3 mins per presenter!

1		Alex	García
2		Amar	Halilovic
3		Grégory	Brivady
4		Jan	Jerićević
5		Jelena	Ćurčić
6		Luka	Šiktar
7		Marine	Petriaux
8		Michael (Michal)	Radin-Rutkowski
9		Michel	Rosselli
10		Moritz	Moosmüller
11		Nikola	Knezevic
12		Nurlan	Kabdyshev
13		Rahul	Ramachandran
14		Riccardo	Morandi
15		Sebastian	Rietsch
16		Youngbin	Yoon
17		Yuyuan	Wu

Alex García

Unifying Geometric Control and Mechanics of Elastic Rods

Àlex Garcia Herranz

Supervised by: Maria Alberich Carramiñana & Franco Coltraro

The Goal:

- Robotic manipulation of flexible objects (cables, hoses, surgical tools).

The Problem:

- **Geometric Control** (Bretl et al.): Excellent at planning complex maneuvers, but often ignores gravity.

- **Mechanics** (Bertails et al.): Models gravity and forces perfectly, but ignores control.

Our Aim: Bridge these two worlds to enable gravity-aware manipulation.
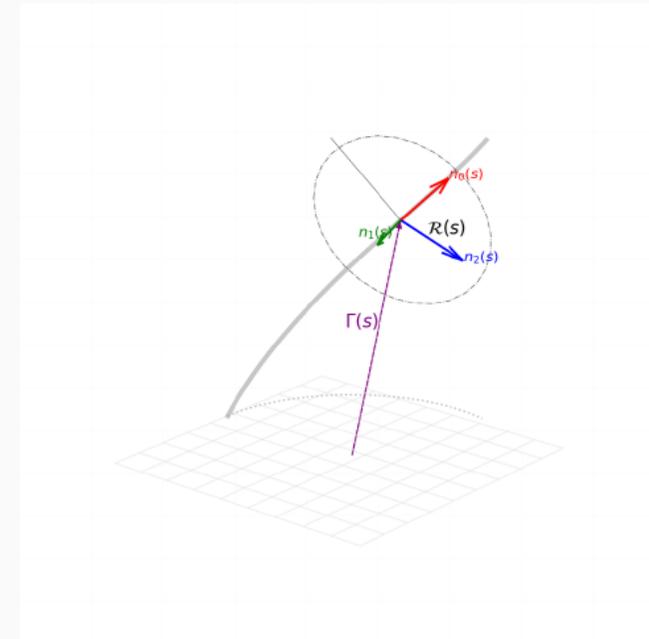
VS

Geometric Control (The Abstract)
Focus: Geometry of $\mathrm{SE}(3)$

- **State:** Curve $q(s) \in \mathrm{SE}(3)$

- **Input:** Controls u_i, along generators $X_i \in \mathfrak{se}(3)$

- **Dynamics:** Costate $\mu \in \mathfrak{se}(3)^*$ related to control parameters u_1, u_2, u_3.

$$q' = q \cdot \left(\sum_{i=1}^{3} u_i X_i + X_4 \right)$$

$$\min_{q,u} \int (c_1 u_1^2 + c_2 u_2^2 + c_3 u_3^2) ds$$

Mechanics (The Physical)
Focus: Forces & Equilibrium

- **State:** Centerline Γ, Frame $\mathcal{R}$

- **Input:** Strains (Curvature)

- **Equilibrium:** Force/Moment Balance

$$\mathbf{M}' + \mathbf{n}_0 \times \mathbf{T} = 0$$

$$\mathbf{T}' + \mathbf{p}' = 0$$

Theorem: The frameworks are mathematically equivalent.

The abstract **Equation** governing the costate evolution:

$$\mu' = \mathrm{ad}^*_{\frac{\delta h}{\delta \mu}}(\mu)$$

…is exactly the **Kirchhoff Equilibrium** equations in the local frame.

Concept	Control Theory	Mechanics	The Bridge
State	$q \in \mathrm{SE}(3)$	$\Gamma, \mathcal{R}$	$q \equiv (\mathcal{R}, \Gamma)$
Strain	Controls u_i	Curvature k_i	$\mathbf{u} \equiv \mathbf{k}$
Equilibrium	Costate μ	Wrench $\mathbf{T}, \mathbf{M}$	$\mu \equiv (\mathcal{R}^T\mathbf{M}, \mathcal{R}^T\mathbf{T})$

F. Bertails-Descoubes, A. Derouet-Jourdan, V. Romero, and A. Lazarus.
Inverse design of an isotropic suspended Kirchhoff rod: theoretical and numerical results on the uniqueness of the natural shape.
Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, 474(2212):20170837, 04 2018.

A. Borum and T. Bretl.
The free configuration space of a Kirchhoff elastic rod is path-connected.
In *2015 IEEE International Conference on Robotics and Automation (ICRA)*, pages 2958–2964, 2015.

T. Bretl and Z. McCarthy.
Quasi-static manipulation of a kirchhoff elastic rod based on a geometric analysis of equilibrium configurations.
The International Journal of Robotics Research, 33(1):48–68, 2014.

Amar Halilović

Explainable Robot Navigation

Environment- and Human-Centered Approach

Amar Halilovic

Ulm University, Germany

Tuesday, 10th February 2026

Explainable Robot Navigation (XRN)

- Making robotic behavior understandable to humans
- Motivated by the rise of Explainable AI (XAI)
- Service robotics in indoor environments
- In XRN, the focus is on explaining:
  - task failures
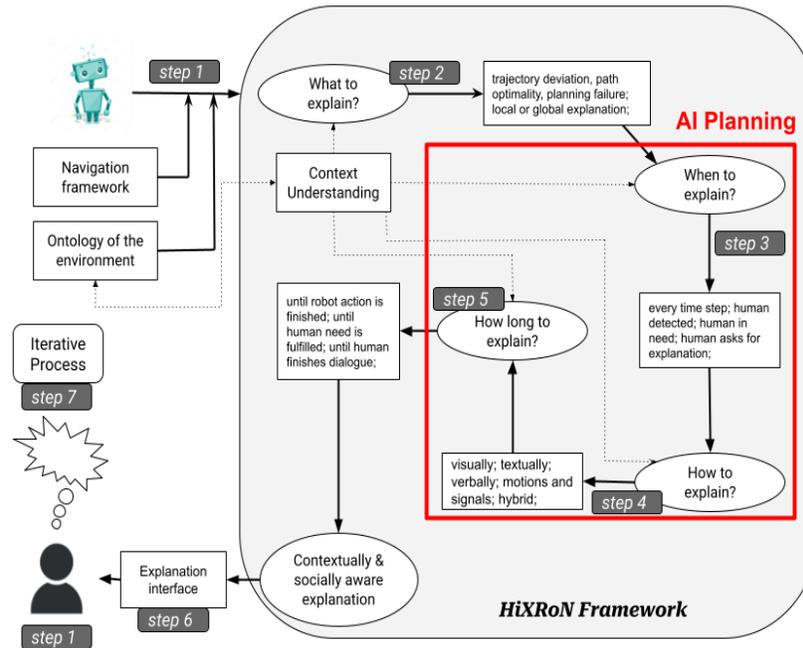 - plan failures
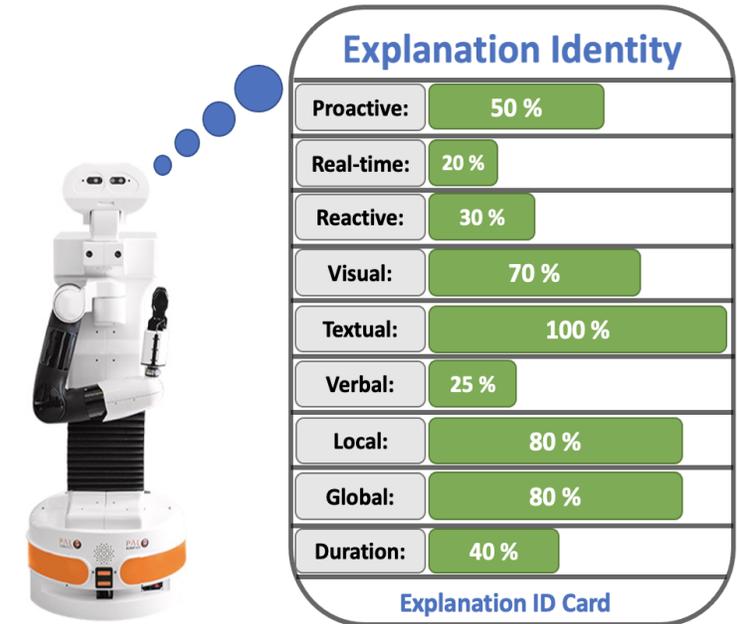 - trajectory deviations

Research Challenges / Thesis Contributions

Environmental Explanations

wall | door | wall

hanger

bookshelf

CH_2

init. traj.

desk

H

CH_1

CH_3

table_1

CH_4

table_2

R

"I cannot continue because the chair and the human in front of me are blocking my way."

Explanation Planning

step 1

What to explain?

step 2

trajectory deviation, path optimality, planning failure; local or global explanation;

AI Planning

Navigation framework

Context Understanding

When to explain?

Ontology of the environment

step 3

until robot action is finished; until human need is fulfilled; until human finishes dialogue;

step 5

How long to explain?

every time step; human detected; human in need; human asks for explanation;

Iterative Process

step 7

visually; textually; verbally; motions and signals; hybrid;

How to explain?

step 4

Explanation interface

step 6

Contextually & socially aware explanation

HiXRoN Framework

step 1

Robot Explanation Identity

Explanation Identity

Proactive:	50 %
Real-time:	20 %
Reactive:	30 %
Visual:	70 %
Textual:	100 %
Verbal:	25 %
Local:	80 %
Global:	80 %
Duration:	40 %

Explanation ID Card

Thank you for your attention!

Grégory Brivady

RAINBOW

Sensor-based and interactive robotics

Design of a Capacitive Interface for Controlling the Grasp Location and Force of a Soft Gripper

Grégory BRIVADY[1], Maud MARCHAL[1,3], Sylvain GUÉGAN[2]

contact: gregory.brivady@irisa.fr

1: Univ. Rennes, INSA, IRISA, Rennes, France
2: Univ. Rennes, INSA, LGCGM, Rennes, France
3: Institut Universitaire de France

- **Motivation:**
  - Haptic feedback can enhance teleoperation
  - Soft robots have new capabilities thanks to their compliance...
  - ... but we need to design new interfaces and control schemes
  - In particular, want to control grasp location and force to manipulate soft objects

- **Approach:**
  - Represent the object with a deformable tangible interface
  - Mimic the grasp applied by the user with the gripper

Rainbow
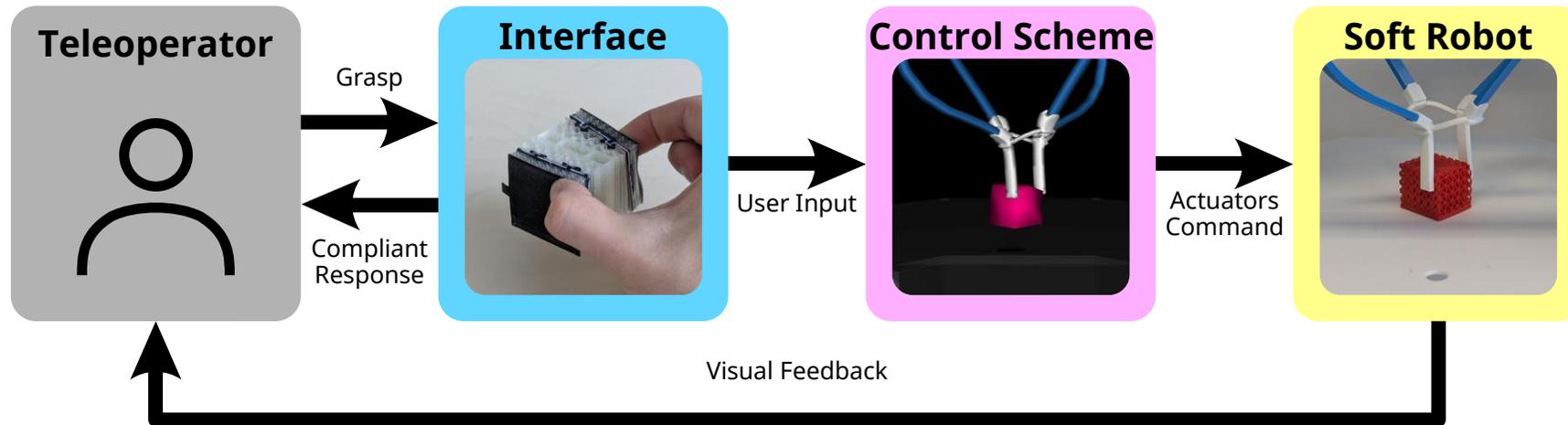
- **Solution:**
  - 3D printed interface with embedded capacitive sensors
  - Physics-based control scheme for the gripper
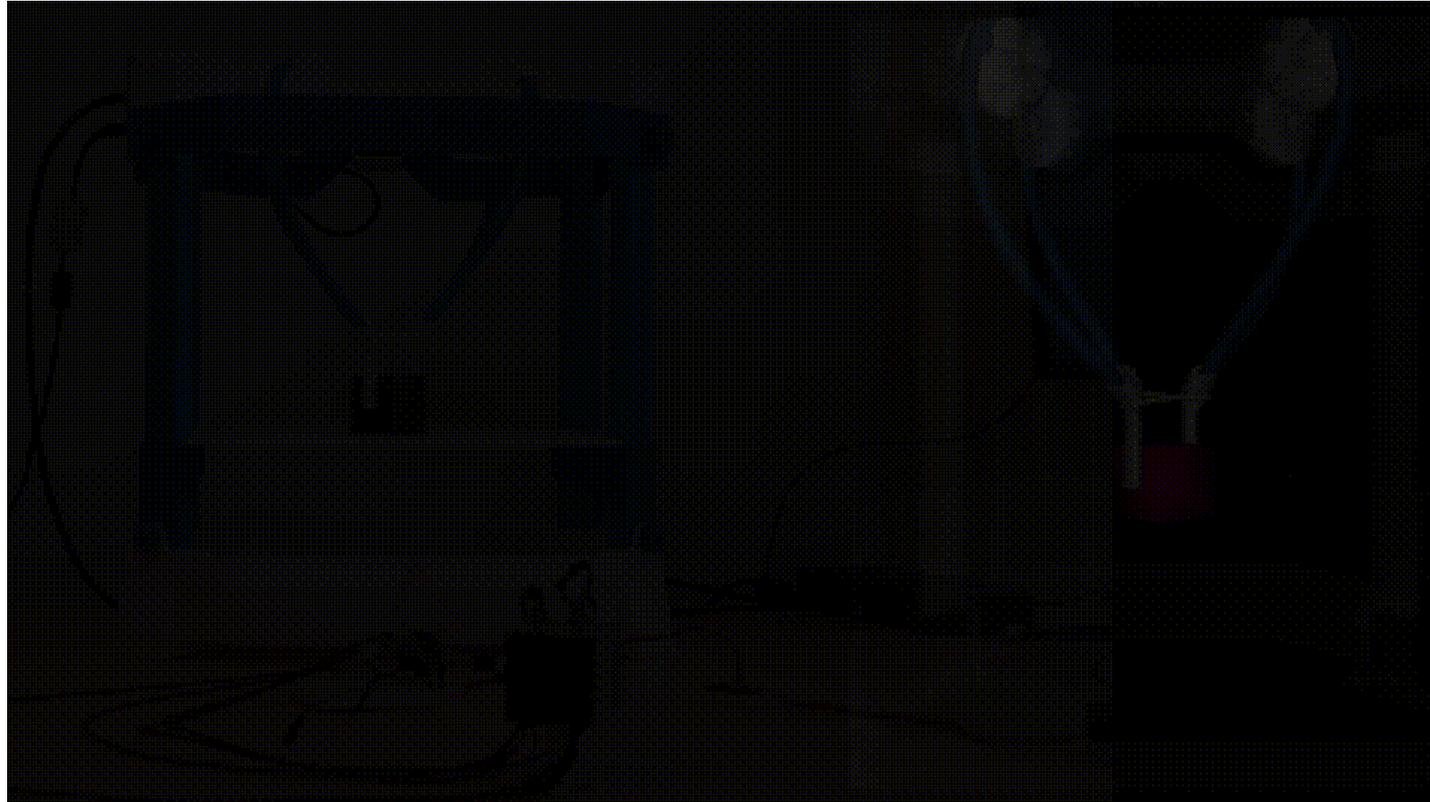
Jan Jerićević

Making Learned Grasps Executable: Capability-Guided Execution for Robust Dual-Arm Cloth Unfolding

Jan Jerićević

Humanoid and Cognitive Robotics Laboratory

ROMANDIC winter school

10. 2. 2026

Kranjska Gora

Good predicted grasps are not always executable

- Joint limits / reachability
- Collision constraints
- Low dexterity near singularities
- Approach vector constraints
- Robot dependant

