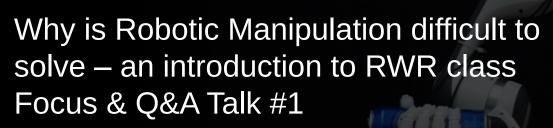
## **= IH** zürich







Prof. Dr. Robert Katzschmann Soft Robotics Lab ETH Zurich

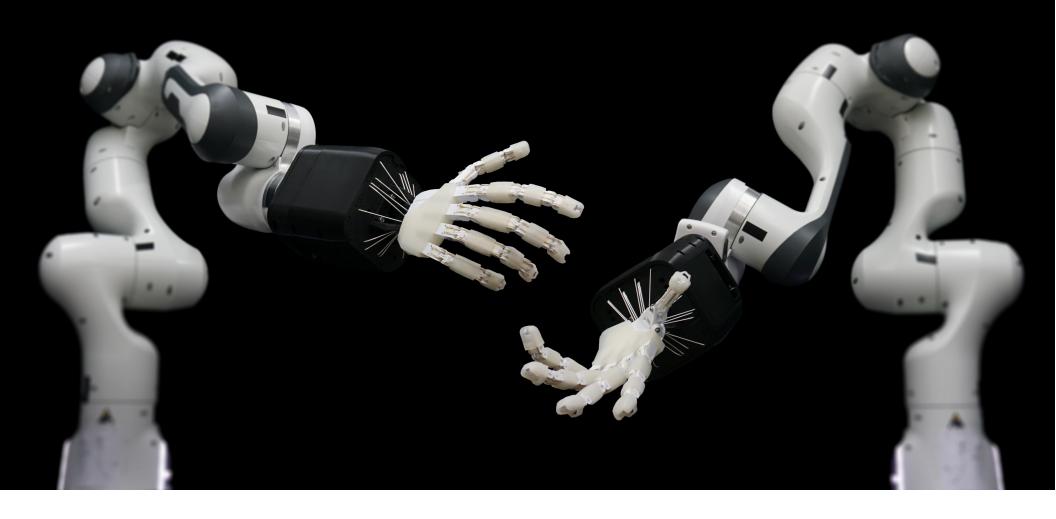


**D** MAVT

# Shall future AI do your art and writing or rather your laundry and dishes?









Make an image on: A cat wearing sunglasses by the lake

Please write me a short poem.



Of course! Here's a brief poem for you:

#### **Silent Bloom**

In quiet moments, flowers grow, Whispers of the earth below. In a breath, the world is new, Bathed in morning's gentle hue.

I hope this captures what you're looking for!

"

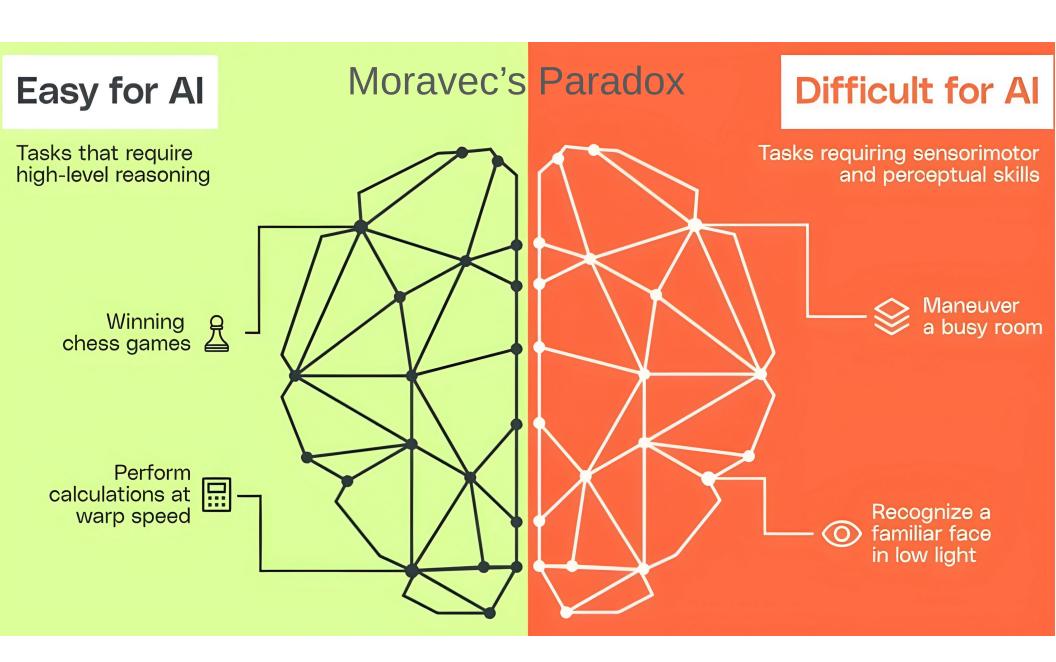
I want AI to do my laundry and dishes so that I can do art and writing,

