

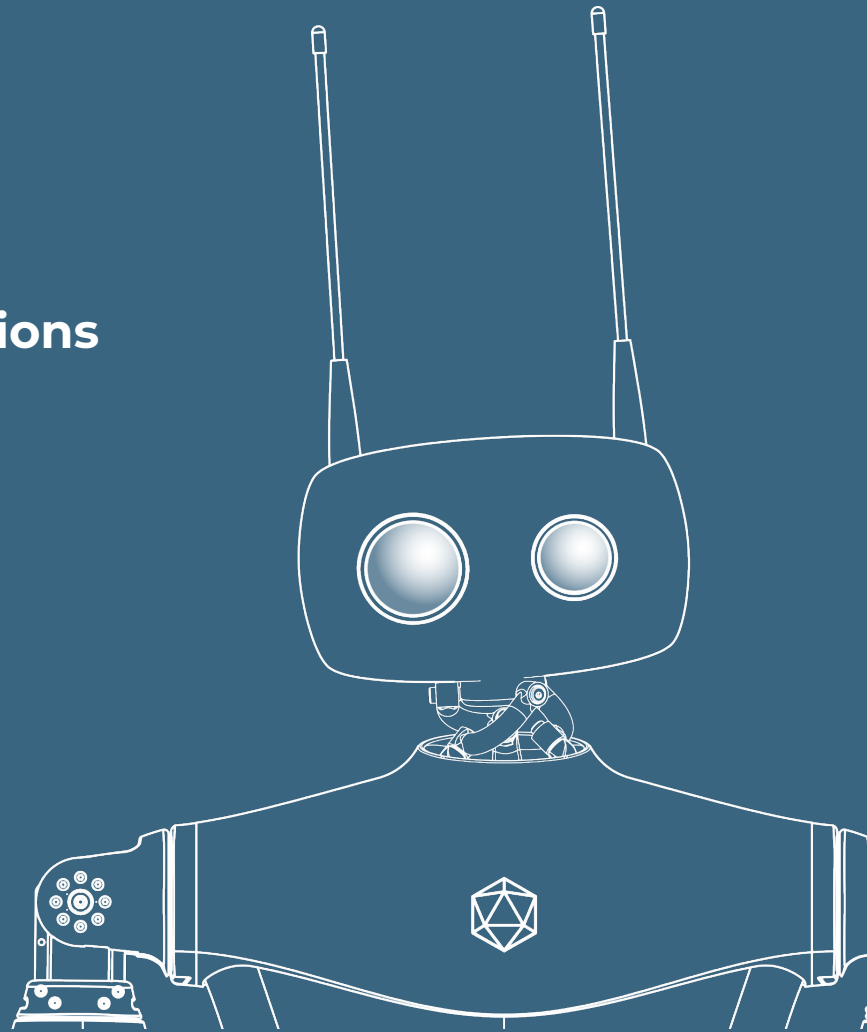
Designing robots for natural interactions

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ICRA 2023 Workshop Toward Robot Avatars

2 June 2023



2nd place at the ANA Avatar XPrize!

A slightly different perspective and approach?

A really small and of the rare non-academic team.

Used our out-of-the-shelf solution as much as we could.

Not really specialised in tele-presence.

→ Designing robots for natural and simple interactions in the real world.

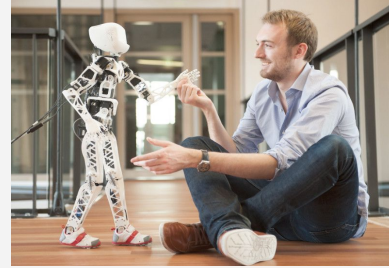


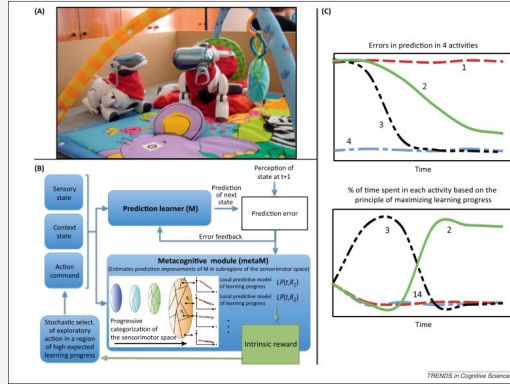
A few words on Pollen Robotics

Founded in 2016 - 7 years old

- **Have robots interacting in the real world**
- Human-robot interaction and collaboration in daily life environment
- **20** persons (4 Phd, 10 R&D eng.) - **12** for the finals and **6** for the semi-finals
- mechanical design, interaction, grasping, control, AI, etc.