Make grasp execution robust without changing the grasp predictor → robot capability
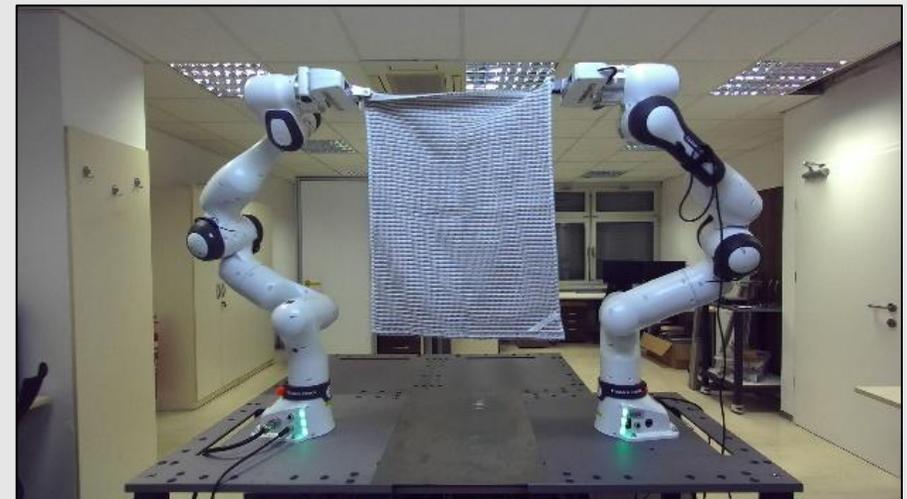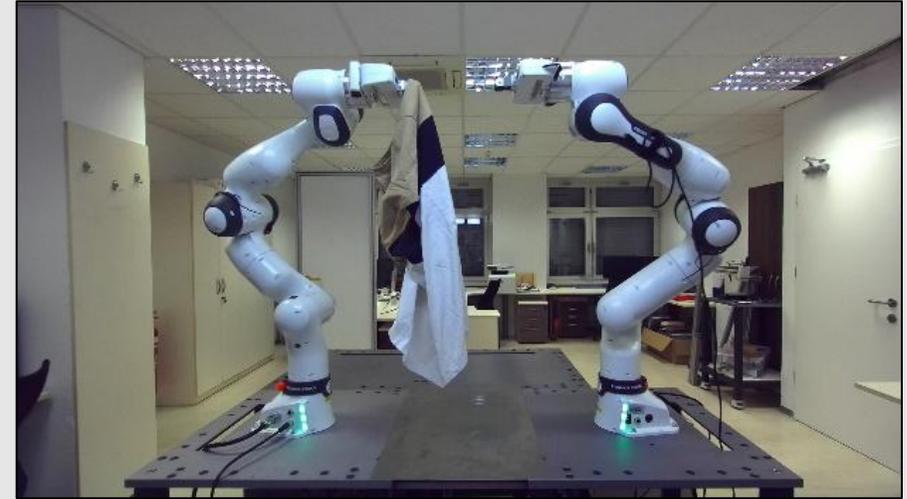
Figure 1 : Cloth unfolding as a result of unsuccessful / successful grasp

1. Grasp highest point
2. Grasp lowest point
3. Start observation
4. Grasp selection and execution
5. Stretching and result observation

Figure 2 : ICRA 2024 Cloth Unfolding Competition – Regrasping in the air[1]

Figure 3 : CeDiRNet-6DoF grasp predictor[2]

[1] V.-L. De Gusseme, et al., Manuscript submitted for publication, presented at the ICRA 2024 Cloth Competition, Yokohama, Japan, 2024

[2] D. Tabernik, P. Nmec, et al., "Vision-Based 6-DoF Grasp Pose Estimation for Robot Cloth Unfolding," manuscript submitted for publication, 2025"

1. Grasp highest point   2. Grasp lowest point   3. Start observation
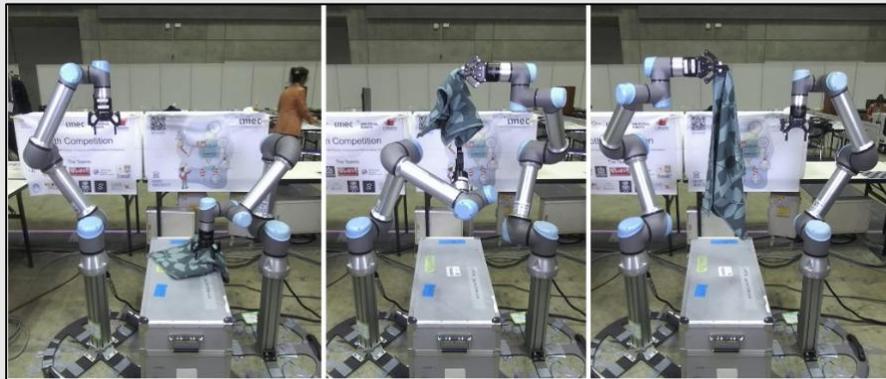
4. Grasp selection and execution   5. Stretching and result observation

Figure 2 : ICRA 2024 Cloth Unfolding Competition – Regrasping in the air[1]
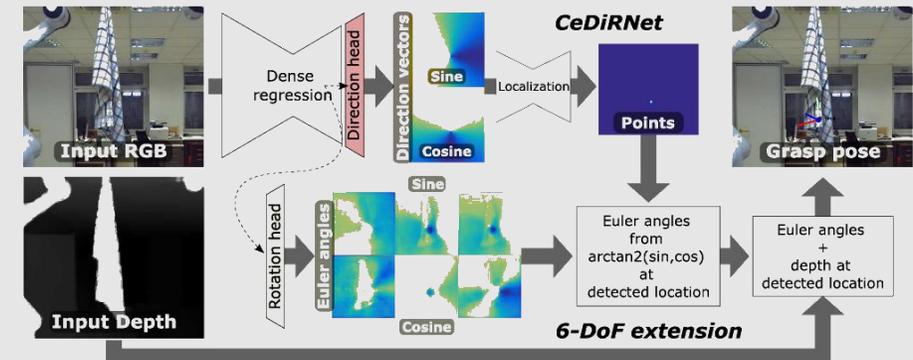
Average coverage	59.4%
Grasp success	67.5%

Figure 3 : CeDiRNet-6DoF grasp predictor[2]

[1] V.-L. De Gusseme, et al., Manuscript submitted for publication, presented at the ICRA 2024 Cloth Competition, Yokohama, Japan, 2024
[2] D. Tabernik, P. Nmec, et al., "Vision-Based 6-DoF Grasp Pose Estimation for Robot Cloth Unfolding," manuscript submitted for publication, 2025"

Bottleneck

- Joint limits / reachability
- Collision constraints
- Low dexterity near singularities
- Approach vector constraints
- Dual arm coupling

Cloth Pose Correction Heuristic

- Check If infeasible
- Reposition cloth (preset hold pose)
- Re-predict + re-plan

Reduced unattempted grasps from 9.4% to 3.6%

a) Initial cloth position   b) Cloth position near   c) Cloth position far

Figure 4 : Robot configurations in the initial, near and far cloth positions

Execution Bottleneck → Heuristic → Capability Maps

Bottleneck

- Joint limits / reachability
- Collision constraints
- Low dexterity near singularities
- Approach vector constraints
- Dual arm coupling

Cloth Pose Correction Heuristic

- Check If infeasible
- Reposition cloth (preset hold pose)
- Re-predict + re-plan

Reduced unattempted grasps from 9.4% to 3.6%

Capability Maps

- Feasibility
  IK + joint margins + collision-free approach
- Dexterity
  Manipulability
- Task-direction dexterity
  Approach vector

a) Initial cloth position   b) Cloth position near   c) Cloth position far
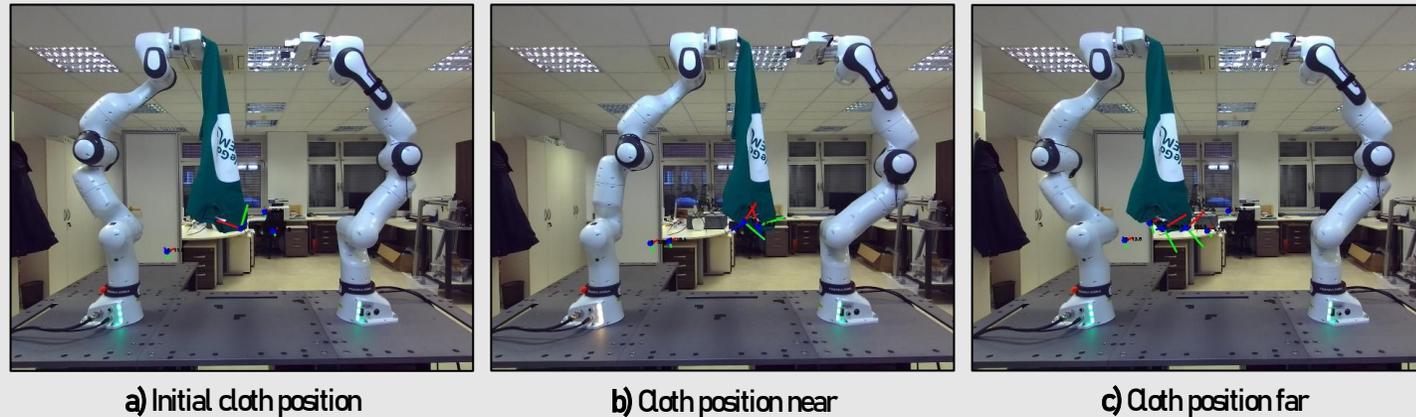
Figure 4 : Robot configurations in the initial, near and far cloth positions
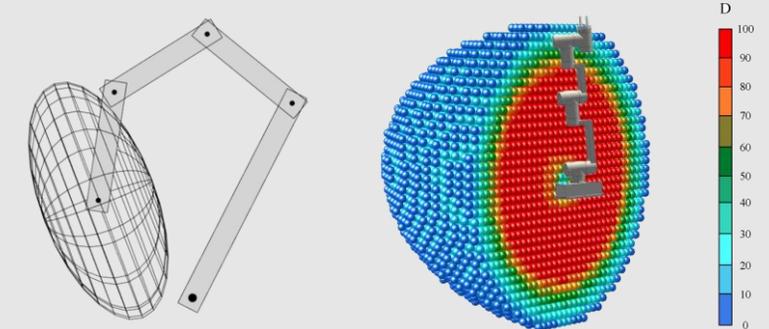
Figure 5 : Left: Manipulability of a 5 DOF manipulator[3].
Right: reachability of a 7 DOF manipulator[4]

[3] Vahrenkamp, et al., Representing the robot's workspace through constrained manipulability analysis. Auton Robot 38, 2015
[4] Quan, Y., et al., The Dexterity Capability Map for a Seven-Degree-of-Freedom Manipulator. Machines 2022

Bottleneck

- Joint limits / reachability
- Collision constraints
- Low dexterity near singularities
- Approach vector constraints
- Dual arm coupling

Cloth Pose Correction Heuristic

- Check If infeasible
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Capability Maps

- Feasibility
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- Dexterity
  Manipulability
- Task-direction dexterity
  Approach vector

a) Initial cloth position   b) Cloth position near   c) Cloth position far

Figure 4 : Robot configurations in the initial, near and far cloth positions

Figure 6 : Moving the grasp to a high-capability grasp region

We keep learned grasp prediction as-is and improve robustness by adapting execution using robot capability

Thank you to my colleagues:

Peter Nmac
Domen Tabernik

Supervisor:
Prof. dr. Andrej Gams

Thank you for your attention!

Contact: jan.jericevic@ijs.si

Jelena Ćurčić

An unoptimized path, finely tuned

Jelena Ćurčić, Groschopp Systems Solutions / Faculty of Technical Sciences,
University of Novi Sad

Hello everyone, my name is Jelena Ćurčić, and I'm a PhD student in Mechatronics,
Mechatronics, Robotics, and Automation at the University of Novi Sad in Serbia. I
Serbia. I work at Groschopp Systems Solutions as a Robotics Software Engineer.
Engineer.

The Core of My Research

Foundations

My background sits at the intersection of **robotics, optimization, and real-world world systems**.

Mobile Robotics

I also work with **physical robots**, with my current experience mostly being with mobile, wheeled platforms.

Decision-Making Under Constraints

My recent work is centred on **decision-making and task planning for planning for autonomous robots under strict constraints**

Previous work and papers

"Evolutionary approach to Time-limited, Profit-based Traveling Salesman problem in Salesman problem in Mobile Robotics" *Curcic J., Kanovic Z., Nikolic M., Savic S. Savic S.*

- Developed a solution for a modified version of the Traveling Salesman Problem (TSP) Problem (TSP)
- Introduced additional constraints such as volume capacity to reflect real-world robotics challenges
- Motivated by autonomous robot strategies for the Eurobot 2024 competition, though applicable to broader contexts like delivery and field sampling
- Modeled the problem as a global optimization task and solved it using a Genetic Algorithm (GA)
- Focused on encoding domain-specific knowledge into the initial population to accelerate convergence
- Simulated and tested different population initialization techniques and their impact on solution quality and speed
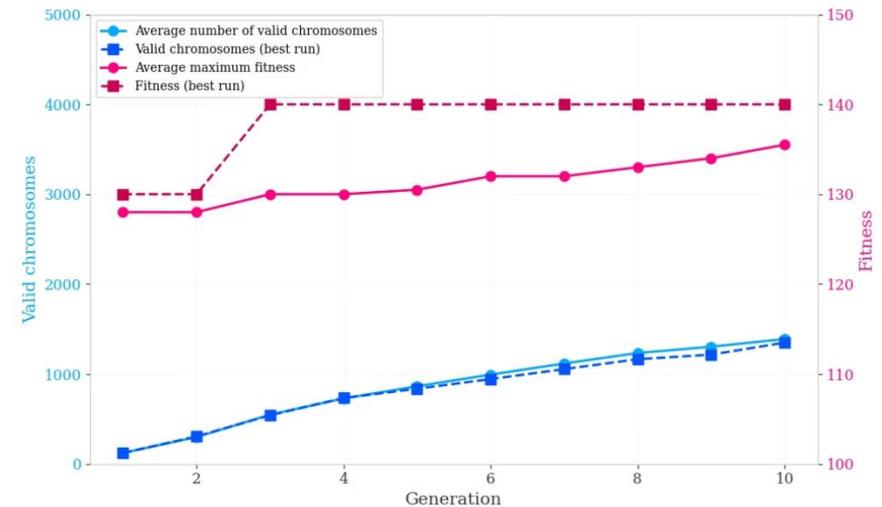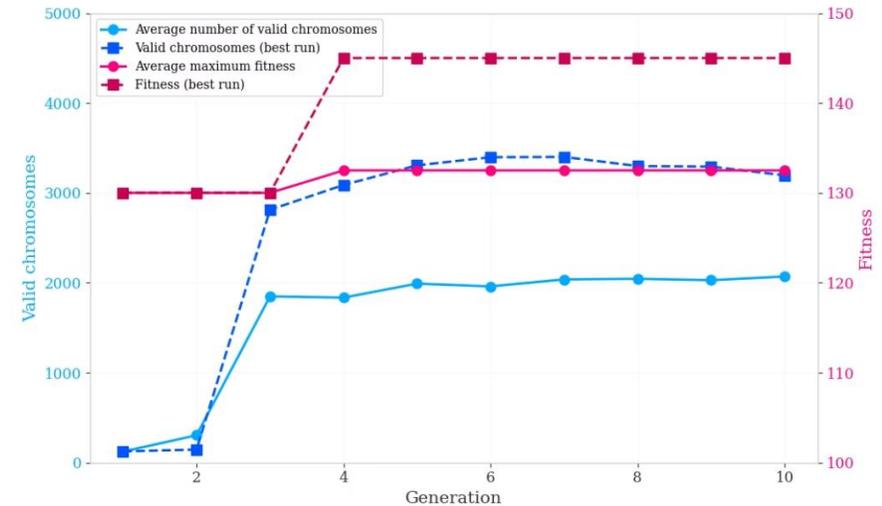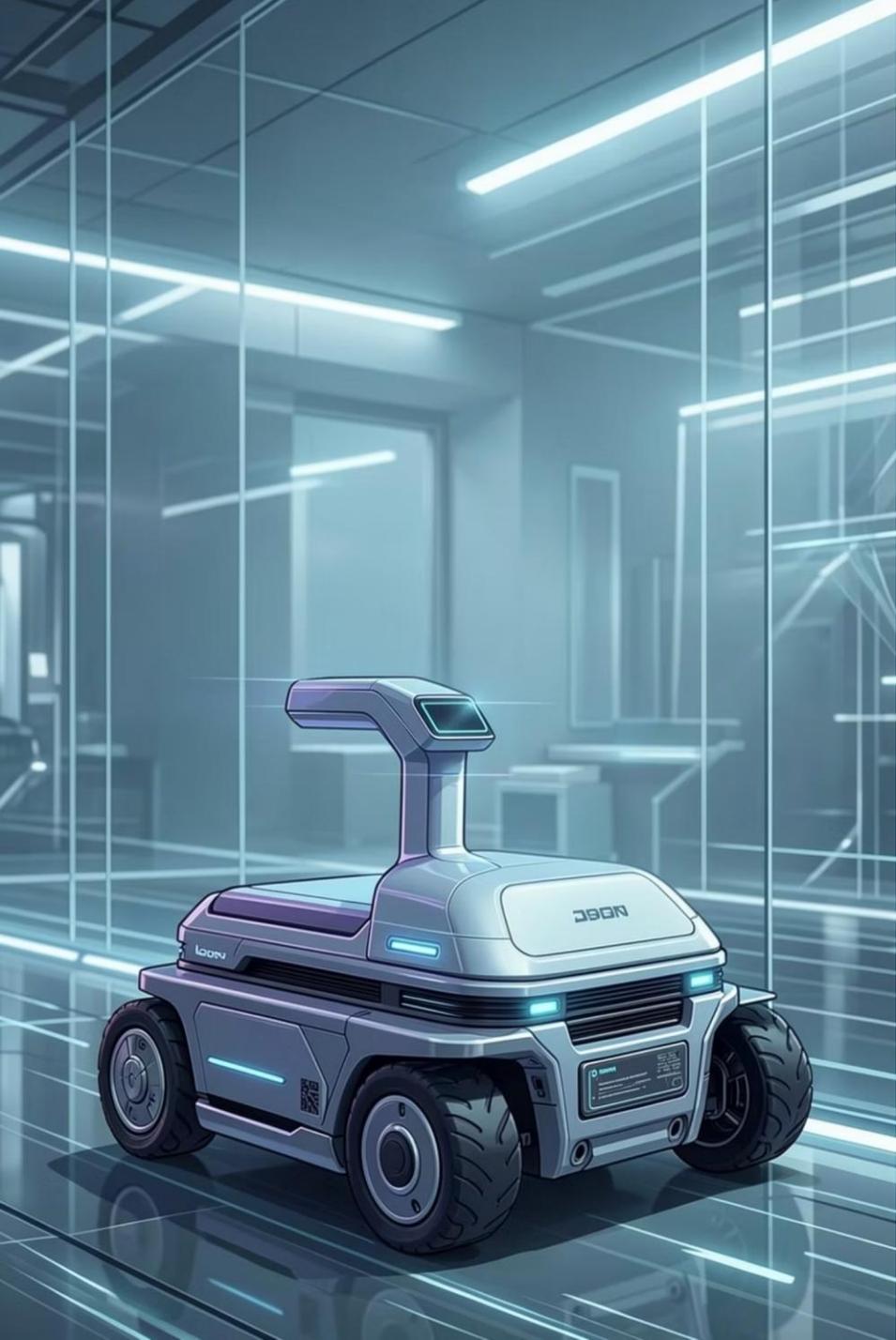
Building Autonomous Mobile Robots: Software & Control

ROS 2 Integration

Alongside optimization, I'm actively working with **ROS 2**, the Robot Operating System, which forms the backbone of advanced robotic applications.