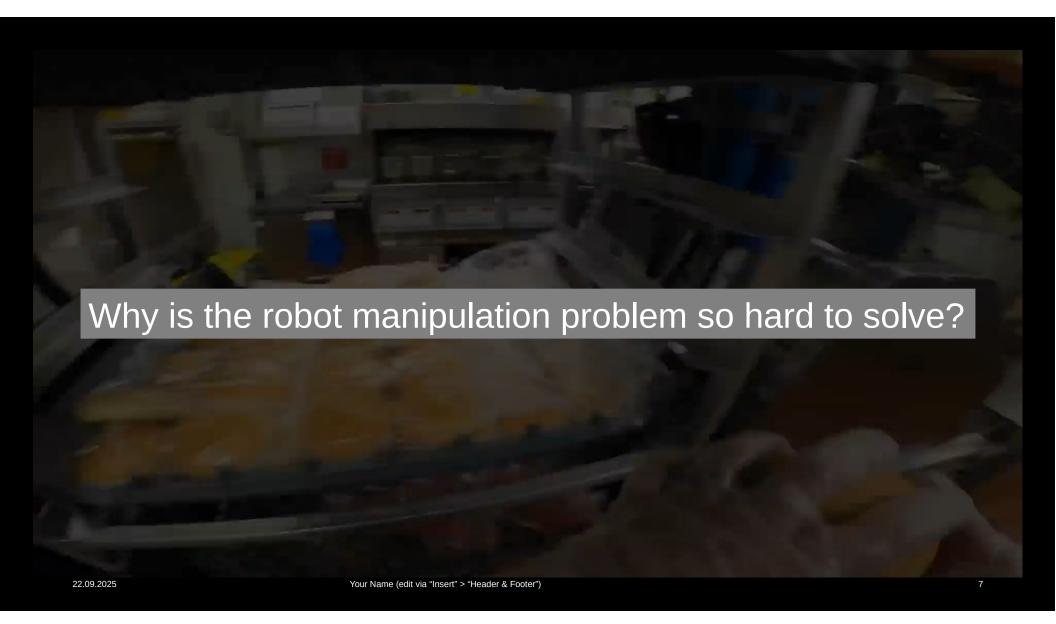
Not for Al to do my art and writing so that I can do my laundry and dishes.

"