Complete R&D team specialized in building, programming real world robots and associated interfaces

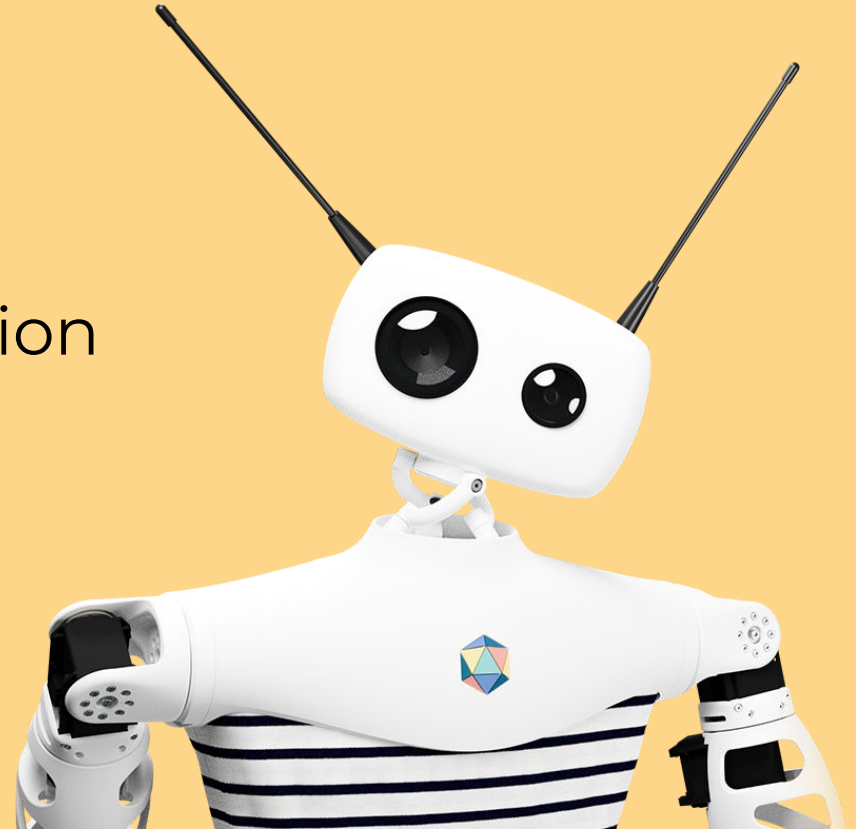




2009-2016 (Inria Flowers, Rhoban, etc.)

Reachy

Physical and Social Interaction



Meet Reachy!

An expressive **open-source humanoid service robot** great for human-robot interaction, object manipulation, and navigation.

Main features:

- 7-Dofs **bio-inspired arms** with gripper
- **Expressive head & orbita neck**
- **Mobile base**
- **ROS2** with **Python** SDK
- **Open-source** (hardware & software)

Commercially available since 2020. Mostly used today as a **research platform** (>60 units in labs all over the world)

Designed for both physical and social interactions



WHY A TELE-OPERATION APP?

Often hard (even for ourselves!) to know if the robot will be able to perform a specific task.

Test on the field in minutes.

Prototype applications.

→ Towards autonomy? - Learning by demonstration using experts data.



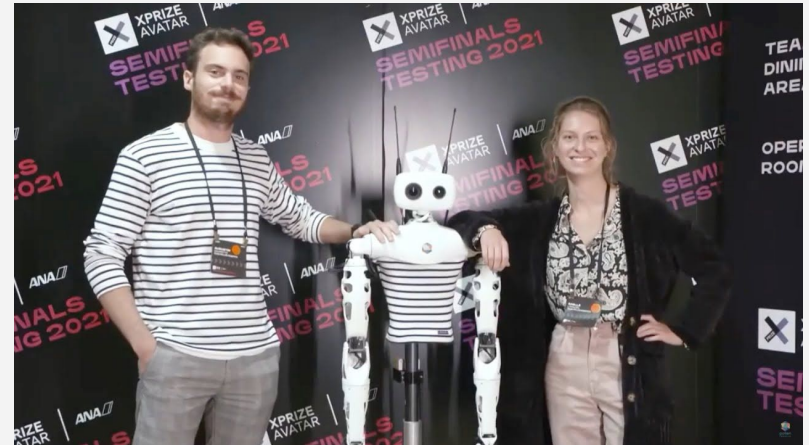
Used without any modification for the semi-finals (hardware or software)!