Behaviour Trees and Simulation Software

I utilise **behaviour trees** to build sophisticated autonomous mobile robots capable of capable of performing complex manipulation and navigation tasks. All of this was first applied was first applied to a simulated environment, specifically in IsaacSim, and later in real world. real world.

Other fields of work

My most recent work (at work) is around the utilization of LLM models for making RAG systems. making RAG systems.

Beyond the Lab:

Basketball Player

In parallel with my academic pursuits, I'm a semi-professional basketball basketball player, enjoying the teamwork and competitive spirit.

Eurobot Organisation

Having participated in Eurobot for three years, I'm now part of the organising the organising committee for Eurobot Serbia 2026, contributing to the next to the next generation of robotics enthusiasts.

Leisure & Socialising

With the very little free time I have left, I also enjoy watching TV series, series, reading a good book, and sharing a coffee with friends.
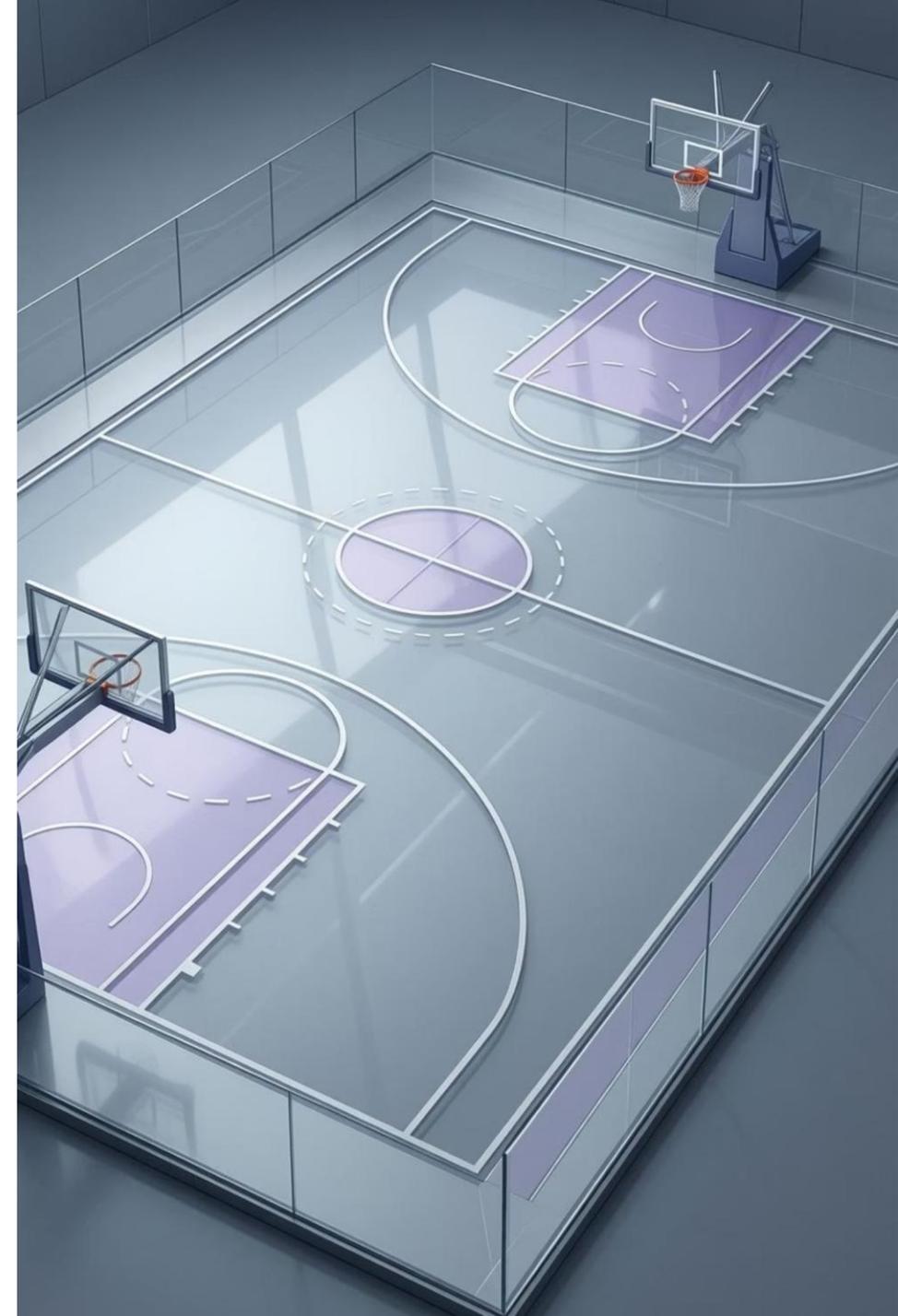
What I Hope to Learn

Although the robots I've worked with so far mostly interact with objects that stay exactly where you put them, I believe the work on manipulation of deformable objects is quite interesting and a missing puzzle piece in my current career-path.

"An unoptimized path, finely tuned"

Looking Forward to an Inspiring Week!

Thank You!

Luka Šiktar
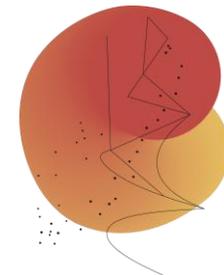
ROMANDIC presentation

Luka Šiktar

2026 | Regional Center of Excellence for Robotic Technology, University of Zagreb, Croatia

ROBOCAMP

- **Complete Search and Rescue framework:**
  - Hexsoon drone, RTK base, Wi-Fi router
  - Wristbands with special emergency call button and GPS module – within Wi-Fi range
  - Central computer – control room
- **GPS wristband follow and CNN person follow**

GNSS satellite

GNSS position

wristband

drone

position,
emergency call

video,
telemetry,
commands

Wi-Fi network

Central computer
and server
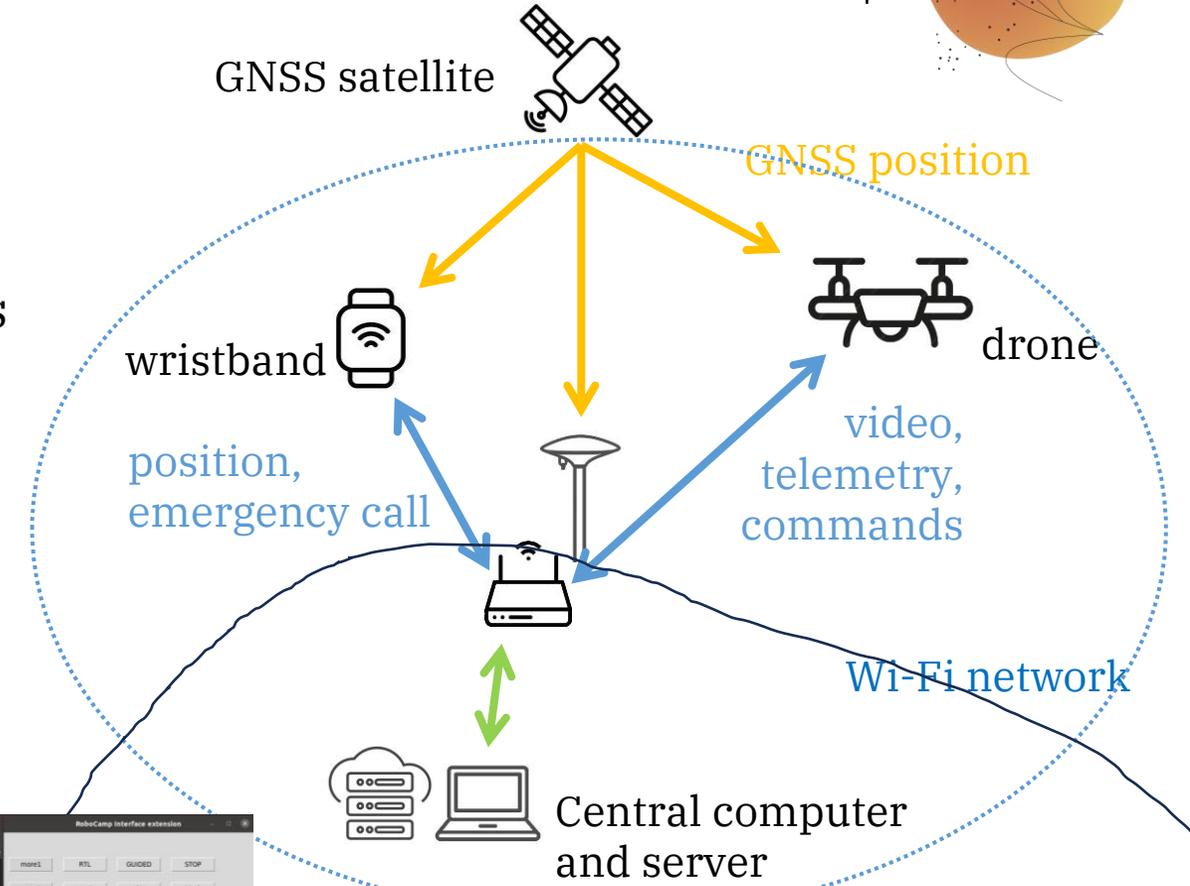
→ GNSS (satellite) data
→ Wi-Fi transmission
→ Web protocols

ROBOCAMP

- CNN person follow

- GPS follow
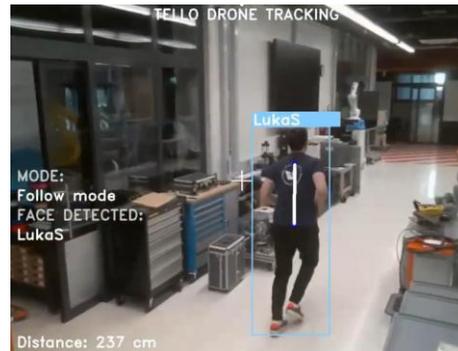
Indoor · Outdoor · Outdoor

- GPS follow (bracelet state)
- Drone

PRONOBIS project

- Robotically navigated prostate biopsy system POC

- 7 DOF robot for automated prostate scanning and biopsy planning

- Deep-learning based prostate segmentation

- Ultrasound-only based 3D prostate reconstruction, biopsy planning and treatment execution

Workflow

Robot

TCP/probe angle information

Dataset

Segmentation model

MicroSegNet

Segmentation output

3D reconstruction

Biopsy treatment planning (pick targets)

Desired slice angle/ Robot angle information

Robot

TCP Position for clinician to perform biopsy

Ultrasound + US probe
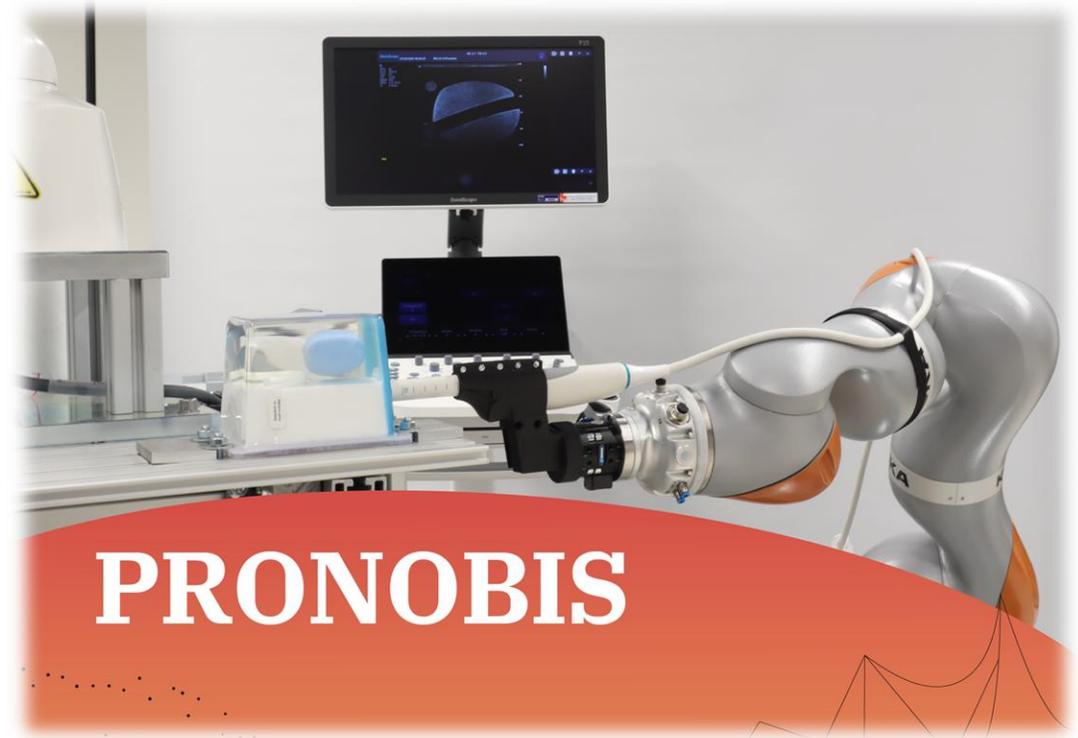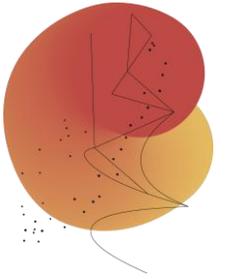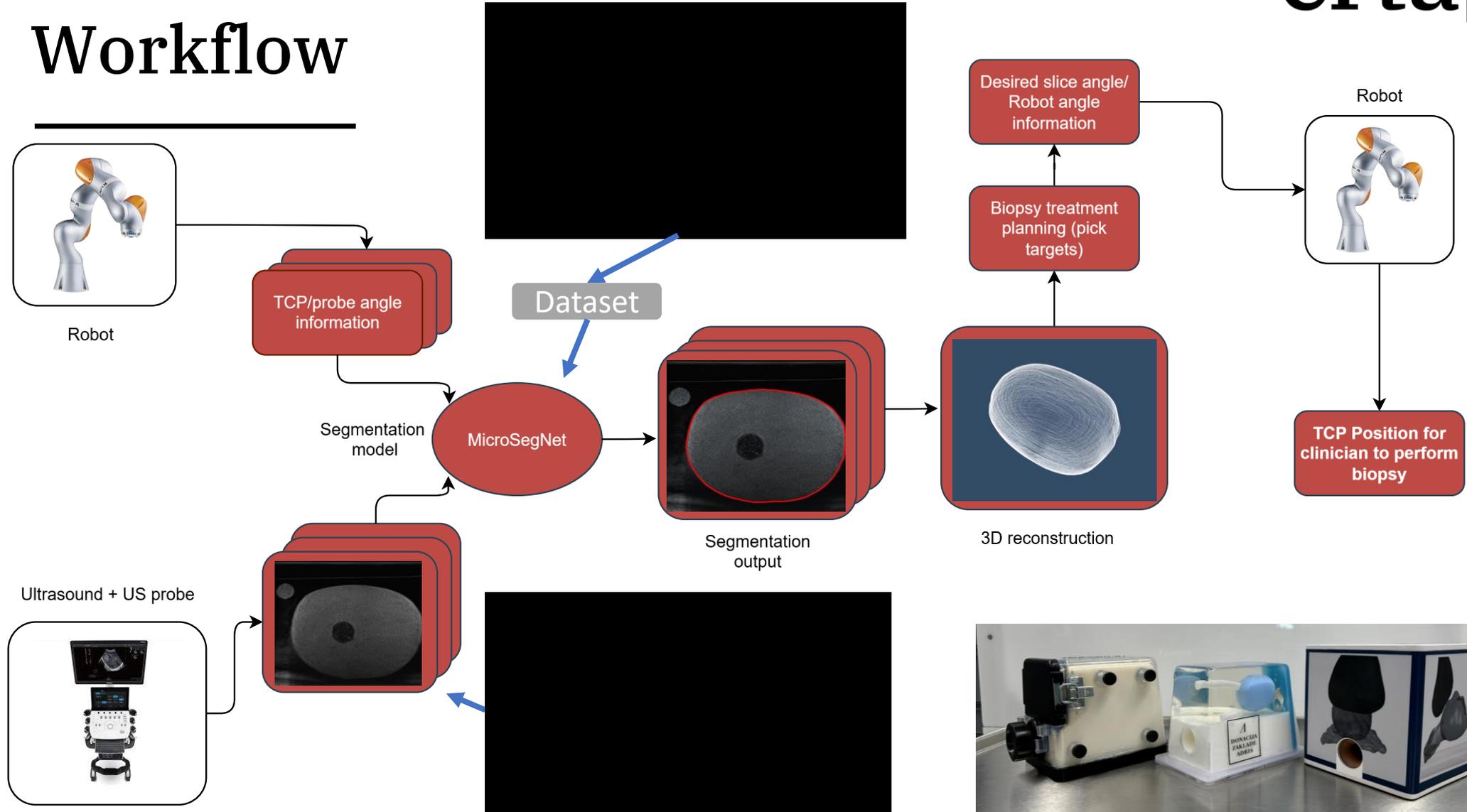
Scanning procedure

Prostate phantoms

MedAP and Model

Real prostate (Micro US)

Input

Output

Classification head

Marine Petriaux

Let's make a robot to help people walk

Our founder's idea :
Use humanoids technology to help people walk again

From day 1, we want to build a hands-free exoskeleton, self-stabilized.
We learnt how to do autonomous locomotion while carrying uninstrumented, unmodeled, heavy loads.

Feb 2025

"Make a humanoid, you have 40 days"

10 FEB

We need arms!

End March

"40 days"

12 FEB

Parts gathering, arms assembly

+6 DoF
+1 RGB-D camera
Same locomotion stack

Use cases : tires and boxes and... What's next ?

Other requests
- windshields, metal sheets
- Cart pushing
- Picking/kitting

We want to build a new manipulation stack to allow:
- **Fast development** of new tasks
- **Low sim2real** gap, as contacts simulation is hard!
- **Easy demonstrations** at the client's site
- **Embodiment**-agnostic as our robot evolves quickly

Our first work in next presentation!

