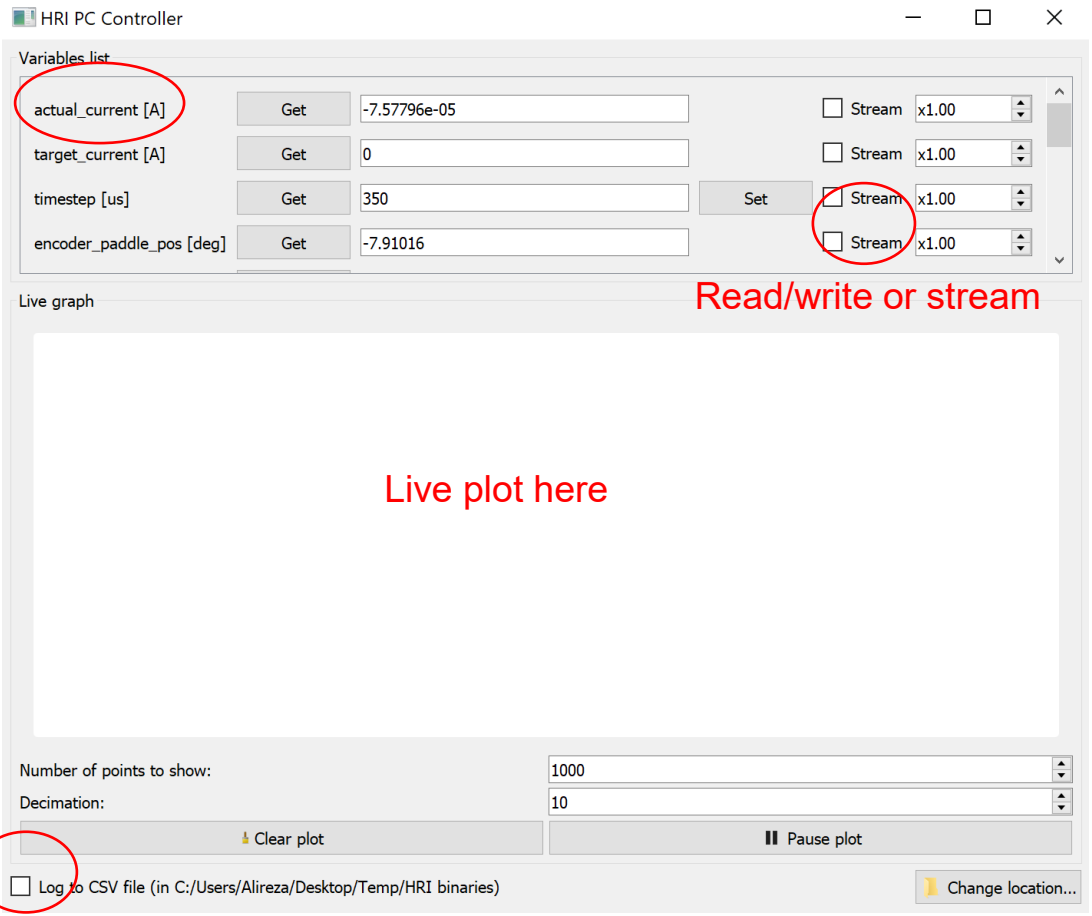
- C language
- System Workbench IDE
- Easy-to-use libraries
  => high-level programming

- Easy plotting and remote access to the firmware variables (R/W)
- Logging for offline data analysis



Focus on the haptic controller behavior, not on the implementation!

Software – GUI

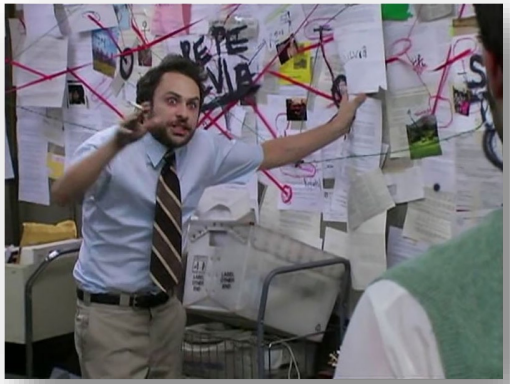


Desired variable

Read/write or stream

TIPS

- Clean and reusable code makes life easier for everyone, including yourself!



- Units are your friends! (or worst enemies…)

Organization

- Groups of **2**
- **Keep the paddle** for the entire semester (treat it WELL!)
- Moodle or mail for questions/announcement/after-hour communication

- 4 Basic Labs
  - Lab 0 – Getting started with the device
  - Lab 1 – Sensor calibration and filtering
  - Lab 2 – Simulation and PID tuning
  - Lab 3 – Impedance control
- Specialization Labs

-> Later labs are dependent on the results of previous ones

Lab 2, Lab 3, and Lab S require a report and they are graded

Do not hesitate to show your results to the assistants

Grading

Graded labs are corrected and sent back to the groups with a feedback.
-> late submissions: penalty of -5/60

A	56-60
B	51-55
C	46-50
D	40-45
F	< 40

To reach 60 points, each part of the labs has a different weight. For more details on the correction criteria, see the syllabus.

Q&A