Was set-up in minutes.

Our goal was reached! A versatile platform that can be easily deployed in real world applications.

Limitations

- no haptics
- small payload
- basic gripper
- no stereo-vision



Finals tests specifications

- way higher payload
- haptics is mandatory

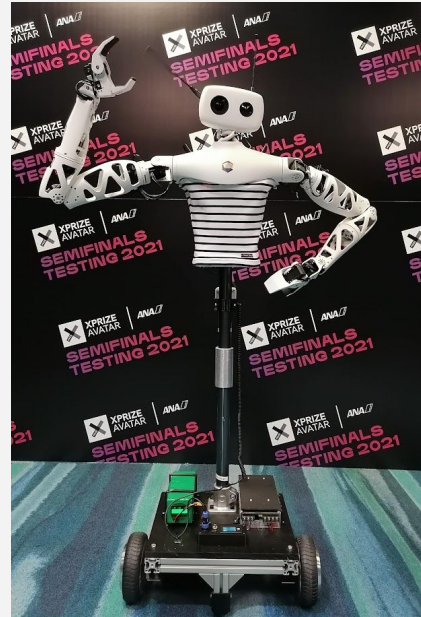
→ We need a new arm!

Buy a cobot arm?

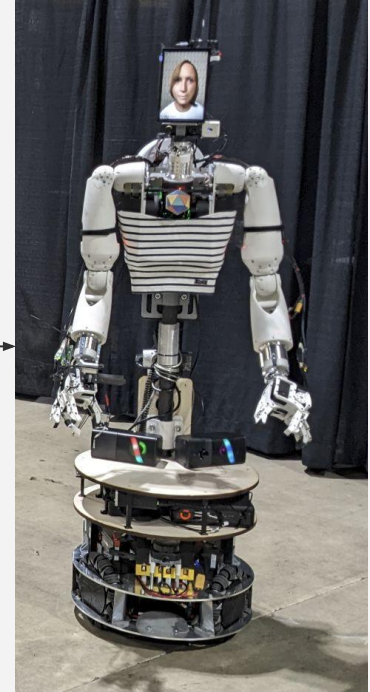
It's on our roadmap but we still haven't start prototyping.

We can only afford a two months rush of the team.

Semi-finals

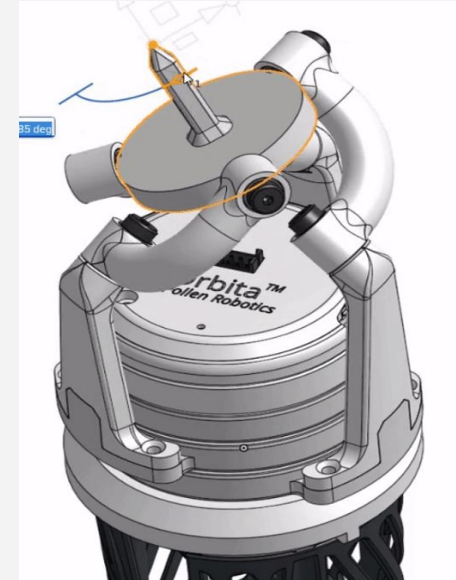
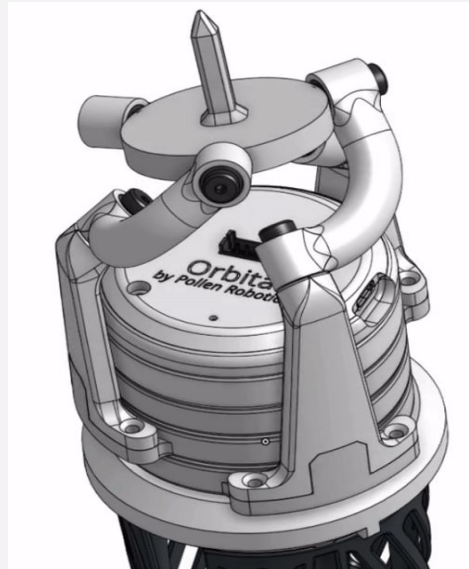