Michel Rosselli

Path Planning within C-Space Safe Corridors

- **Goal**: Collision-free motion from $\mathbf{x}_{\text{start}}$ to $\mathbf{x}_{\text{goal}}$
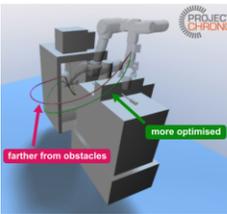- **Our Proposal**: A novel geometric planner coupling **Safe Corridor** definition with **Spline-based Optimization**
- **Method**: Constructs corridors using **Overlapping Axis-Aligned Bounding Boxes** (AABBs) via a Goal-Biased exploration (GBPFC-connect)
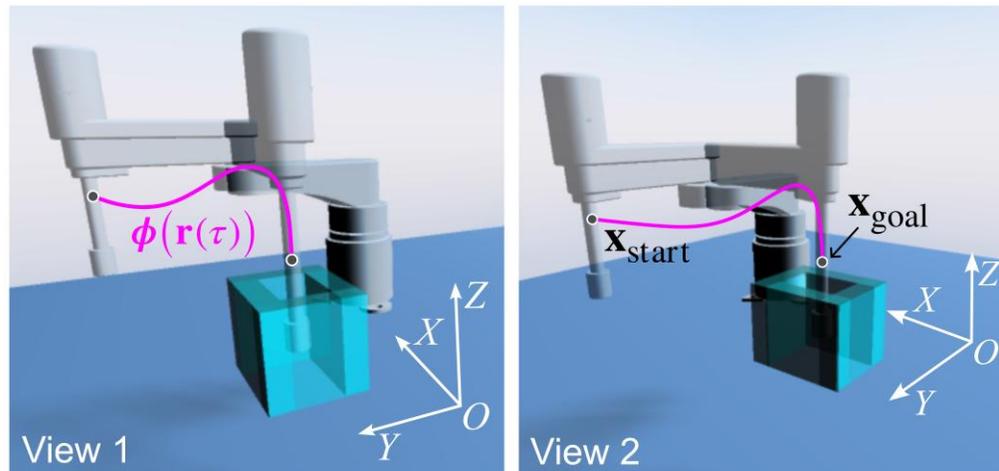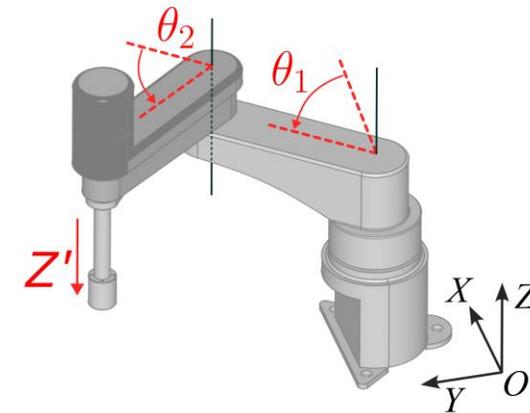
(a)   (b)

Safe Corridor (S) Construction

- **Exploration Strategy (GBPFC-connect)**:
  - Grows two foams (ξ_A, ξ_B) rooted at q_{start} and q_{goal}
- **Condition**: Terminates when foams intersect ($\xi_A \cap \xi_B \neq \emptyset$)

(c)
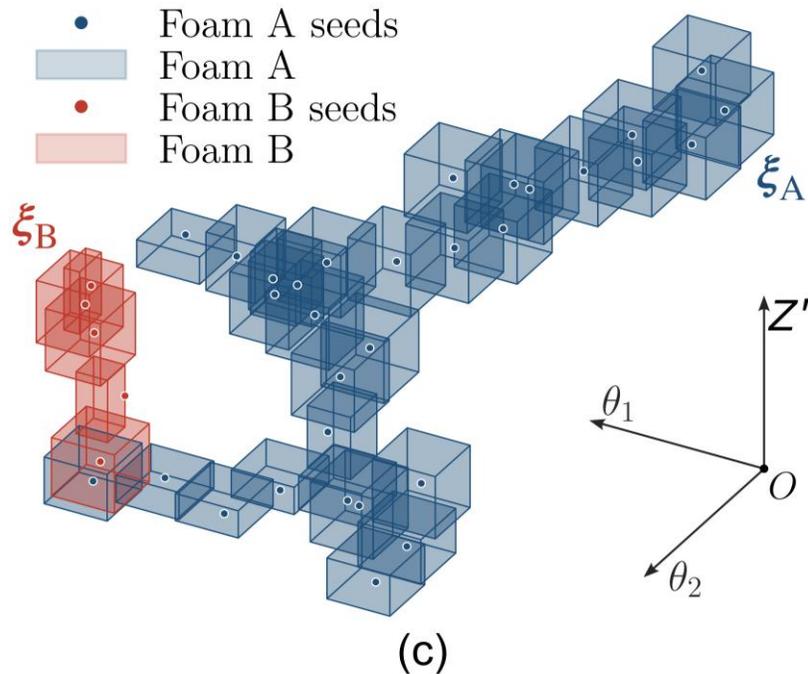
Safe Corridor (S) Construction

- **Exploration Strategy (GBPFC-connect)**:
  - Grows two foams (ξ_A, ξ_B) rooted at q_{start} and q_{goal}
- **Condition**: Terminates when foams intersect ($\xi_A \cap \xi_B \neq \emptyset$)
- **Refinement**: **Shortcut & Partial Shortcut** extract the minimal overlapping subsequence S
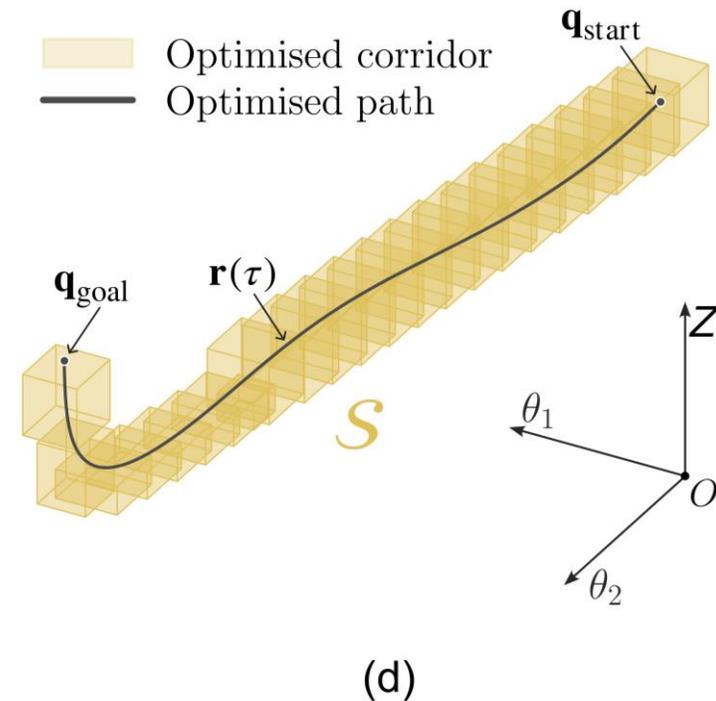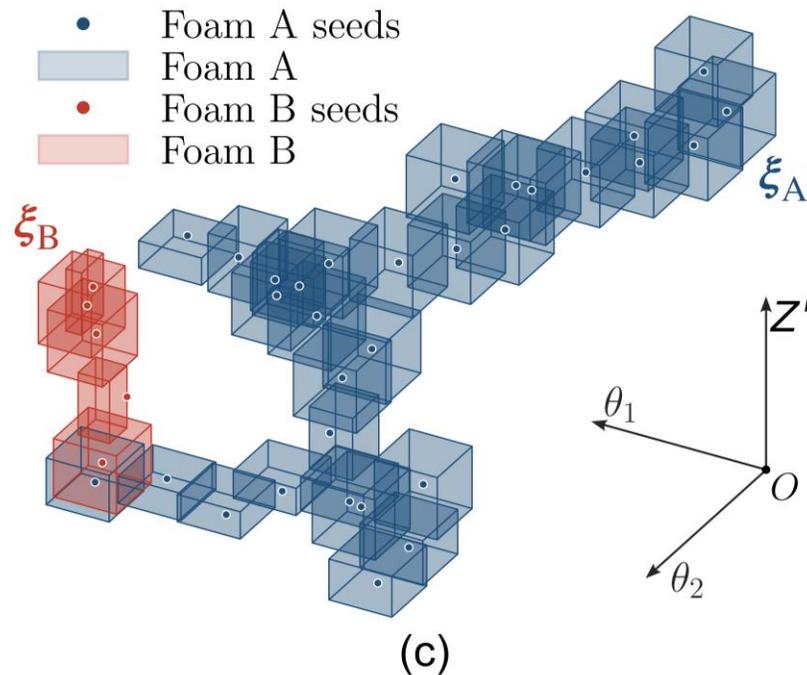
(c)

(d)

Spline-Based Optimization

- **Goal**: Compute **Multidimensional B-Splines** inside the safe corridor
- **Method**: **LCQP** (Linearly Constrained Quadratic Programming)
- **Objective Function**:
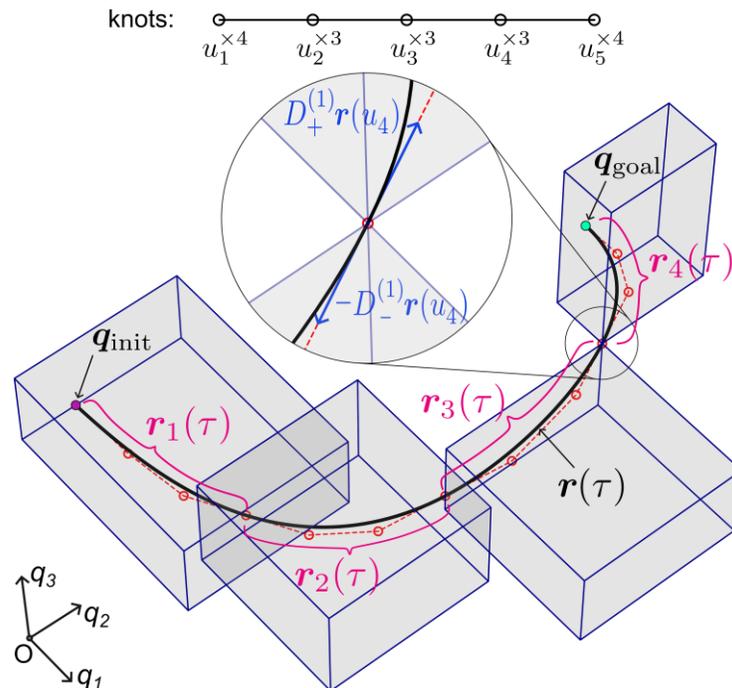
$$\min_{x} f(x) = \alpha_1 \, f_1(x) + \alpha_2 \, f_2(x)$$

Spline-Based Optimization

- **Goal**: Compute **Multidimensional B-Splines** inside the safe corridor
- **Method**: **LCQP** (Linearly Constrained Quadratic Programming)
- **Objective Function**:

$$\min_{x} f(x) = \alpha_1 f_1(x) + \alpha_2 f_2(x)$$

- α_1: **Reduces Geometric Acceleration** (Smoothness)
- α_2: **Increases Distance from Obstacles** (Safety)

$\alpha_1{=}1.00, \ \alpha_2{=}0.00$
$\alpha_1{=}0.95, \ \alpha_2{=}0.05$
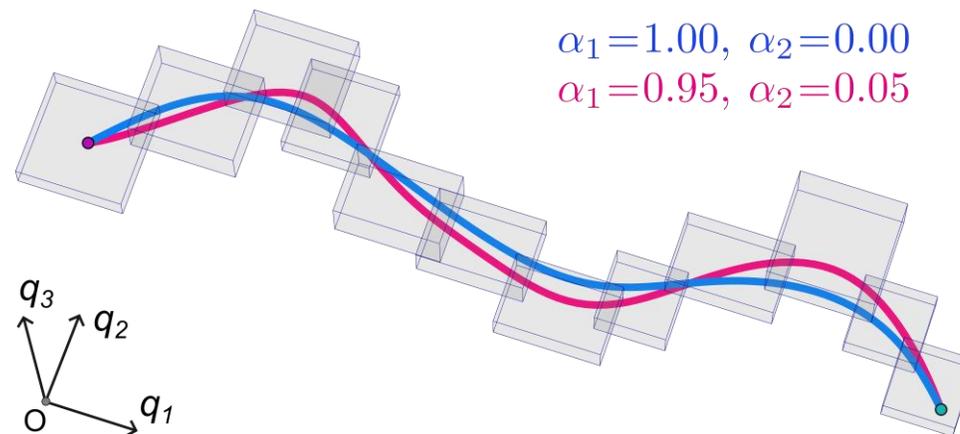
Results

Env.	Method	Successes (\10)	Path length (m)	C-space expl. CPU time (s)	Optim. CPU time (ms)
	Our (α_1=1.0, α_2=0.0)	10	**1.553±0.032**	**3.9±2.5**	**10±1**
	Our (α_1=0.998, α_2=0.002)	–	1.602±0.201	–	264±95
	Our (α_1=0.95, α_2=0.05)	–	1.640±0.144	–	331±54
	RRT [4] + optimisation	8	2.220±0.064	171.7±59.7	2145±587
	PRM [2] + optimisation	10	2.253±0.463	240.0±175.6	4576±1216
	RRT* [6] + optimisation	5	2.007±0.335	522.0±124.3	2588±1098
	Informed RRT* [9] + optimisation	7	1.732±0.293	438.2±196.9	2898±447
	KPIECE [42] + optimisation	5	1.857±0.514	8.8±4.4	3579±1459
	Our (α_1=1.0, α_2=0.0)	10	**1.535±0.167**	**27.4±21.7**	**12±3**
	Our (α_1=0.975, α_2=0.025)	–	1.625±0.282	–	205±75
	Our (α_1=0.95, α_2=0.05)	–	1.630±0.324	–	226±71
	RRT [4] + optimisation	10	1.677±0.032	121.4±81.2	3332±1901
	PRM [2] + optimisation	7	1.815±0.161	407.9±226.9	2865±279
	RRT* [6] + optimisation	4	1.757±0.124	513.8±197.9	2765±341
	Informed RRT* [9] + optimisation	7	1.754±0.058	461.7±224.6	3318±811
	KPIECE [42] + optimisation	9	1.727±0.094	108.2±98.9	2329±561
	Our (α_1=1.0, α_2=0.0)	8	**2.453±0.340**	**56.5±24.3**	**16±2**
	Our (α_1=0.975, α_2=0.025)	–	2.570±0.102	–	234±54
	Our (α_1=0.95, α_2=0.05)	–	2.613±0.057	–	221±45
	RRT [4] + optimisation	3	2.725±0.064	277.2±178.5	2145±587
	PRM [2] + optimisation	6	2.693±0.062	667.6±406.2	3367±1216
	RRT* [6] + optimisation	8	2.660±0.081	363.8±126.9	3265±1168
	Informed RRT* [9] + optimisation	6	2.782±0.066	582.5±128.0	1605±428
	KPIECE [42] + optimisation	6	2.932±0.232	351.9±147.6	516±458
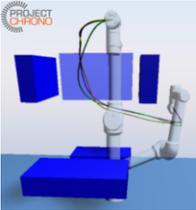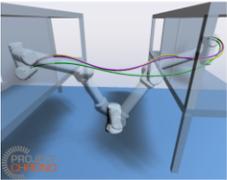
Constrained Path

- **Goal**: Enforce **Task-Level Constraints** (e.g., end-effector orientation)

- **Method**: **Manifold Projection**

  - Projects C-space configurations onto the **Task Manifold ($\mathcal{M}$)**

  - Generates a **Manifold-Guided Safe Corridor**

CartesianRobot
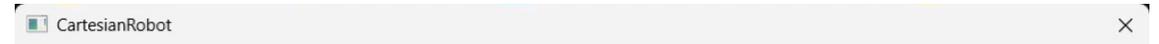
References

[1] R. Abbati, M. Riboli, M. Rosselli, A. Tasora, and M. Silvestri. A general approach to path planning within c-space safe corridors. IEEE Robotics and Automation Letters, 11(1):578–585, 2026

[2] ProjectChrono. http://projectchrono.org. Accessed: 2026-02-01.

Questions?

Paper

Michel Rosselli

michel.rosselli@supsi.ch

Moritz Moosmüller
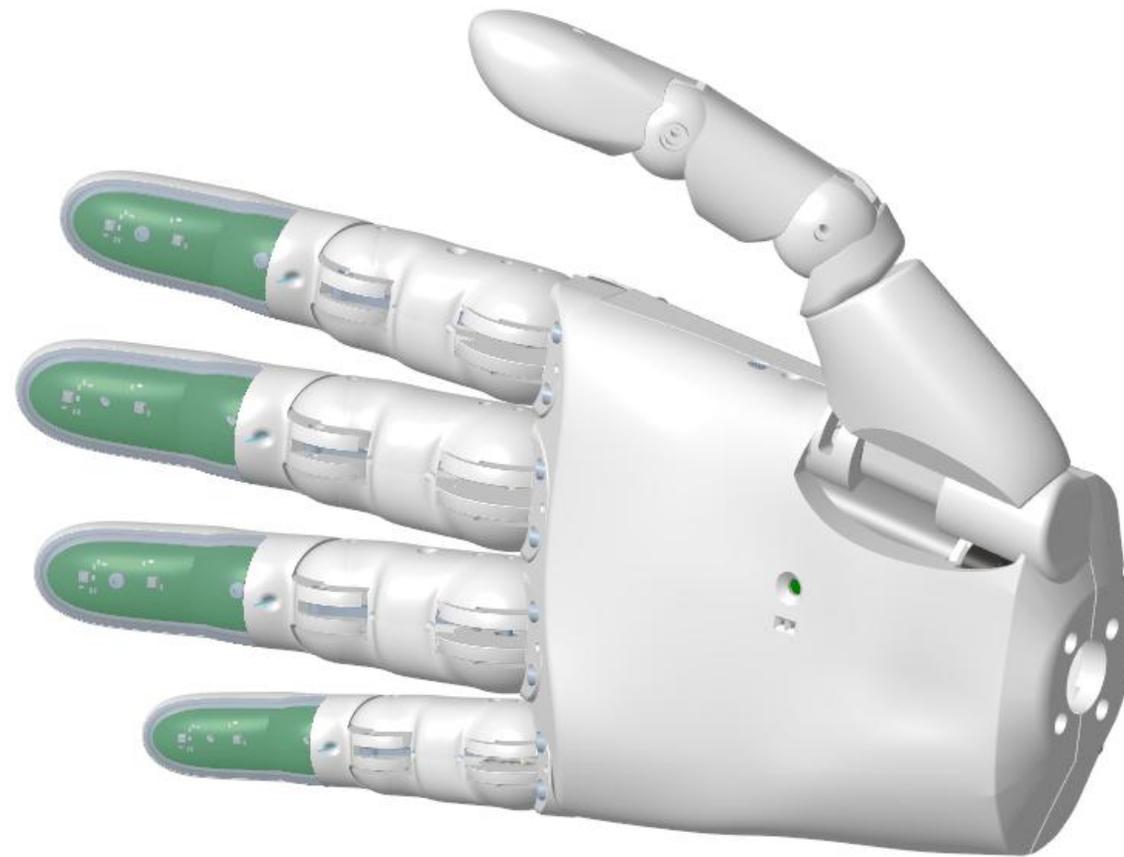
Humanoid Hand Design
with Tactile Force Sensors

Moritz Moosmüller
Karlsruhe Institute of Technology (KIT)
Institut for Anthropomatik and Robotik (IAR)
High Performance Humanoid Technologies (H²T)

H²T
High Performance Humanoid Technologies

Previous developments of humanoid hands at H2T
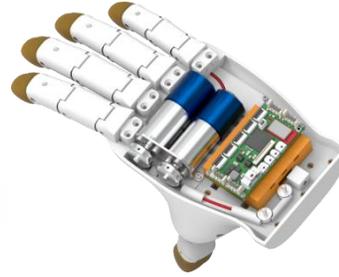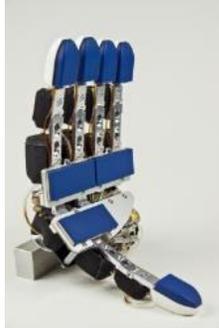
→ Requirements for deformable object manipulation?