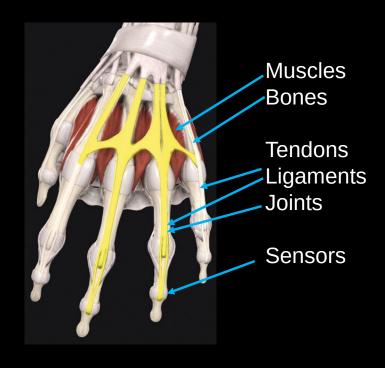
- Joanna Maciejewska







### **The Problem - Hardware**



**W.l.P.** 16/08/12 www.chrisi.com.au

27 degrees of freedom (DoF) over 17,000 touch receptors just in the palm

22.09.2025

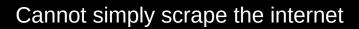
### **The Problem - Control**

Data

### **Control Frequency**

**Cross-embodiment** 







Need real time control



Diverse observations and actions

### The RWR class – what you will learn





Design and Fabrication



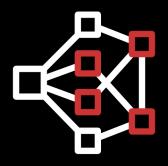
Kinematics, Dynamics and Control



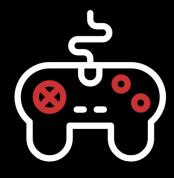
Sensors



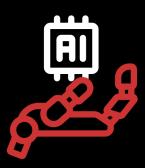
Simulation



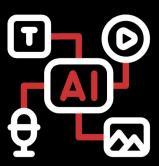
Reinforcement Learning



Teleoperation and Data Collection



**Imitation Learning** 



VLAs and Foundation models

## Market

# **Complex Manual Labour Tasks**





# **Market - Humanoids**



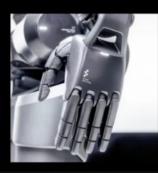


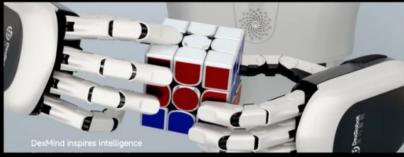
# **Market - Robotic Hands**























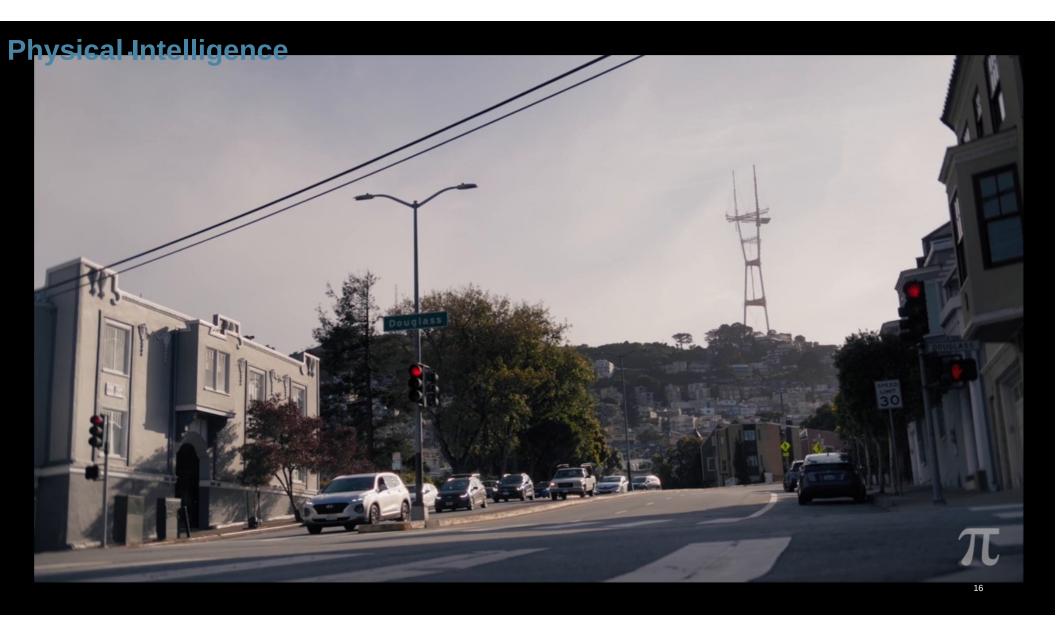




### **Generalist Al**



a preview of model capabilities



### **Dexterous Robotic Manipulation @ SRL**

### Continuous iterations to create better hardware

2021

2023



#### **FAIVE PO**

11 DOF 4 Servomotors

This tendon-driven 3D-printed robotic hand is fabricated using PLA and covered with a soft silicone skin. The hand incorporates 16 joints with 11 independent degrees of freedom. Each finger is designed with 2 rolling contact DoF, while the thumb offers enhanced mobility with an additional pin-joint.

2021

2022



#### INKBIT

16 DoF 4 Pneumatic Musdes

This biomimetic hand is printed in a single process using Vision Controlled Jetting, featuring a rigid skeleton, soft joint capsules, tendons, and printed touch sensors. It incorporates a human-inspired forearm and replaces electric motors with 22 independently controlled pneumatic artificial



**FAIVE P2** 

16 DoF 4 Servomotors

This 16-DoF tendon-driven hand features a soft, sensorized tactile skin fabricated using multi-material 3D printing, which preserves its range of motion and speed. Its design includes only rolling contact joints, while the skin and the piezoresistive sensors enables firmer



FAIVE P3

16 DoF DCMotors

The tendon-driven robotic hand utilizes 16 DC motors—three per finger and four for the thumb—with two tendons connected to each motor. Two-part spools couple the motor shafts to the tendons, enabling bidirectional finger movements. This prototype emphasizes durability, ease of assembly, and maintainability.