Finals



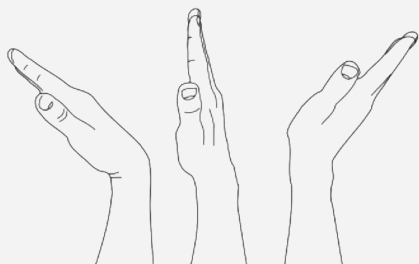
3 DoF spherical parallel actuator

Real rotation on one point - biomorphism - direct quaternion control
More efficient - the three motors share the load

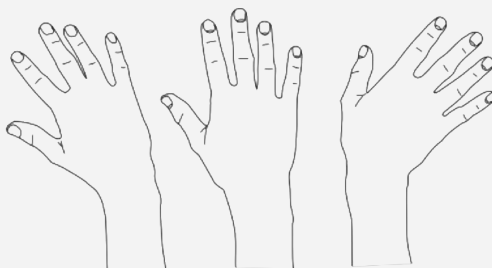


First tested as a neck but was designed to be a wrist!

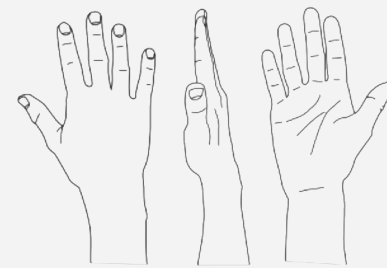
3DoF spherical parallel actuator



Flexion / Neutral / Extension
(75°/75°)



Radial Deviation / Neutral / Ulnar Deviation
(20°/45°)



Pronation / Neutral / Supination
(76°/85°)



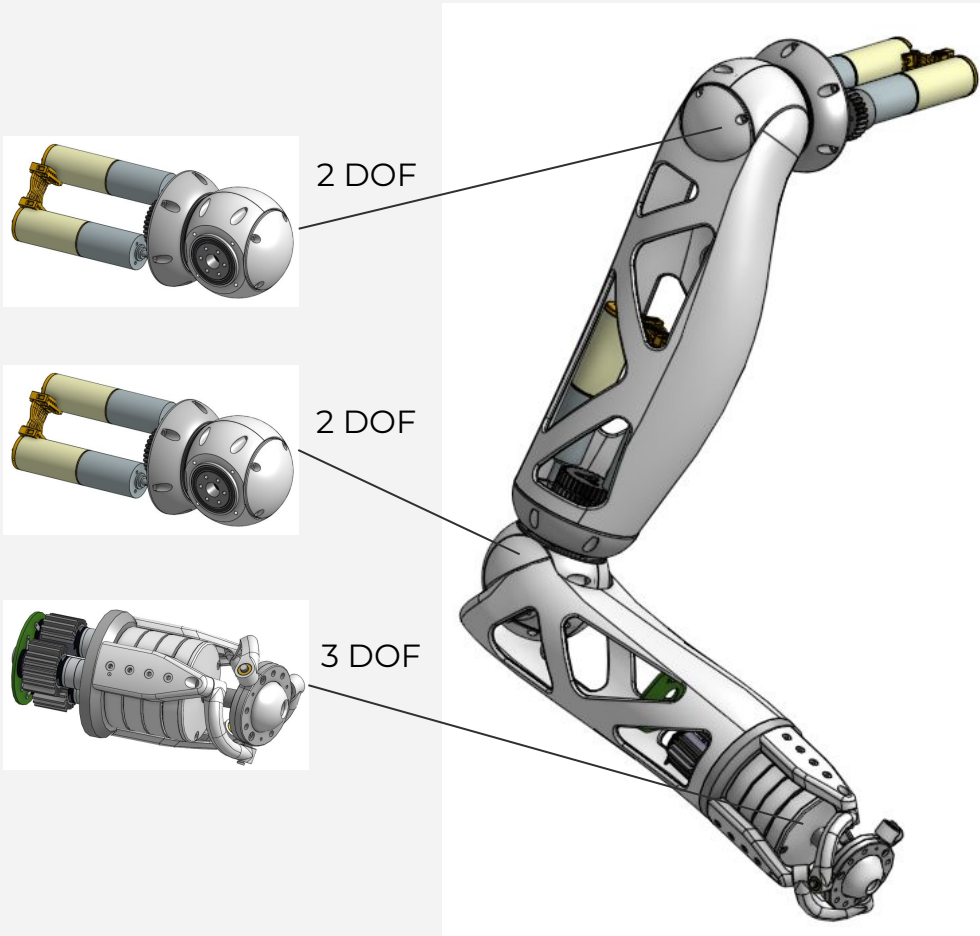
+/- 45° (in V1)