Requirements for deformable object manipulation

- Force sensing during grasping

- High dexterity for various grasping configurations

- → Current developments?

Weiner et al. 2021, IEEE
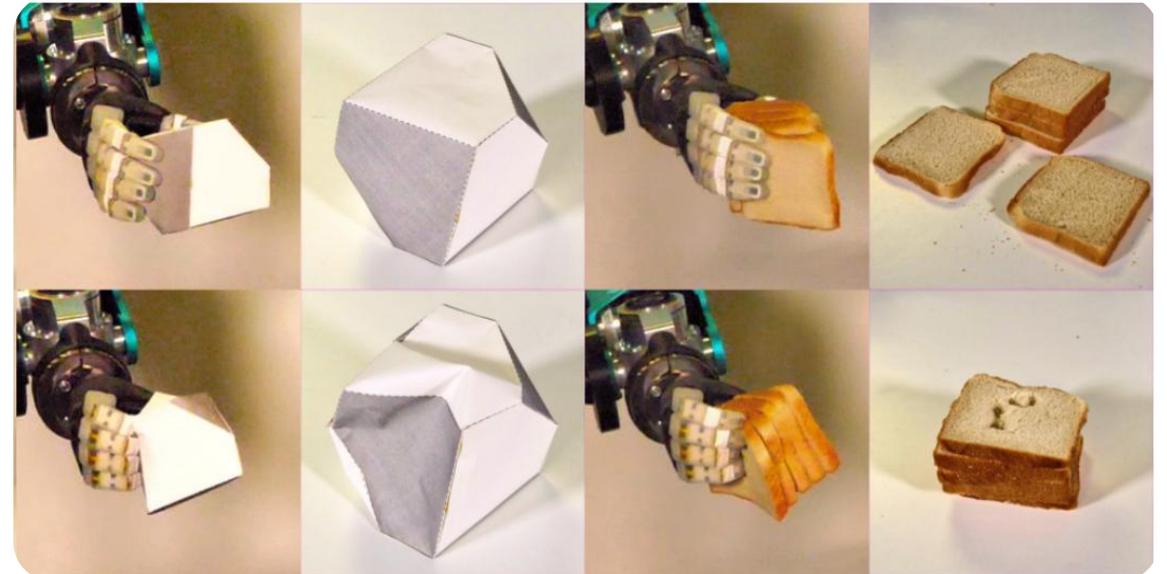
Developments in the design of the fingers

- Four-bar mechanism **matches** the trajectory to the **standard human grasp trajectory** [Kamper et al. 2003]

- **Underactuated:** Tendon-driven for coordinated flexion and passive extension with torsion springs.

- **Compliant fingertip** made of soft silicone with integrated (barometric) **tactile sensing**.
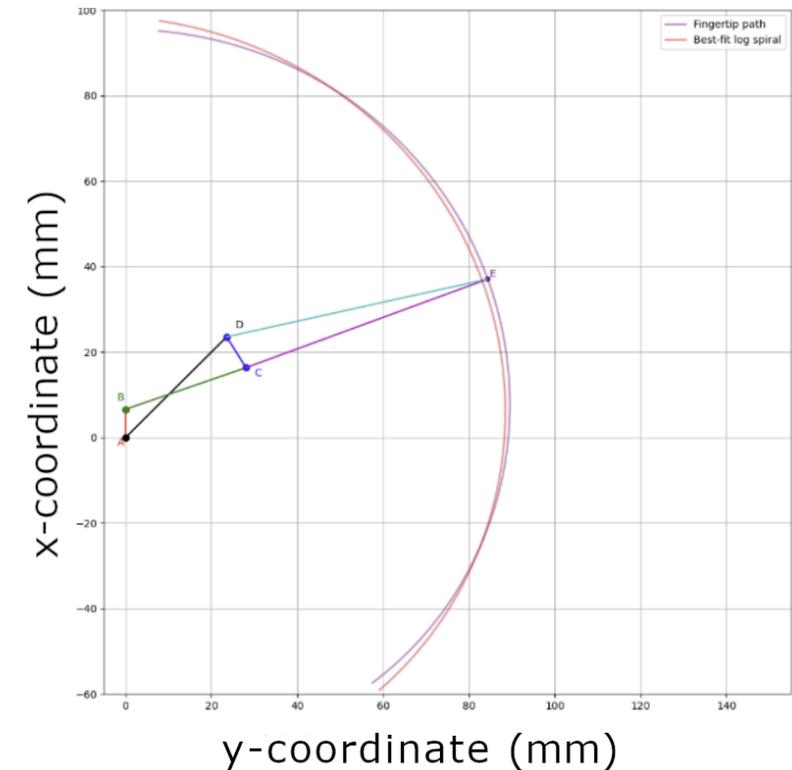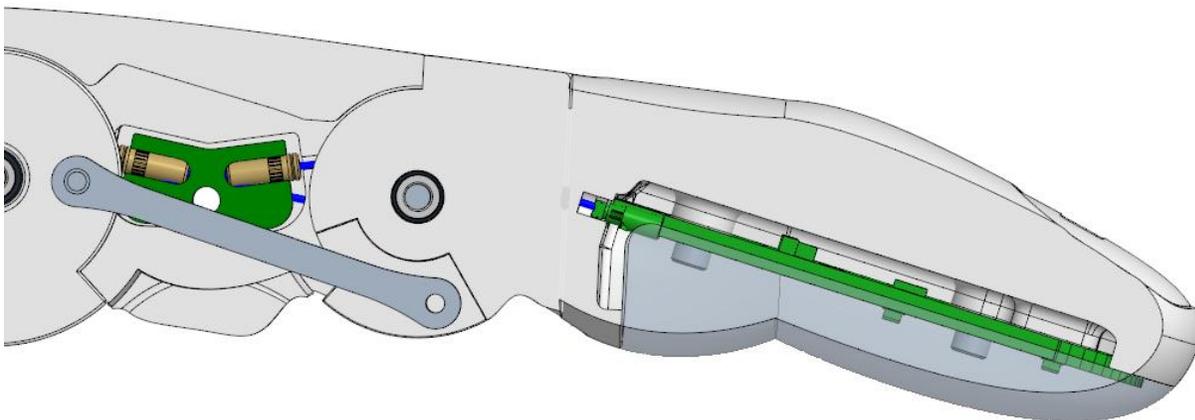
Hundhausen, Moosmüller et al., *GRC* (2026)

Tactile sensors

- Microcontroller in the distal finger segment reads sensor data

- Power Line Communication (PLC): Transmission of data and power via the mechanical coil springs

    - Datarate: 30 kbit/s.

    - Testing: zero failures over 500 flexion–extension cycles.

Hundhausen, Moosmüller et al., *GRC* (2026)
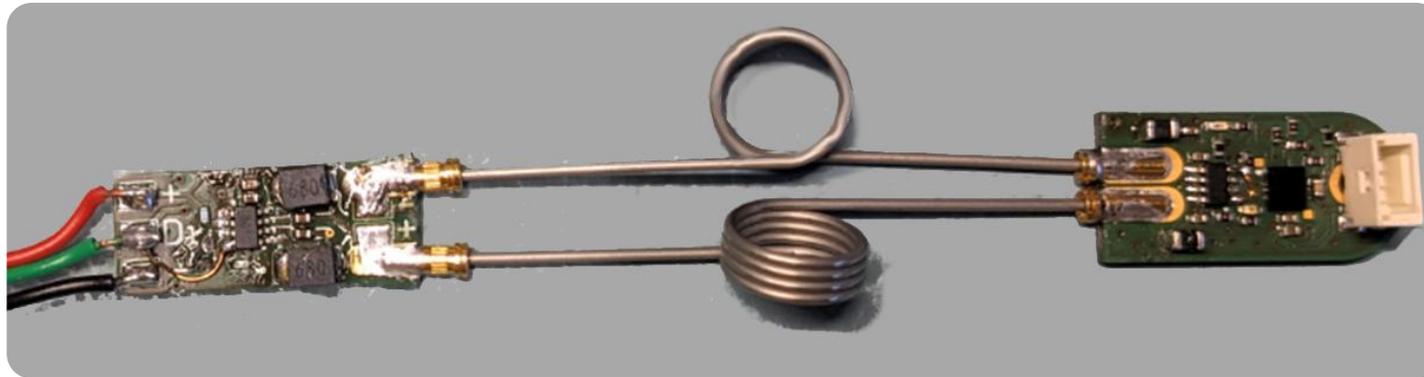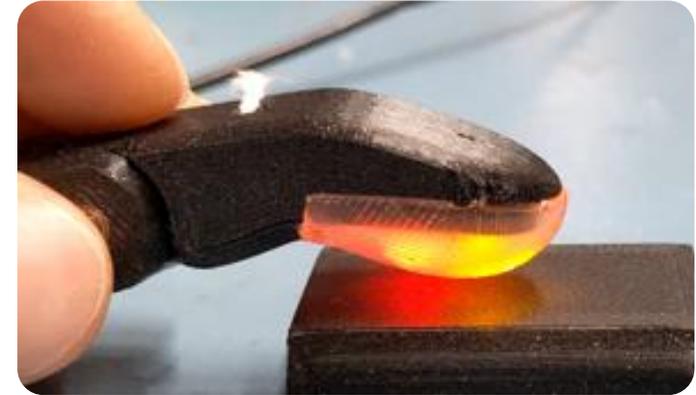
Outlook for my PhD

- Hands with underactuation → direct drive

- Torque based compliance for grasping

- Dexterity-Rating for humanoid hands

Moritz
Moosmüller
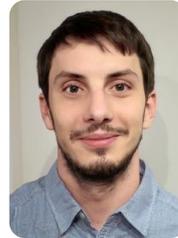
Felix
Hundhausen

Tamim
Asfour

www.humanoids.kit.edu

Thank you!

Nikola Knežević

PEOPLE

- **Assc. Prof. Kosta Jovanović**
- Research: **physical human-robot collaboration, cobots applications**

- **Asst. Prof. Nikola Knežević**
- Research: **human-robot collaboration, AI/ML in robotics**

- **Zaviša Gordić, PhD**
- Research: **industrial robotics, collision detection**

- **Branko Lukić, PhD**
- Research: **VSA, stiffness control, robot control**

- **Maja Trumić, PhD**
- Research: **soft robots, robot control**

- **Filip Bečanović, PhD**
- Research: **human motion analysis, inverse optimal control**

- **Miloš Petrović** PhD student
- Research: **human motion analysis, ergonomy, MoCap**

- **Gorana Milovanović,** PhD student
- Research: **Hu man-machine interfaces**
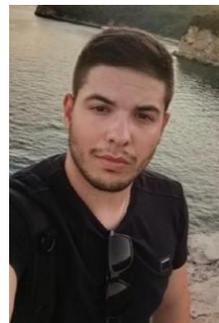
- **Nikola Ružić,** PhD student
- Research: **ROS, Mobile manpilators**

- **Veljko Todić,** PhD student
- Research: **human-robot interaction in XR**

- **Anastasija Rakic,** PhD student
- Research: **inverse RL**

LABORATORY

cooperative industrial robot cell
(by ABB, Denso and Siemens)

industrial SCARA robot
(by FANUC)

mobile cobot
(Franka Research III on
Robotnik omniwheel base)

VSA actuators

reconfigurable
soft grippers

F/T sensors

sensors for biomechanics

Franka Emika Panda

AI-powered cobot
with integrated
vision - MAiRA

ABB YuMi
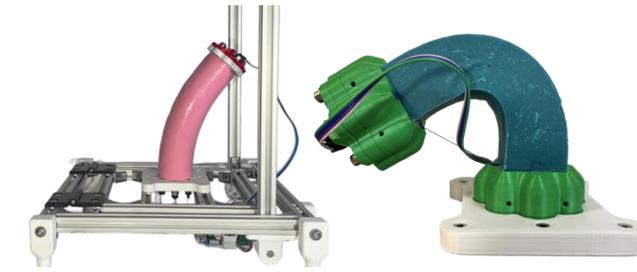
Soft robotics –
lab prototypes

RESEARCH

Research challenges:

1) **Development and control of new actuators**
   complaint (VSA/antogonistic), bio-inspired

2) **Human motion and behavior pattern analysis and prediction**
   based on MOCAP + wearables sensors (EMG, EEG, IMU)
   more efficent pHRI and improved human ergonomics

3) **New methods for assesment of safe and efficient pHRI**
   with minimal set of sensors – based on signal processing and control theory

4) **New robot control methods for safe and efficient pHRI**
   mechanical impedance shapping and control
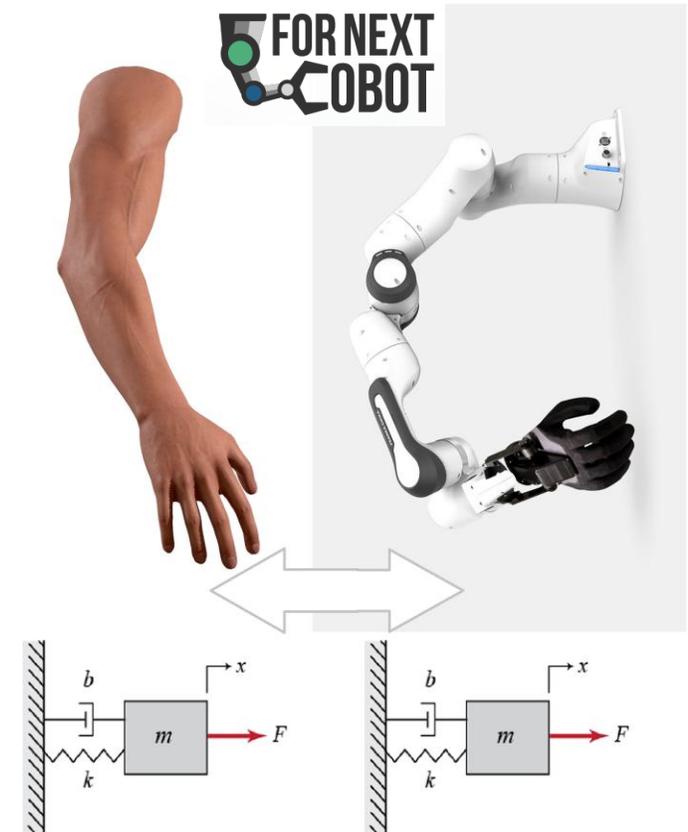
A Geometric Approach to Task-Specific Cartesian Stiffness Shaping

- Methods for shaping Cartesian stiffness matrix of a robot singular decomposition of the stiffness matrix, optimal exploitation of the stiffness space and joint positions, nonlinear sequential least square programming optimization
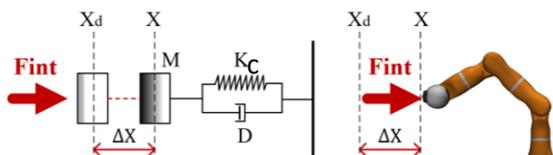
$$K_C = (J(q) K_j^{-1} J(q)^T)^{-1}$$

$$K_C = U \Lambda U^{-1}$$
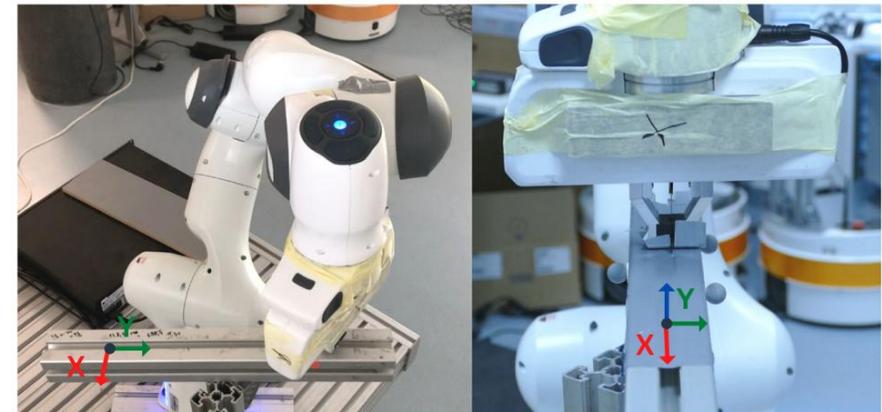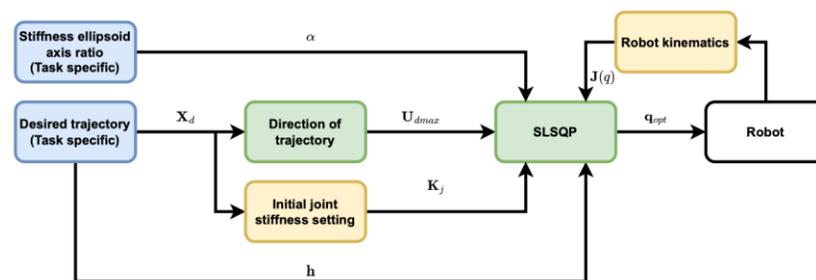
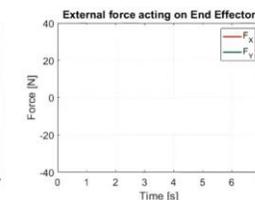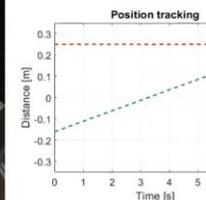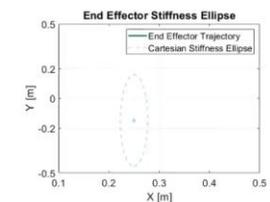A Geometric Approach to Task-Specific Cartesian Stiffness Shaping
KJ N. Knezevic, B. Lukic, T. Petric
Journal of Intelligent & Robotic Systems 110 (14), 1-11

Online cartesian compliance shaping of redundant robots in assembly tasks
B Lukić, K Jovanović, L Žlajpah, T Petrič
Machines 11 (1), 35

Neuroergonomic Workstation for Human-Centered Cobot-Supported Manual Assembly Process

Assembling different products with specific models in low batches requires a high level of worker attention and engagement making the manufacturing laborious.