#### 2023

#### **ROTOGRAB**

11 DOF 4 Servomotors

Rotograb is a tendon-actuated robotic hand that combines the dexterity of a human hand with the efficiency of industrial grippers through its innovative rotating thumb design. The rotating thumb not only enlarges the operational workspace but also enables inhand manipulation.



#### MIMIC

16 DoF DC Motors

2024

2025

Developed by SRL spin-off startup Mimic Robotics, this tendon-driven, 3D-printed robotic hand integrates pin joints driven by DC motors, and a silicon skin. It is further equipped with integrated cameras for data collection, for easier and scalable imitation



#### **FAIVE P4.5**

16DoF 4 Servomotors

This 16-Dof robotic hand features a soft TPU skin for enhanced compliance and improved grasping, a low-friction design for smoother motion, and an active cooling system to ensure reliable operation even in high-stress environments like surgical rooms.



#### **ORCA**

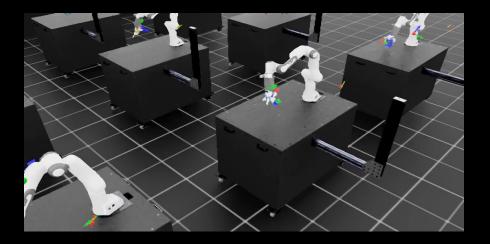
17 DoF

The ORCA hand is a low-cost, 17-dof tendondriven robotic hand equipped with integrated tactile sensors that can be assembled in under eight hours. It features innovative design elements such as popping joints and autocalibration, which reduce mechanical complexity while enhancing reliability.

From RWR class!

