

MODULE 3-P1: ETH MIKE – a robotic device for sensitive assessment of hand proprioceptive and motor impairments

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1 Introduction

- Neurological disorders frequently lead to **motor and sensory** impairments of the **hand**.
- These impairments, especially of proprioception, are **difficult to detect** using conventional clinical measures.
- Recently developed at the RELab, **ETH MIKE robot** can provide **sensitive, objective and rapid** assessments of hand proprioceptive and motor impairments.
- This device has been shown **reliable, valid and feasible** to be used with **stroke** patients, persons with **multiple sclerosis** and children with **cerebral palsy** [1-3].

2 ETH MIKE: apparatus

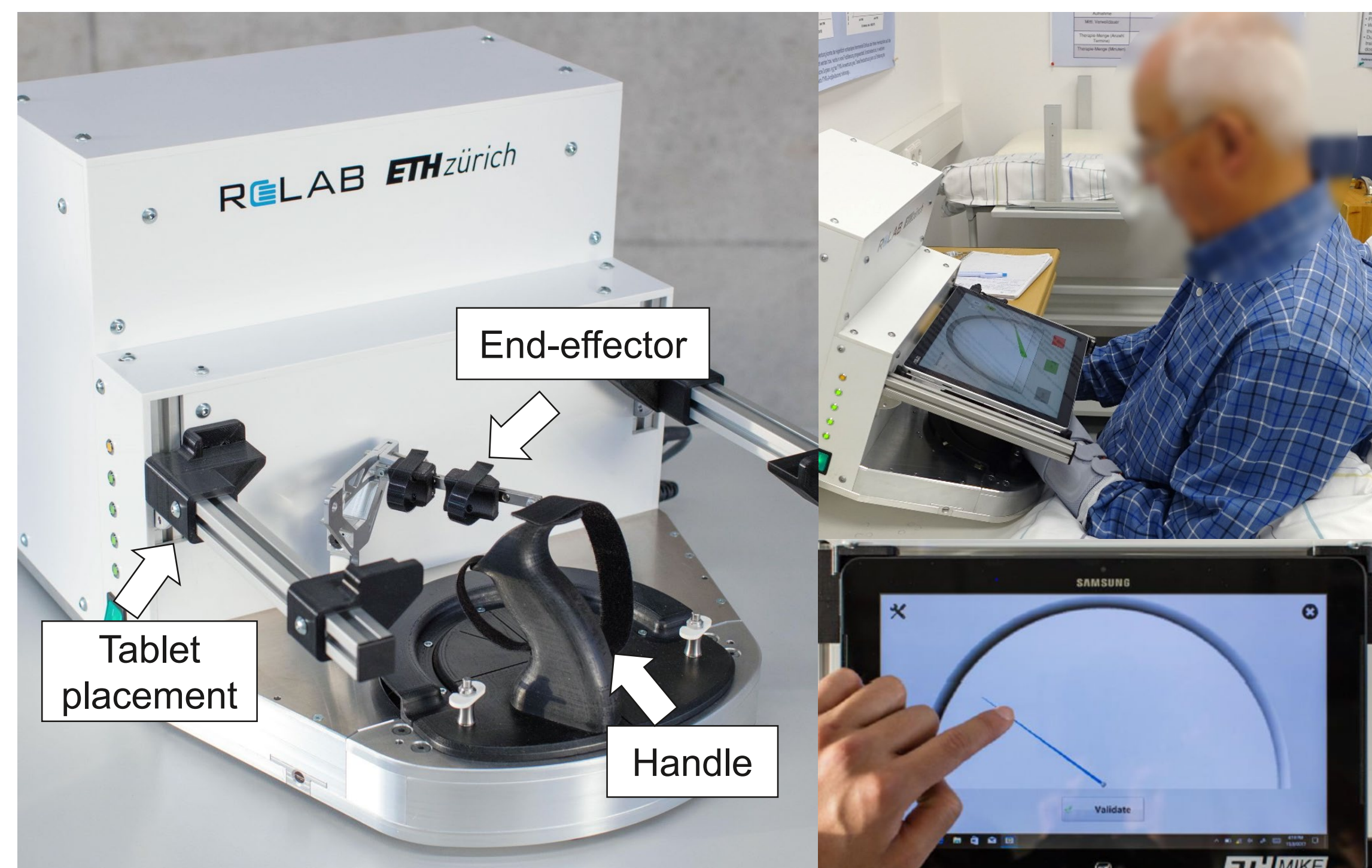


Figure 1: The ETH MIKE (Motor Impairment and Kinaesthetic Evaluation) is a one degree-of-freedom robot, which assesses hand proprioceptive, motor, and sensorimotor impairments. It consists of an end-effector, 3D printed handles and a tablet computer located above the hand. The rotation of the end-effector is centered around the metacarpophalangeal (MCP) joint of the index finger.