The objective of the BrainWatch is to increase the productivity of such processes while improving workers' satisfaction by human-centred modular neuroergonomic workcell:

➢ Module 1: physical assistance (**Cobot**)

➢ Module 2: audio-visual assitance (**ADIN** – adaptive GUI),

➢ Module 3: physical assesment (**M2O2P-L** – non-invasive HMI)

➢ Module 4: non-physical (cognitive) assesment (**BrainWatch**),

➢ Module 5: strategic support (expert system - **FLINT**).

Toward Industry 5.0: A Neuroergonomic Workstation for a Human-Centered, Collaborative Robot-Supported Manual Assembly Process
N Knežević, A Savić, Z Gordić, A Ajoudani, K Jovanović
IEEE Robotics & Automation Magazine
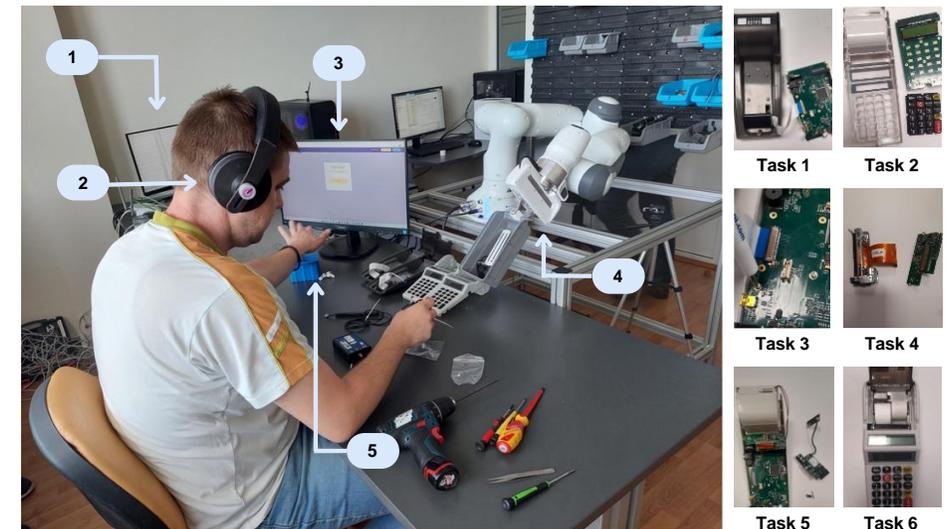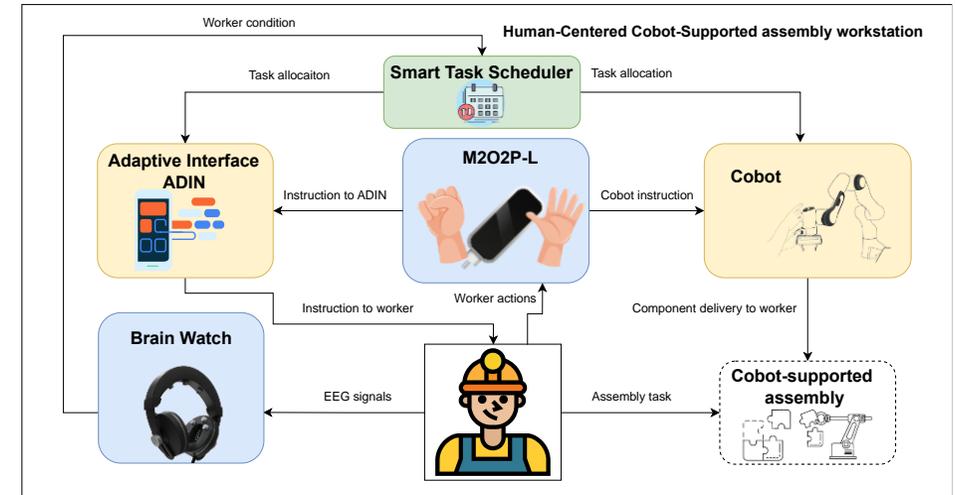
Neuroergonomic Workstation for Human-Centered Cobot-Supported Manual Assembly Process

BrainWatch 2.0 – Cobot + XR headset
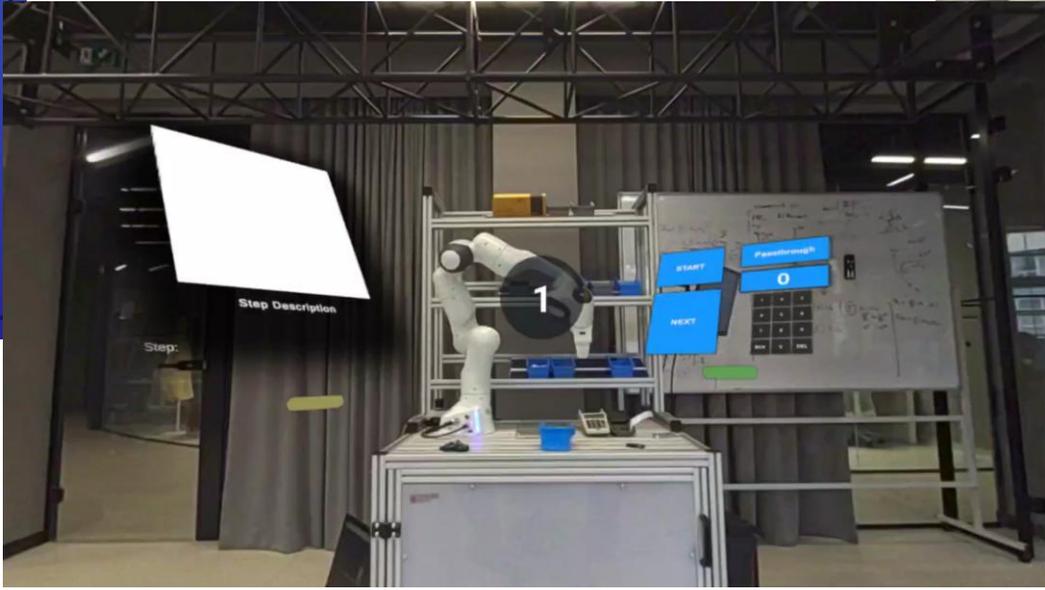
CONTACT

Thank you for your attention!

- **Asst. Prof. Nikola Knežević**
- Research: **human-robot collaboration, AI/ML in robotics**

website: http://robot.etf.rs/

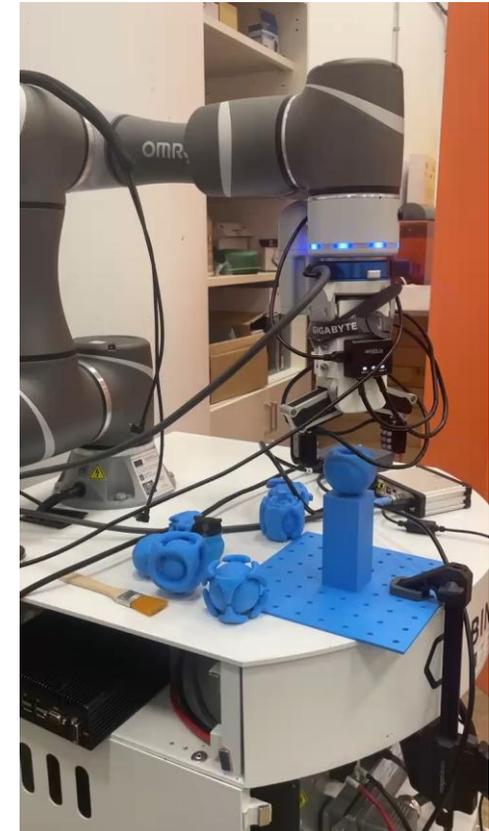e-mail: robot@etf.rs, knezevic@etf.rs
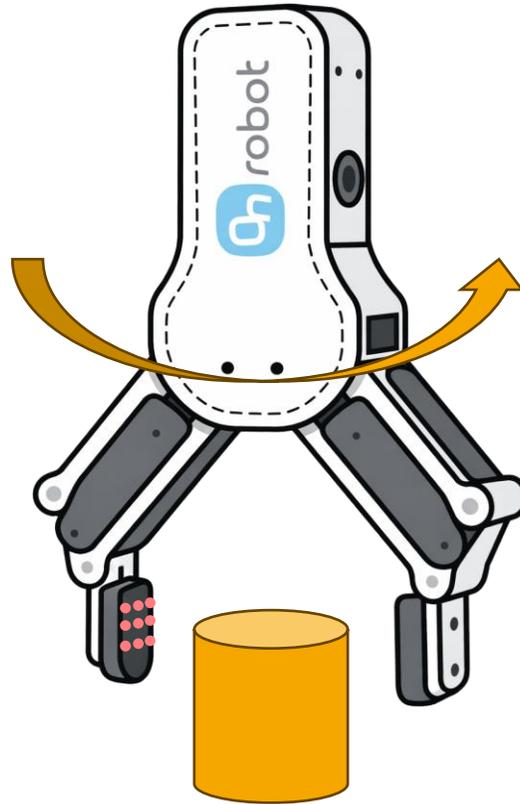
Nurlan Kabdyshev

Active Tactile Exploration for Object Understanding in Robotic Manipulation

Nurlan Kabdyshev

CiTIUS, University of Santiago de Compostela (Spain) and Institut Pascal, Clermont Auvergne INP (France).
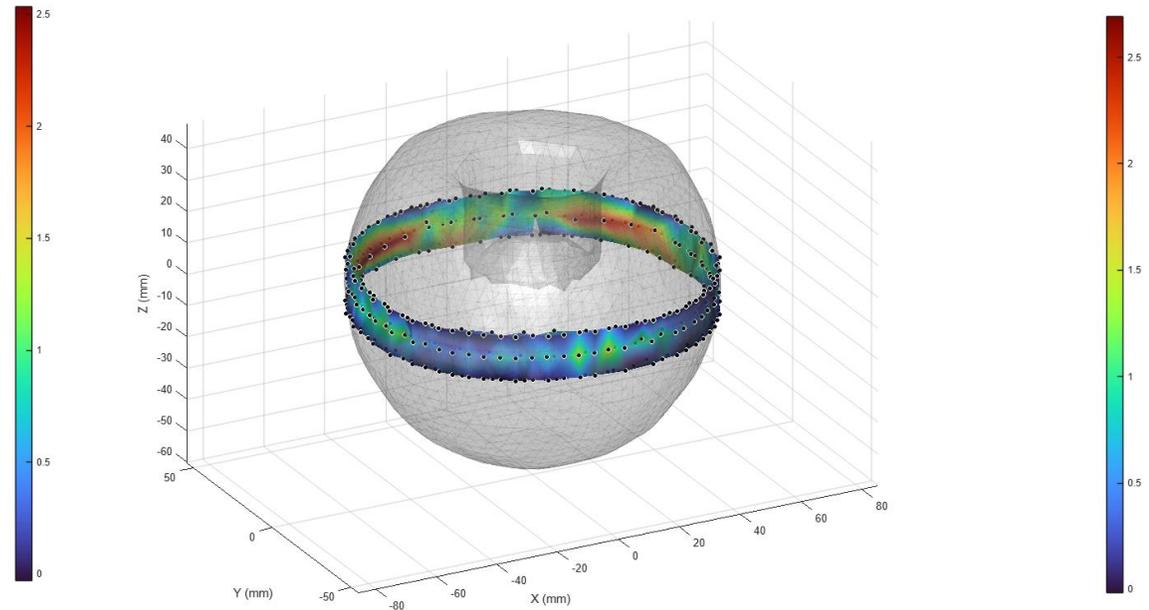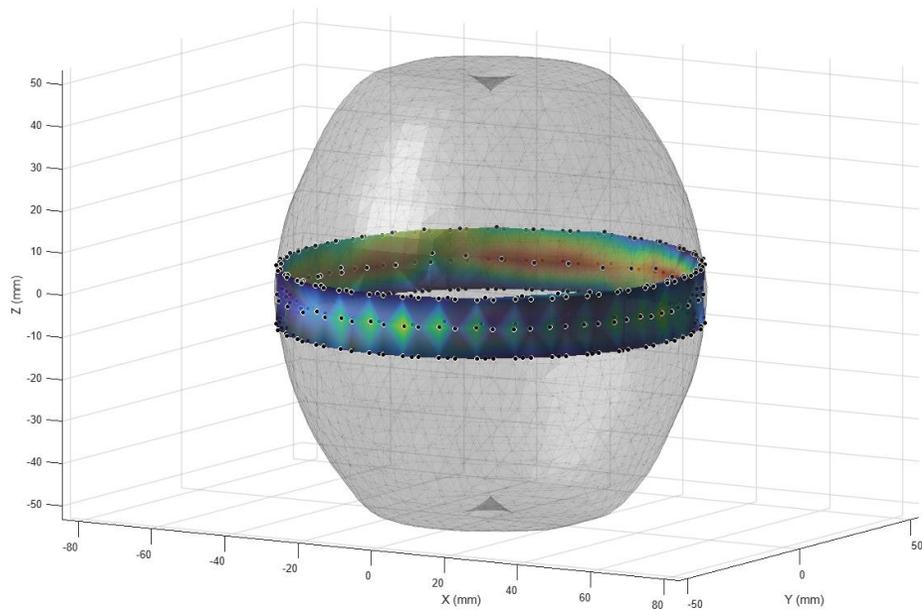
Supervisors: Juan Antonio Corrales Ramon;
Youcef Mezouar

Experiment Setup

Preliminary Results

Color-coded tactile measurements projected onto a reconstructed surface band from bilateral contact.

Acknowledgements

Rahul Ramachandran

ROMANDIC

THE NATIONAL
ROBOTARIUM
PEOPLE CENTRED :: INTELLIGENCE DRIVEN

Introduction and Recent Work

Presentation By,

Rahul R. Ramachandran
Robotics Engineer
Manipulation Team Lead
The National Robotarium (UK)

r.ramachandran@hw.ac.uk

About Me

Education and Experience:

B.Tech in Mechatronics engineering (First Class) from SRM, India
Visiting Research Student, Tokai University, Japan
MSc by Research (MRes) in Robotics (Distinction) from BRL, UK
I had worked in different areas of robotics namely, Marine Robotics, Aerial robotics, Continuum robotics, and Human-Robot interaction (HRI)
5+ years of Industry experience - 2 years in the Aerospace/Defense Industry and 3.6 years with The National Robotarium so far

Hobbies:

I like reading murder-mystery novels, traveling, playing snooker/pool and Badminton.

Experience:

- Robotic system design
- Planning and Control
- Robot vision-based navigation
- Robotic Simulation

Skills Summary:

- Language: Python, C++, LabVIEW, MATLAB
- Softwares: ROS1, ROS2, Isaac Sim, Fusion360

THE UNIVERSITY of EDINBURGH

HERIOT WATT UNIVERSITY

THE NATIONAL ROBOTARIUM
PEOPLE CENTRED :: INTELLIGENCE DRIVEN

The National Robotarium's Physical Presence

Incubation & Colocation

Office Space

Events, Meetings & Seminars

Hot-Desks

Workshop

Talent & Skills

Schools

Colleges

Continuing Professional Development (CPD)

Public Engagement

Test Facilities

Wave Tank

Outdoor Test Area

RAS Lab

Living Labs

People

Robot Systems Engineers

Academics

Researchers

Robot Technicians

Project Managers

Students

Lab Space

Robotics & Autonomous Systems (RAS)

Human-Robot Interaction

Lasers

Outdoor Test Area

User Defined

Robots

Spot	UAVs
Husky	Flash
Pepper	FurHat
iCub	TIAGo
Nao	...and more

The National Robotarium's Reach

The National Robotarium Network

Industry	Health & Social Care	Universities	Robotic Centres	Finance	Global Reach
Energy	NHS	Research	UK	Private	UK
Healthcare	Private	Teaching	Global	Public	Dubai
Construction	Social Housing				Malaysia
Hospitality					
Agriculture					
Space					
Manufacturing					

THE NATIONAL ROBOTARIUM
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NR Manipulation Focus Group Demo 1

About the Demo:

**Pick and Place using ROS 2 and Isaac Sim**

This project demonstrates vision-based pick-and-place of objects using Aruco tags to identify and differentiate objects for sorting. The demo is implemented on the Ufactory xArm5 robot and uses an Intel RealSense D435i depth camera.

A digital twin of The National Robotarium (NR) RAS lab cobot stations was created in NVIDIA Isaac Sim, and the software is implemented using ROS 2, MoveIt2, and NVIDIA Isaac Sim Omnigraph.