# **Dexterous Robotic Manipulation @ SRL – Learning Strategies**

RL and Simulation



IL and Cross-Embodiment



# **Dexterous Robotic Manipulation @ SRL - Applications**

Robot Hands for Surgery Rooms

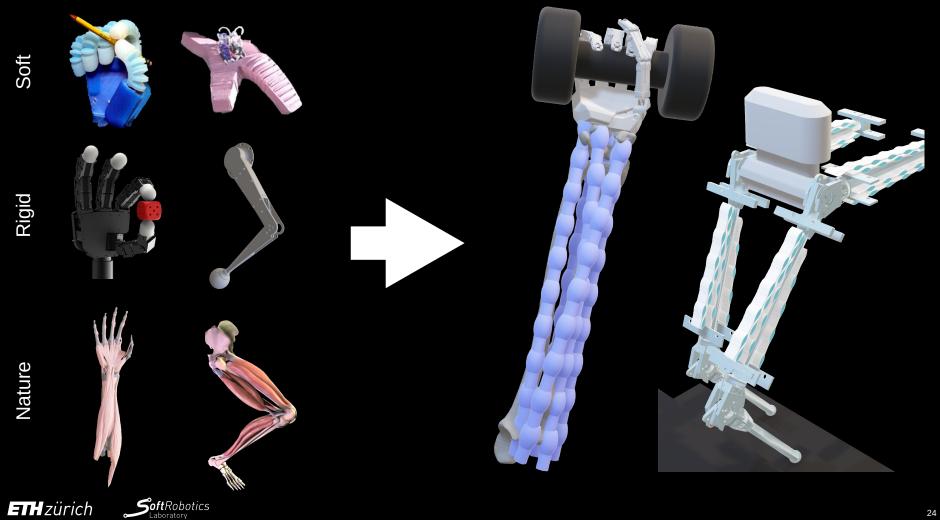


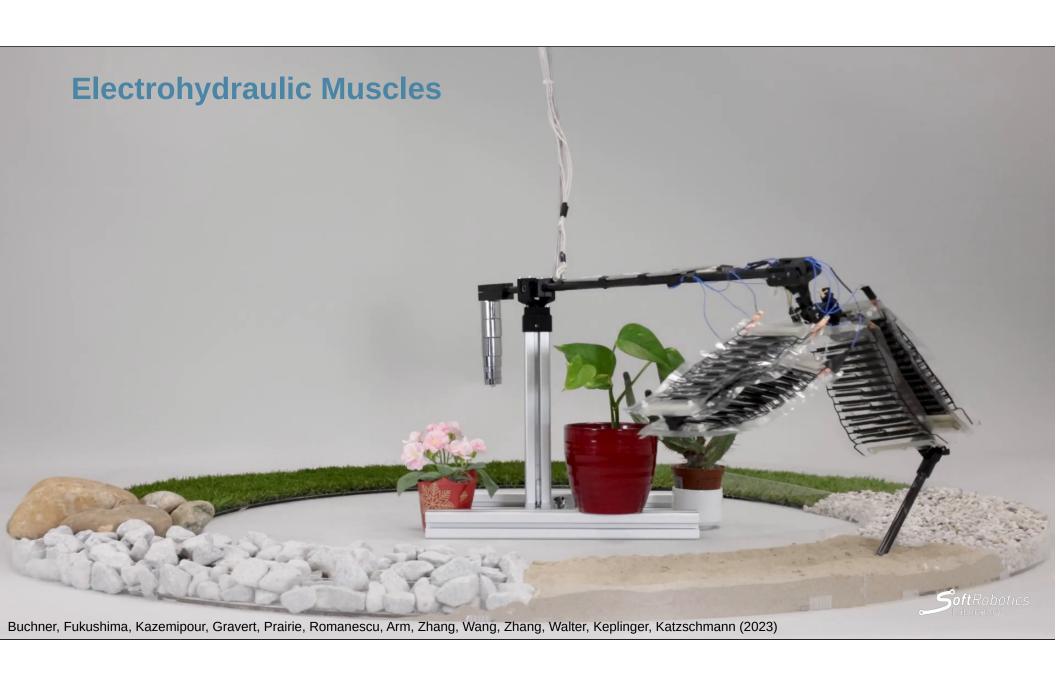
Megahand for disaster response

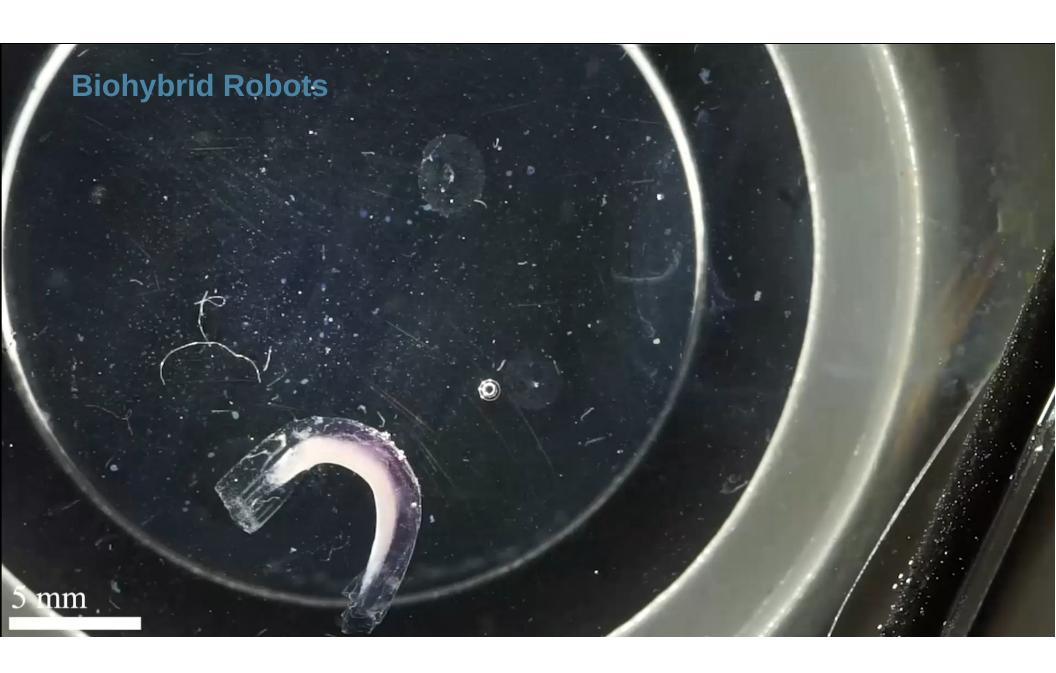


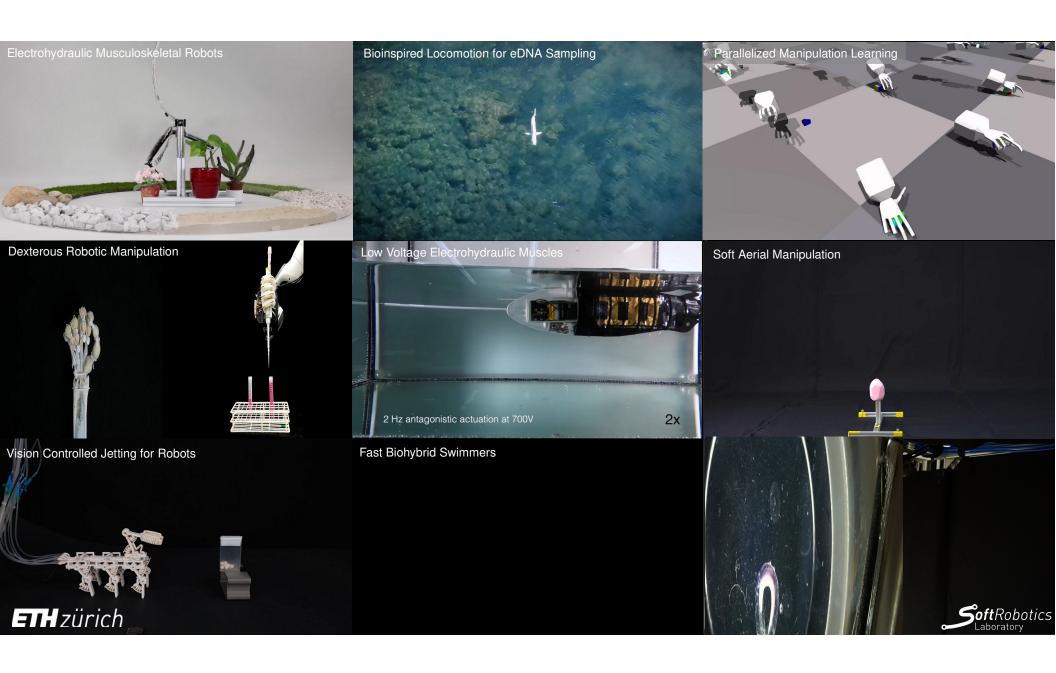
# Beyond this class

# Musculoskeletal designs bring together multiple worlds









### **Teaching Team**



Prof. Robert Katzschmann

Lead Organizer





**Dr. Ronan Hinchet**Sr. Scientist @ SRL



**Yasunori Toshimitsu** *PhD @ SRL* 



Chenyu Yang
PhD @ SRL



**Davide Liconti**PhD @ SRL



Jaehoon Kim
PhD @ SRL



Robert Jomar Malate
Lead Teaching Assistant



Aristotelis Sympetheros



Filippos Katsimalis
Teaching Assistant



Habib Ben Abda Teaching Assistant



Esteban Padilla Cerdio

**Dr. Anhui Wu**Lab Technician
+ Manager



**Dr. Ronan Hinchet**Electrostatic Actuators
and Soft Robots



Federica Poltronieri Lab Admin + Organizer



**Dr. Miriam Filippi**Perfusable

Large-scale Muscles



Thomas Buchner
Printed Robots +
Electrohydraulic Legs



Chenyu Yang Learning Representation for Musculoskeletal Robots



Lewis Jones
Volumetrically Printed
Cardiac Muscles



**Deniz Albayrak**Electric Muscles for
Robots



Yasunori Toshimitsu Co-optimized Robotic Hands



Aiste Balciunaite Untethered Biohybrid



Amirhossein Kazemipour

Autonomous



Hehui Zheng Soft Robotic Reconstruction



Manuel Mekkattu Modeling Biohybrid Muscles



Gavin Cangan
Proprioceptive Robotic
Manipulation



Mike Michelis Learned Multiphysical Surrogates



**Asia Badolato** *Neurotised Biohybrid* 



**Davide Liconti** Learning-Based Control -



Elvis Nava
Dexterous Robotic
Transformers