3 Use case: track recovery

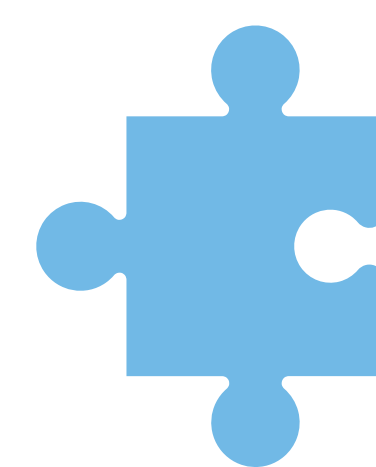
- The ETH MIKE is used in the FHT longitudinal study to **track recovery** from few days until 3 years after stroke.
- It **complements other devices** due to its focus on hand, proprioception and suitability for patients with hand paresis.



Figure 2: Three different technologies are used in the FHT longitudinal study to accurately and sensitively track the recovery after stroke. That includes the ETH MIKE, the Virtual Peg Insertion Test (VPIT) and wearable sensors (Shimmer).

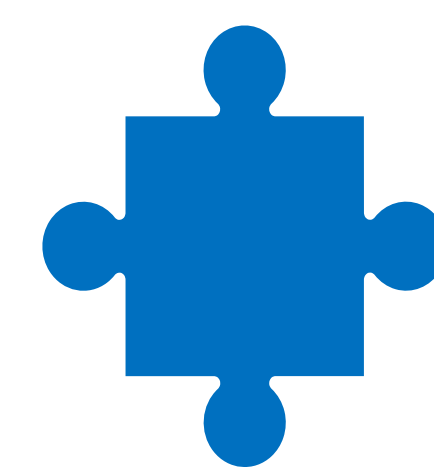
4 ETH MIKE: assessments

- The ETH MIKE **task battery** can assess proprioception, motor function and combined sensorimotor function.
- Their outcome measures are derived based on **position, velocity and force data** sensitively measured by the robot.
- The assessment tasks are the following:



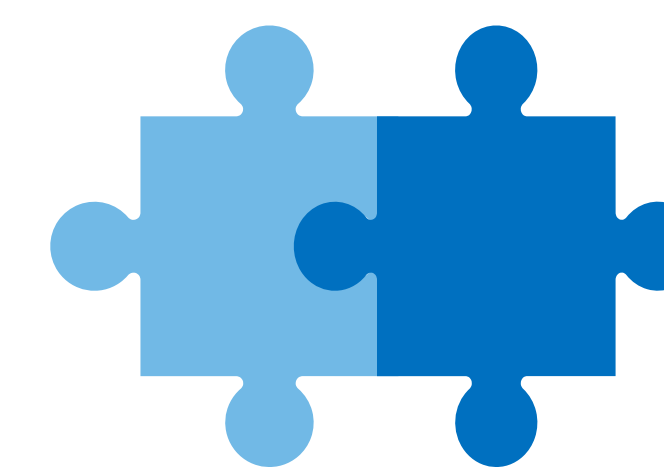
Proprioception:

- Gauge Position Matching Task



Motor Function:

- Maximum Force
- Range of Motion
- Fast Target Reaching



Sensorimotor Function:

- Trajectory Following

5 Proprioception assessment

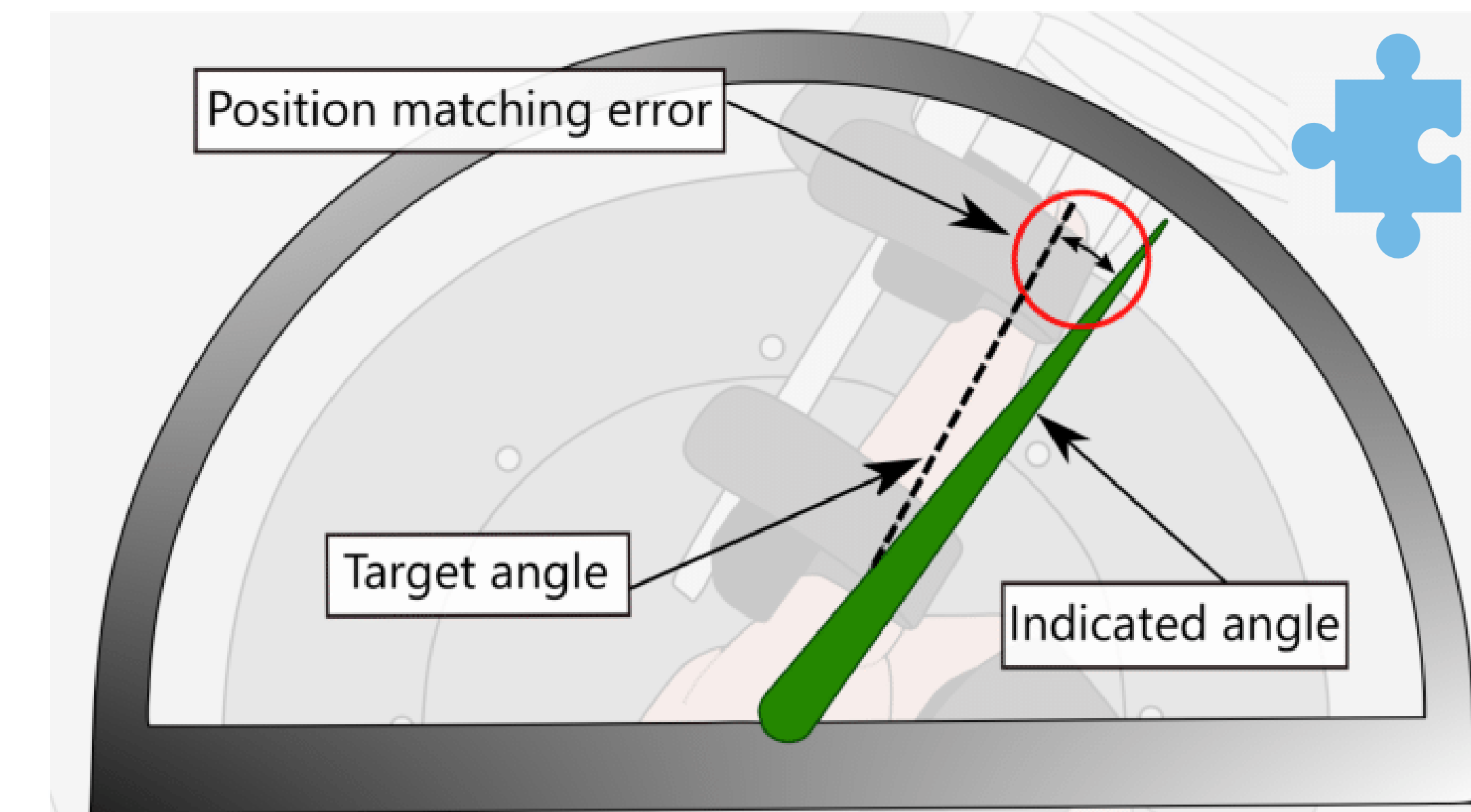


Figure 3: Visualization of the proprioception assessment [1]. The finger of the patient is passively moved by the robot to a position and the patient needs to indicate on the tablet screen the perceived finger position.