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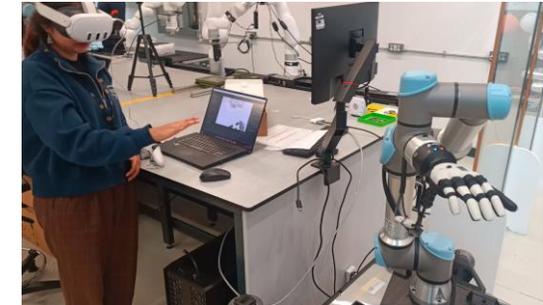THE UNIVERSITY of EDINBURGH
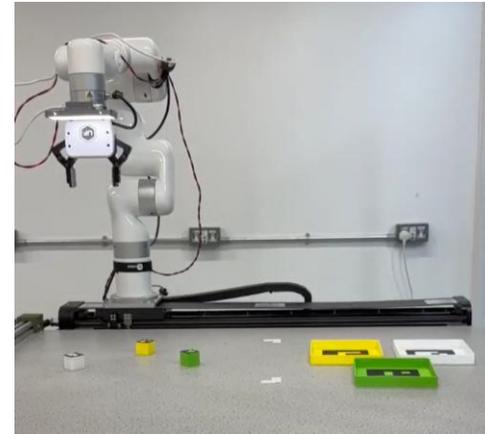
Demo 1 Implementation framework

- xArm ROS 2 developer packages from Ufactory

- Nvidia Isaac Sim OmniGraph for simulation (SITL)

- OnShape for robot design

- High-fidelity simulation
- ROS 2 ecosystem integration
- Synthetic data generation
- Digital twin potential
- Scalable experiments
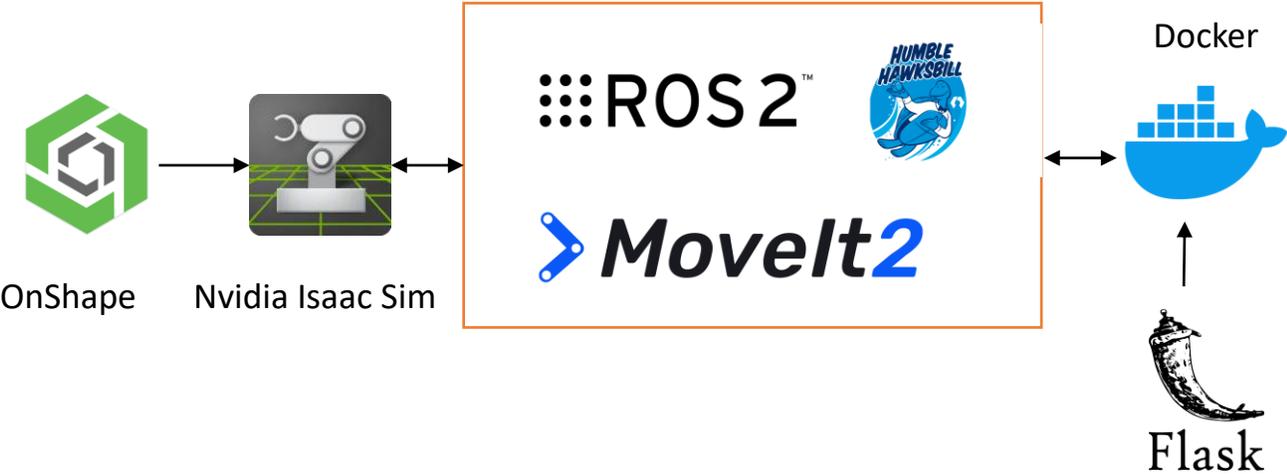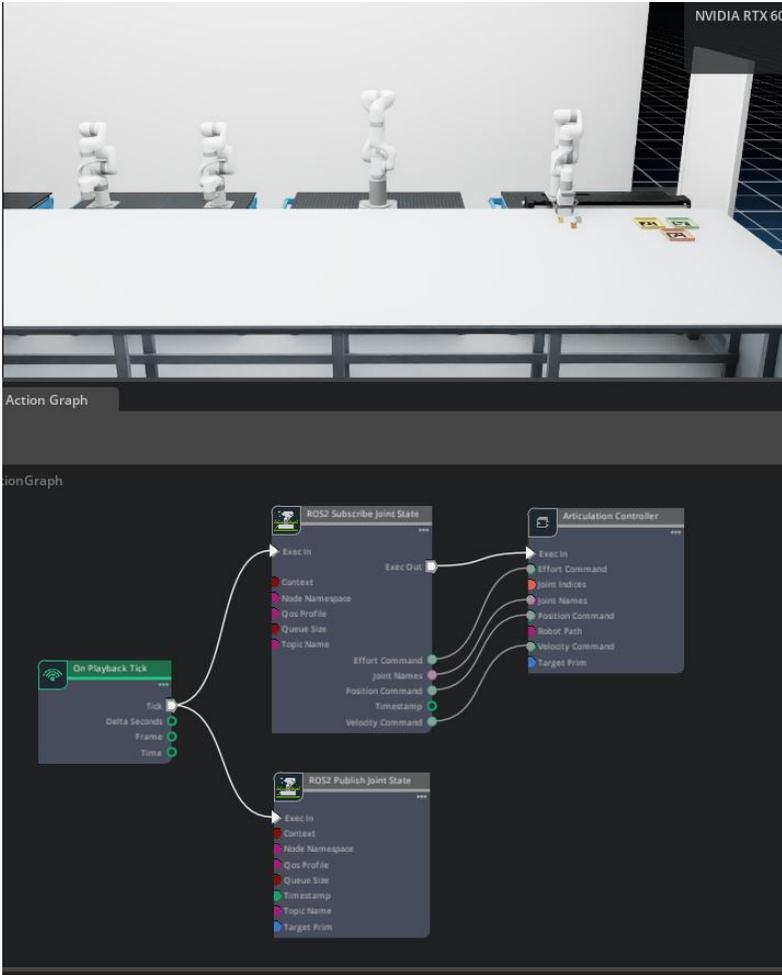
Looking to Collaborate

1. Benchmarking efforts in collaboration with COMPARE group - Open-Source Ecosystem for Robotic Manipulation.

2. Collaboration with University research groups looking into robot testing and validation using digital twin but not limited to.

3. Anyone from Industry looking for facilities such as ours and looking for testing and validation support.

Thank You

Looking to Collaborate, let's connect

The National Robotarium
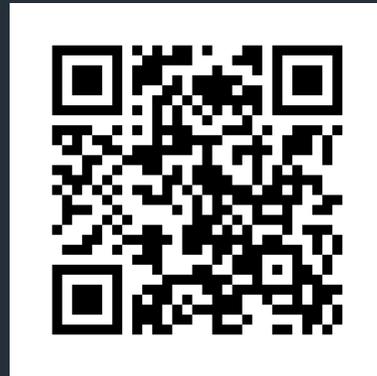
Rahul R. Ramachandran

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THE UNIVERSITY *of* EDINBURGH

Riccardo Morandi

Lagrangian Model Order Reduction of Deformable Objects Dynamics

Riccardo Morandi

ROMANDIC Winter School

Kranjska Gora, February 2026

Riccardo Morandi

PhD student since October 2025

Research Interest

- **Robot learning** and **control**
- **Physics** and **differential geometry** as **inductive biases**
- **theoretically grounded** and **data-efficient** methods
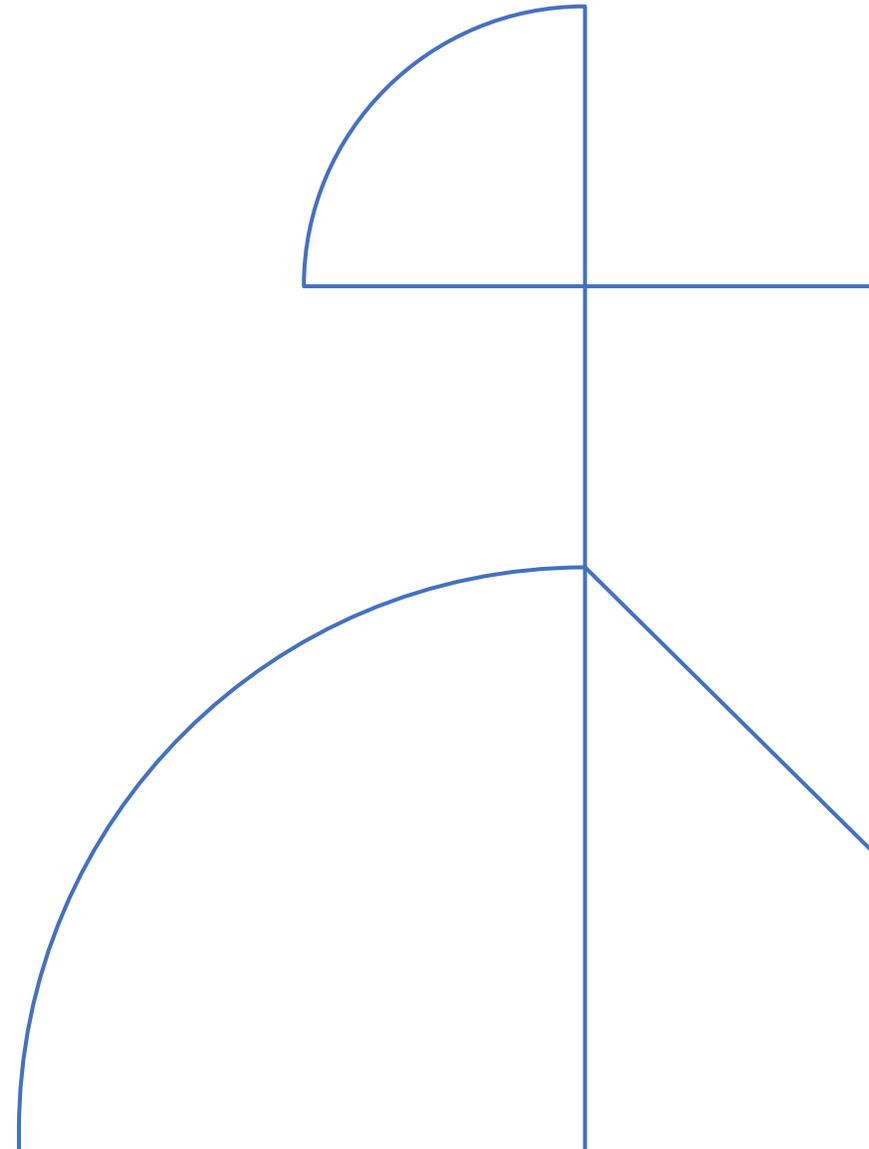- Application to **deformable object manipulation**

Supervisor:

Prof. Noémie Jaquier

Group:

Geometric Robot Learning Lab

KTH – Dept. of Robotics, Perception and Learning

Deformations as Points on a Fréchet Manifold

In continuum mechanics, the system has infinitely many degrees of freedom. Instead of discrete coordinates, the configuration is a **deformation of a body**.

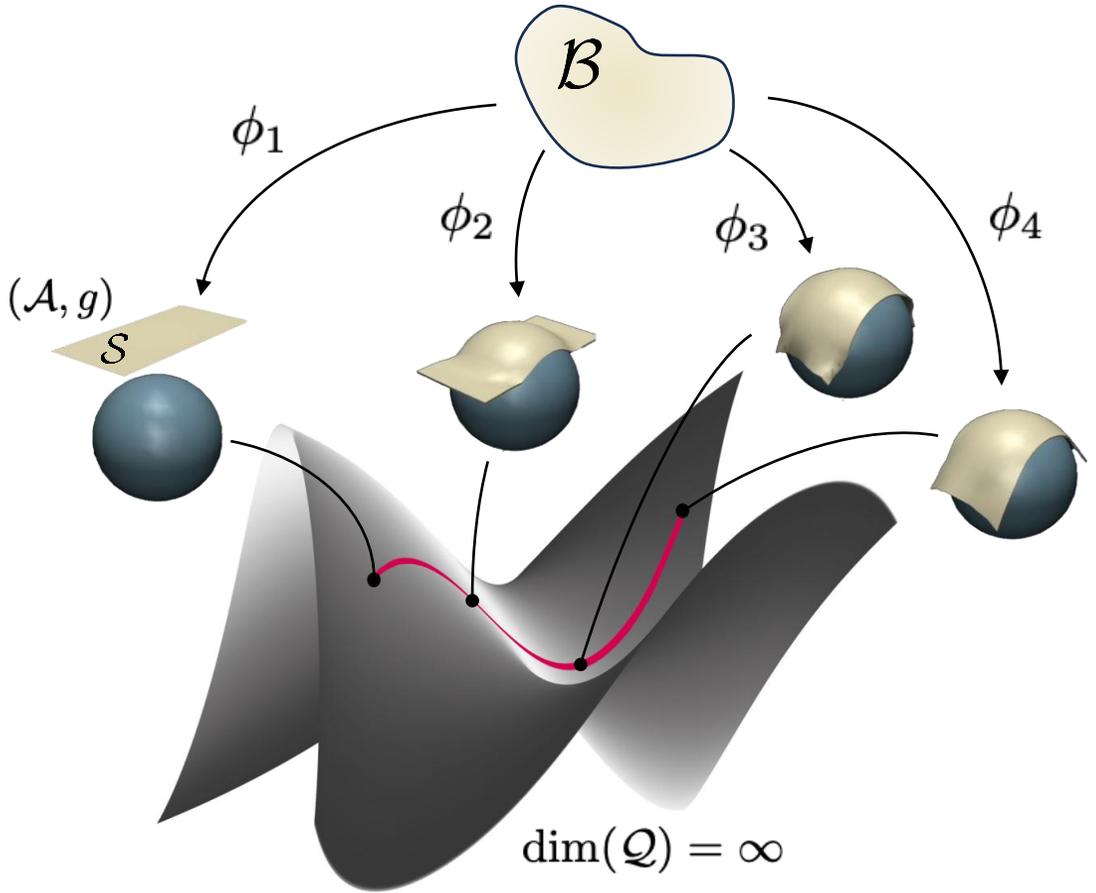Each deformation can be represented as an **embedding:**

$$\phi : \mathcal{B} \to \mathcal{A}$$

Therefore, the configuration manifold is the infinite dimensional Fréchet manifold of embeddings:

$$\mathcal{Q} = Emb(\mathcal{B}, \mathcal{A})$$

The **Lagrangian functional** is an integral over the body:

$$\mathcal{L} : (\phi, v) \mapsto \frac{1}{2} \int_{\mathcal{B}} \rho_0 \|v\|^2 - \left[\int_{\mathcal{B}} \rho_0 e(\nabla_X \phi) + \int_{\mathcal{B}} \rho_0 g \cdot \phi \right]$$

W. Noll. A new mathematical theory of simple materials. Archive for Rational Mechanics and Analysis. 1972.
Masrden J. E. and Hughes T. J.R. Mathematical Foundations of Elasticity. Dover. 1994.
B. Kolev and R. Desmorat. An intrinsic geometric formulation of hyper-elasticity, pressure potential and non-holonomic constraints. Journal of Elasticity. 2021.

Model Order Reduction as Embedded sub-Manifold

In practice, we try to **learn** a **surrogate dynamical system** and its parameters that preserves the original Lagrangian structure via a structure-preserving MOR.

Leveraging the geometric setting, we consider the reduced system to be a **d-dimensional embedded sub-manifold** of the configuration manifold.
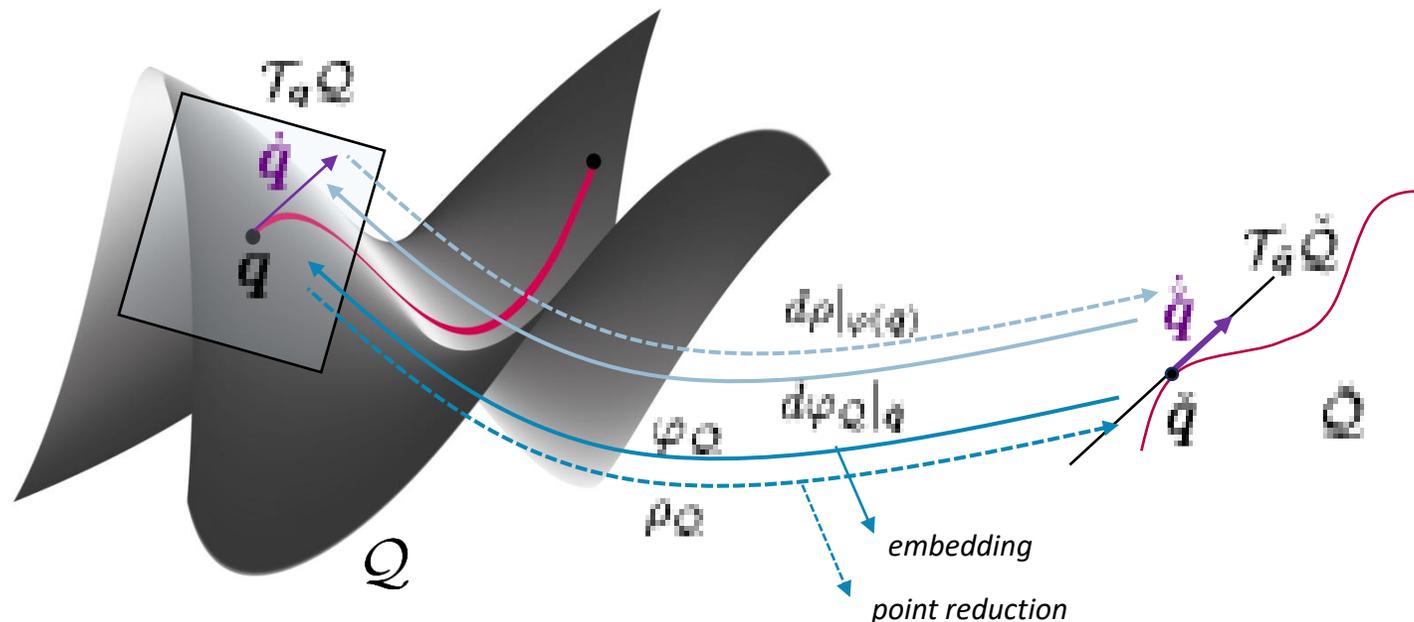
This framework turns continuum mechanics PDEs into a **finite dimensional ODE** which can be treated with classical tools, while preserving the geometry and physics of the configuration manifold.

$$\rho_0 \partial_{tt} \phi = \nabla_X \cdot \left(\frac{\partial W}{\partial F} (\nabla_X \phi) \right) + \rho_0 b$$

$$\tilde{M}(\tilde{q})\ddot{\tilde{q}} + \tilde{c}(\tilde{q}, \dot{\tilde{q}})\dot{\tilde{q}} + \tilde{g}(\tilde{q}) = \tilde{r}(\tilde{q})$$

P. Buchfink, S. Glas, B. Haasdonk, and B. Unger. Model reduction on manifolds: A differential geometric framework. Physica D: Nonlinear Phenomena. 2024

Sebastian Rietsch

Combining Visual Imitation Learning and Reinforcement Learning for Robotic Manipulation

Sebastian Rietsch

Karlsruhe Institute of Technology (KIT)

H2T

High Performance Humanoid Technologies

Motivation

- Imitation learning is showing promising results, but robot demonstrations are **expensive and hard to acquire**
    - Especially true for dexterous hands and deformables

- Visual human demonstrations, on the other hand, are **intuitive and cheap,** but lack concrete action labels and suffer from an embodiment gap between human and robot

➡

▶   Leverage reinforcement learning to bridge the gap

Sparse geometric constraints for reinforcement learning

- Given a small set of human demonstrations, extract a task representation that generalizes to object instances of objects of the same category