Up to +/- 60°
(depending on
the configuration)



Infinite rotation





Reachy v2 arm

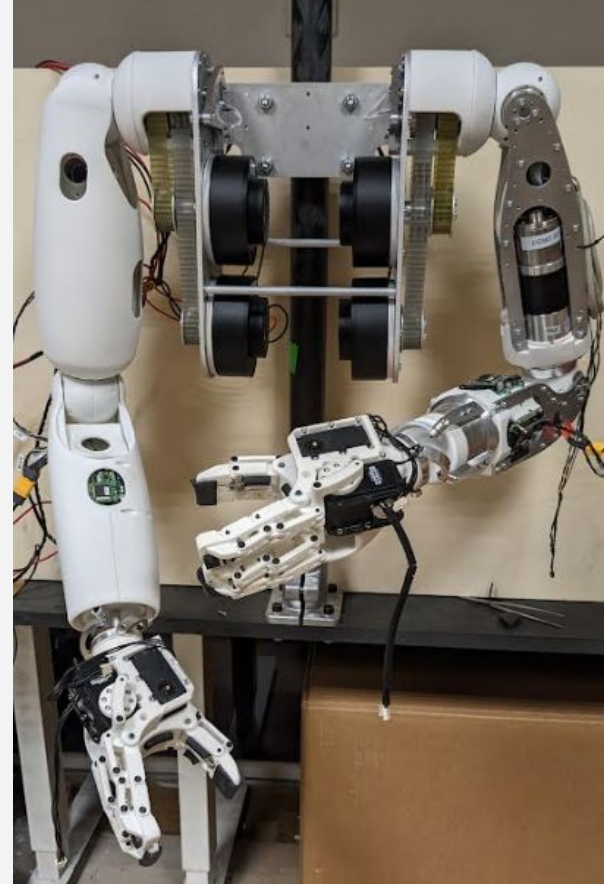
- Extensive use of **parallel actuators**
- Real rotation & bio-inspired so we can use **direct cartesian control** (form of morphological computation)
- Highly expressive (large range of motion)
- Weight is as high as possible (motors of the shoulder are not carried by the arm)

Delays are too short to order specific motors, so let's use the ones we have!

Shoulders and elbows are oversized. Need to use belt for the shoulders

No spare!

Full 7dof generic/versatile arm with about the same range of motion than a human one...





...Sometimes specific design goes a long way, real quick.

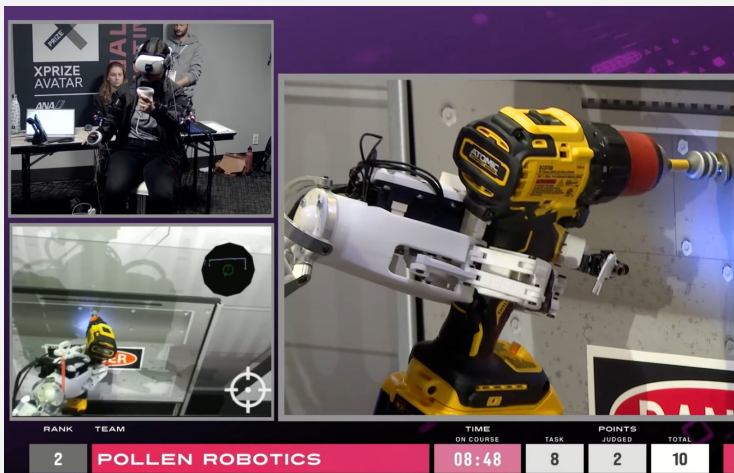
No time, money or control ability for a five fingers hand..

A gripper designed specifically for the tasks and the objects - a finger for the trigger (2 weeks for 2 people)

No real force control

Semi-passive mechanism

BOM ~750\$



DESIGN THE ROBOT TO MAKE THE INTERFACE SIMPLER

- **Match the robot capacities with the control and interface capabilities (many robots were more capable than Reachy but way harder to use).**
- **Direct cartesian control of the arms and the head! We did not use/need anything fancy.**
- **Having a small and focused team probably helped preserving an homogeneous and balanced solution.**

Thank you

Questions?