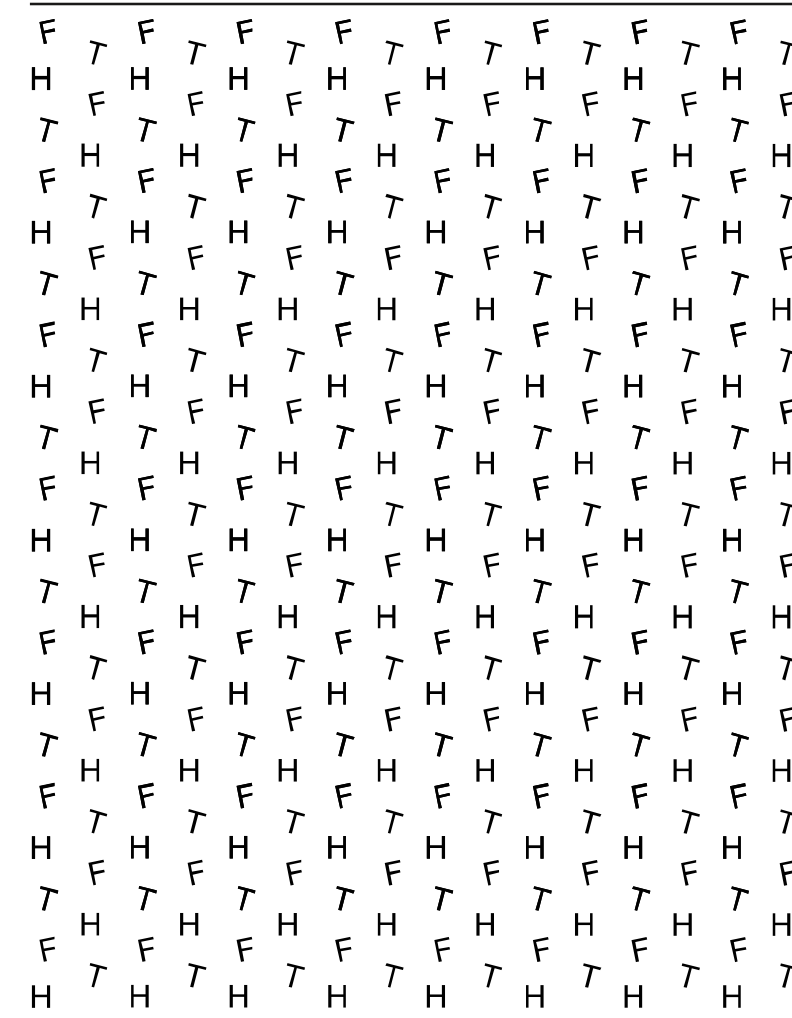
6 Future work

In parallel to the FHT longitudinal study, the following research avenues could be explored using the ETH MIKE:

- Comparison between **proximal** and **distal proprioception**.
- Assessment-driven **proprioception therapy** (RehabGym).

References:

- [1] Zbytniewska, M., Kanzler, C.M., Jordan, L., Salzmann, C., Liepert, J., Lambercy, O., Gassert, R. Reliable and valid robot-assisted assessments of hand proprioceptive, motor and sensorimotor impairments after stroke, *Journal of NeuroEngineering and Rehabilitation (JNER)*, 18:1, 2021
- [2] Zbytniewska-Mégret, M., Decraene, L., Mailleux, L., Kleeren, L., Kanzler, C.M., Gassert, R., Ortibus, E., Feys, H., Lambercy, O., Klingels, K.. Reliable and valid robotic assessments of hand active and passive position sense in children with unilateral cerebral palsy, *Frontiers in Human Neuroscience*, 8:22, 2022
- [3] Zbytniewska-Mégret, M., Kanzler, C.M., Raats, J., Yilmazer, C., Feys, P., Gassert, R., Lambercy, O., Lamers, I.. Reliability, validity and clinical usability of a robotic assessment of finger proprioception in persons with multiple sclerosis, under review in *Multiple Sclerosis and Related Disorders*.



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