- Translate into a reinforcement learning problem where the reward function gives
    - **Weak guidance** on where to manipulate
    - **Strong guidance** on what to imitate

- Emphasis on training of **non-demonstrated objects**
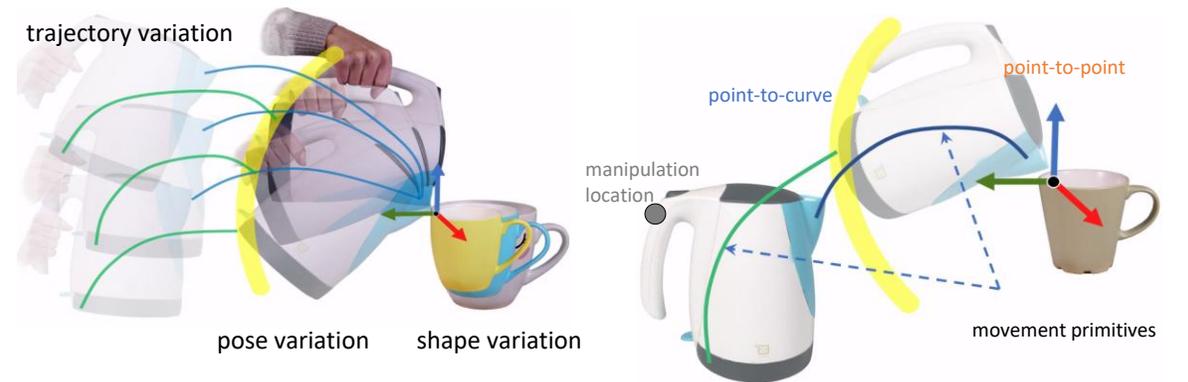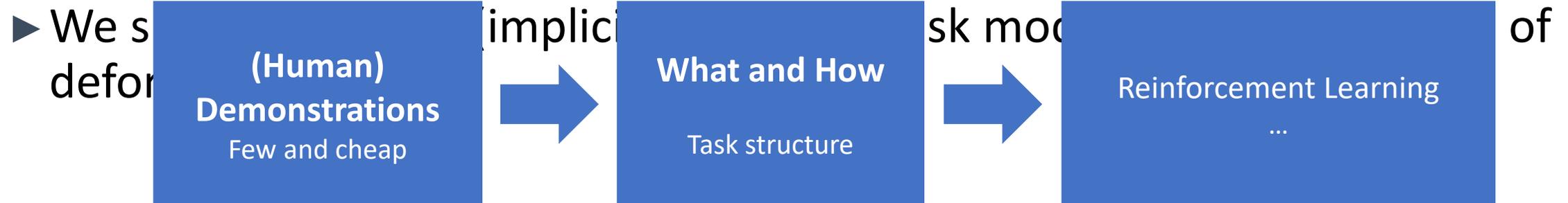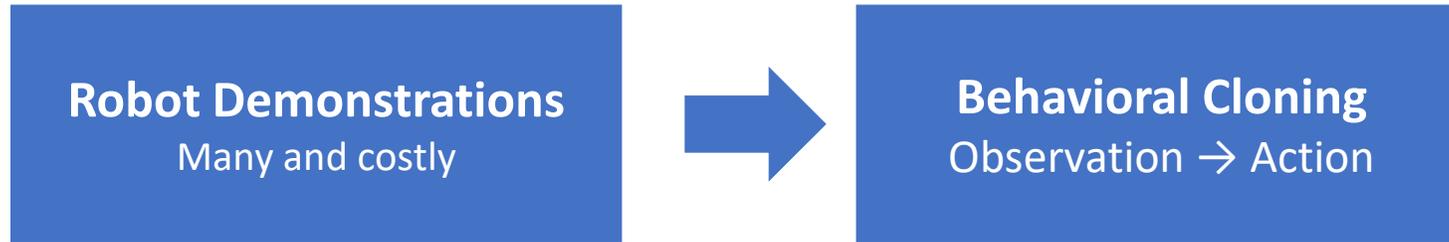

Visual demonstration

Keypoint-based geometric constraints
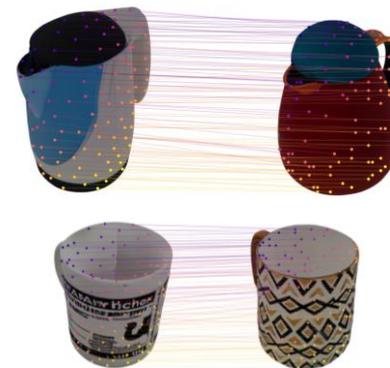
Keypoint correspondence
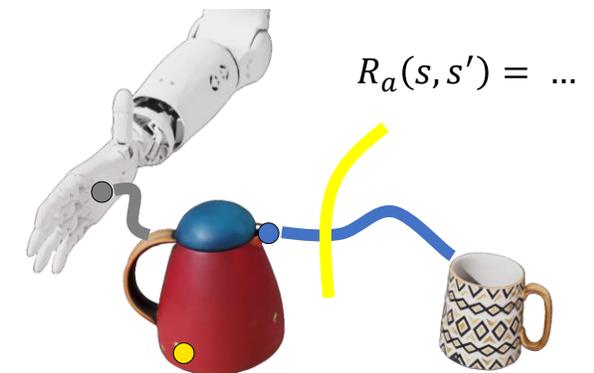
Dense reward formulation

$$R_a(s, s') = \ ...$$

Gao et al., T-RO (2023),   Gao et al., *ICRA* (2024)

Pitch for ROMANDIC?

▶ Instead of falling for the behavioral cloning trap

| Robot Demonstrations
Many and costly | → | Behavioral Cloning
Observation → Action |

▶ We s̶ ̶ ̶ implic̶ ̶ ̶sk mo̶ ̶ ̶ of defo̶

| (Human)
Demonstrations
Few and cheap | → | What and How

Task structure | → | Reinforcement Learning
... |

Sebastian
Rietsch

Jianfeng
Gao

Tamim
Asfour

www.humanoids.kit.edu

Thank you!

Youngbin Yoon

A Human Demonstration Dataset for Analyzing Topological Changes in Knot Tying
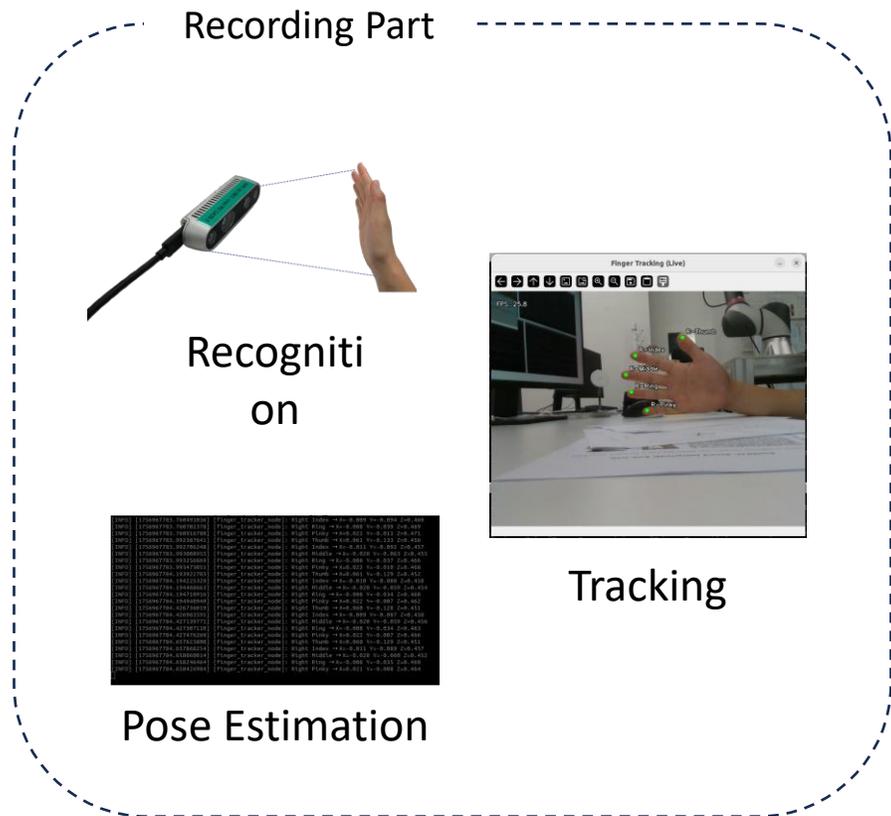
Youngbin Yoon

My research

Knot tying

- Study how to transform a current knot state into a desired knot configuration

- Enable robots to tie knots through human demonstrations

Finger tracking

crossing & topology

My research

Knot tying

Recording Part

Recognition

Tracking

Pose Estimation

Reproduction Part

Robot Control

Knot Tying

My research

Dataset

- Constructed a human demonstration dataset for knot tying

- Captured knot configurations at multiple stages of the tying process

- Organized knot states in a structured representation
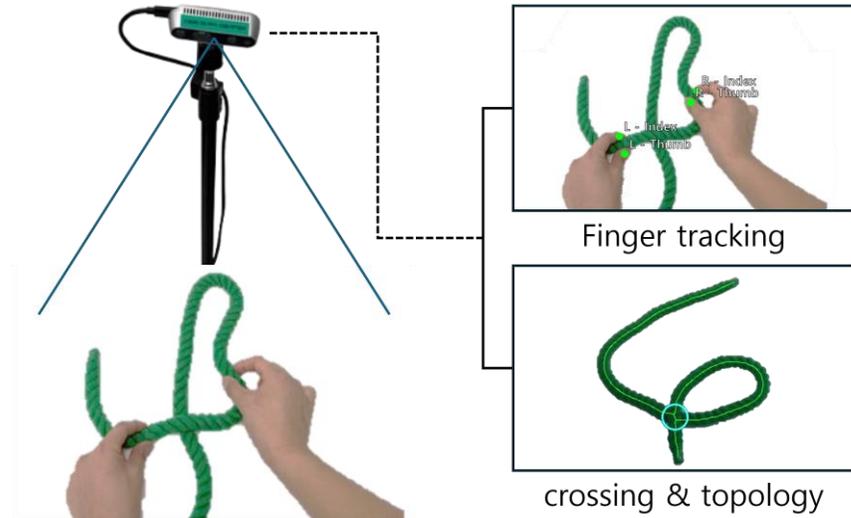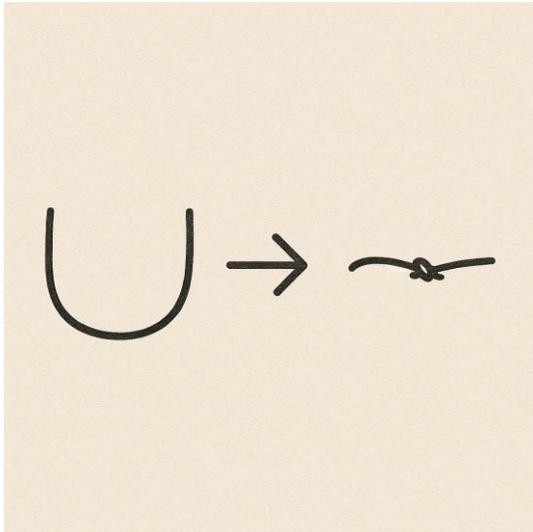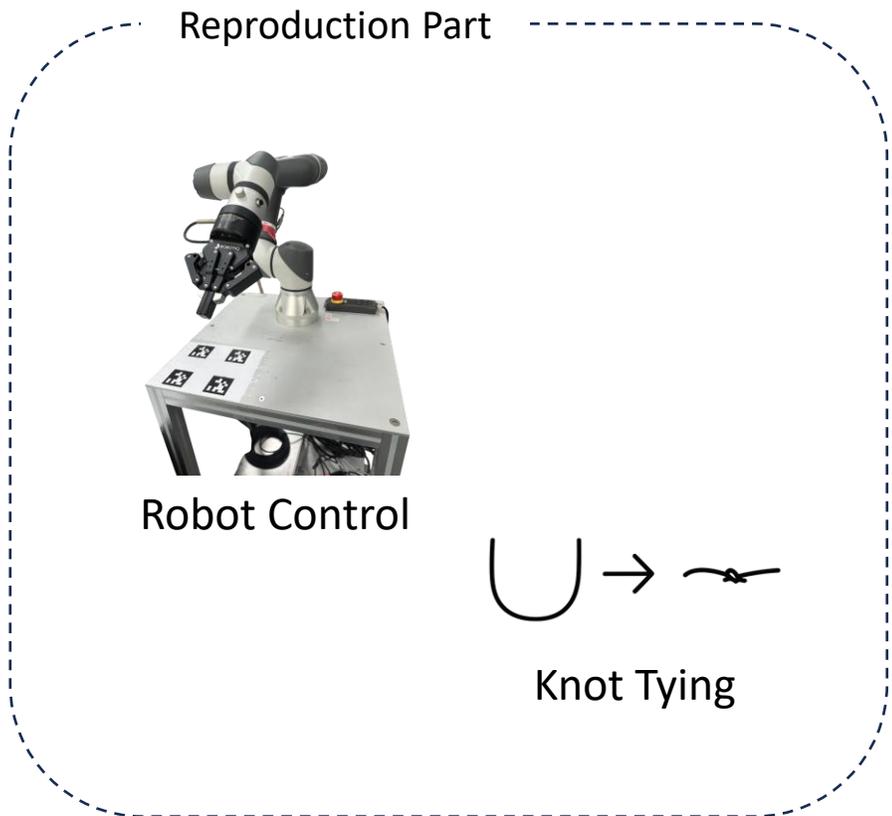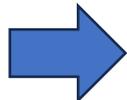
Yuyuan Wu

Multimodal Teleoperation and Imitation Learning

- Intuitive 6-DoF (Torque) control

- Scalable to diverse hardware configurations

- Real-time feedback of multi-modal data (visual, haptic, auditory) within an immersive UI

- High-quality demonstration collection

Contact: Yuyuan.Wu@UGent.be

Multimodal Teleoperation and Imitation Learning

Tactile Sensor Development

- Sensing: High-Density Magnetic Tactile Matrix

- Control: Compliant Torque-level Framework (UR Series)

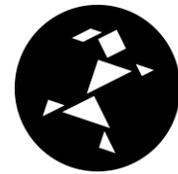- Learning: Tactile-Driven Imitation Learning

ROMANDIC

GHENT UNIVERSITY
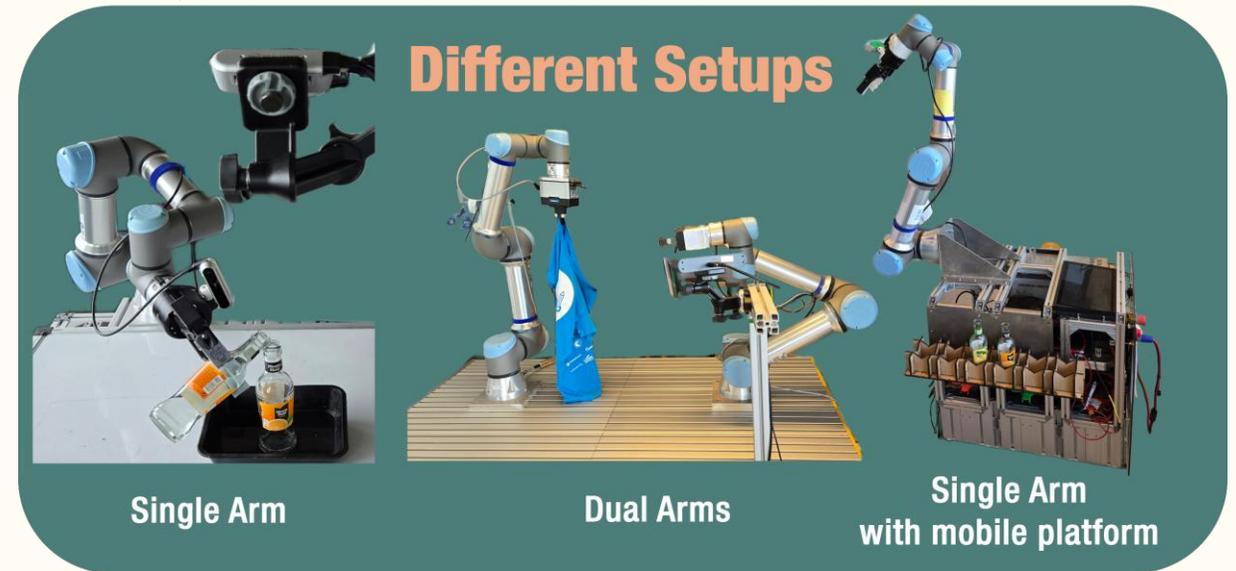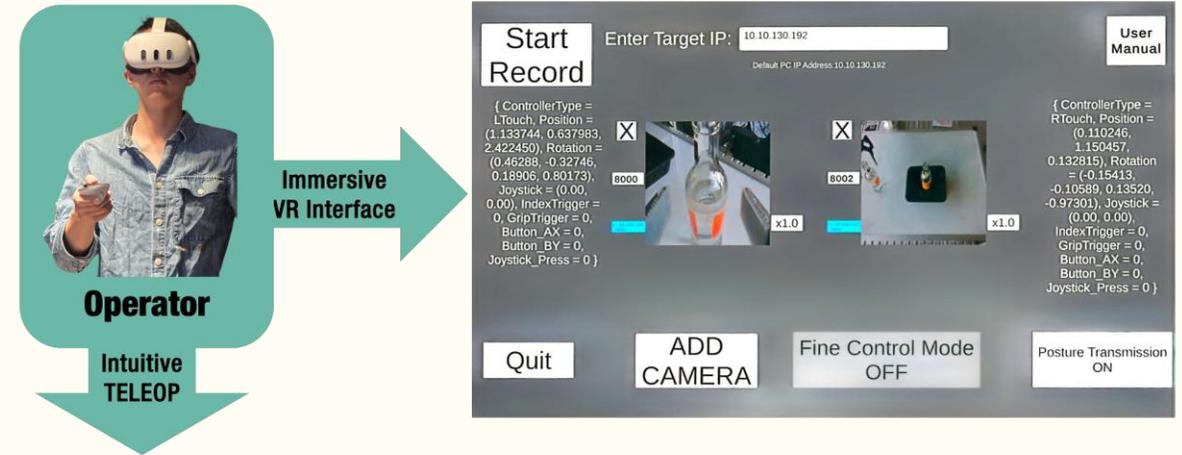
IDLab
INTERNET & DATA LAB

Contact: Yuyuan.Wu@UGent.be