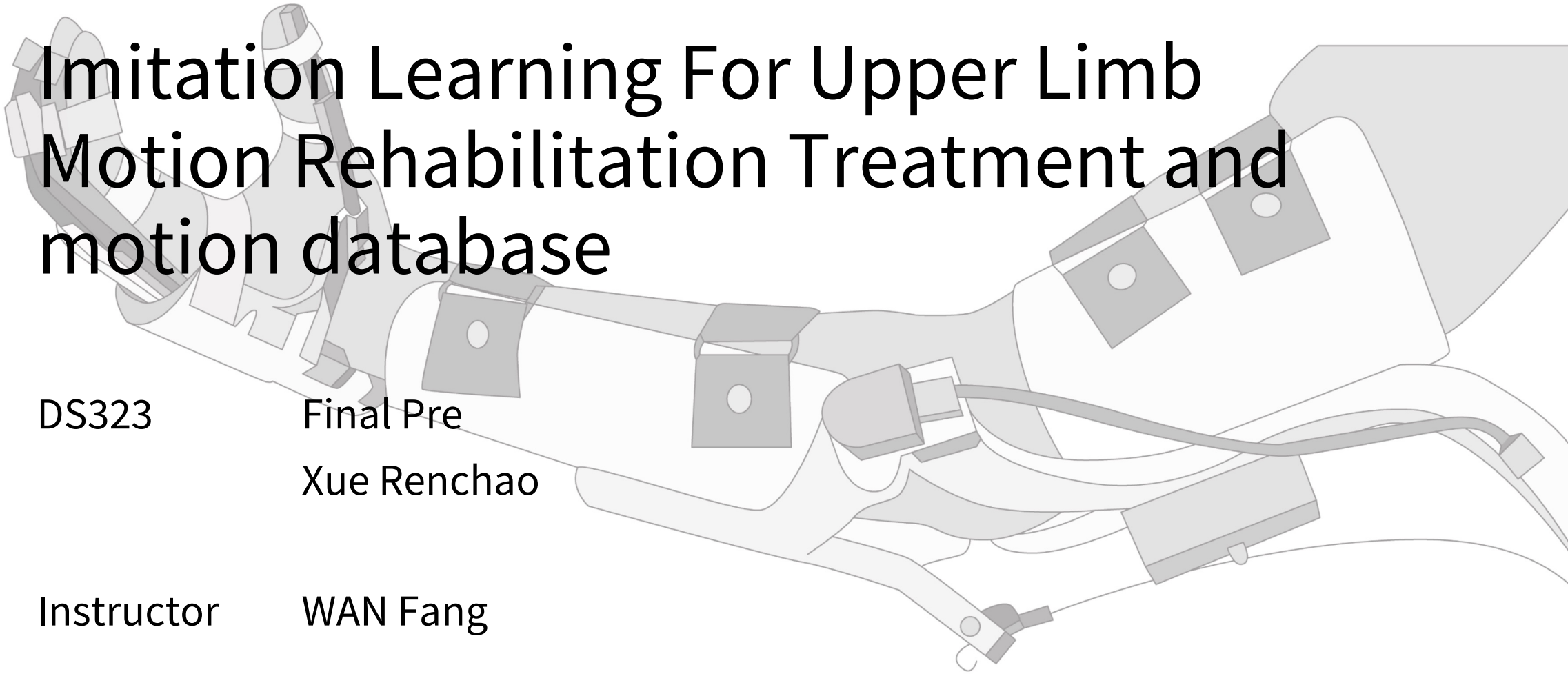
Imitation Learning For Upper Limb Motion Rehabilitation Treatment and motion database



DS323 Final Pre

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Preparation

Current researches and products

Prosthetics

The man-machine comfort. For complete relax in the recovery process can help enhance recovery effect, it requires equipment should have good **comfort** and can't make the patient produces psychological resistance. (Kang et al., 2016)

… poor controllability and **lack of sensory feedback**. Owing to the absence of tactile sensory information, prosthetic users must rely on incidental **visual and auditory cues**. (Mastinu et al., 2020)

Rehabilitation plans

Traditional **therapist-based** post-stroke rehabilitation requires long sessions of rehabilitation training and a significant amount of human labor leading to high costs, rendering it **impractical** and **unaffordable** for many physicians and patients.

https://www.youtube.com/watch?v=E_tRXuZniv4

https://www.youtube.com/watch?v=jrmVr66AlLI

Why using machine learning?

- Difficulty & complexity in some motion
  e.g. water bottles are often slippery, easily deform, and contain moving contents
- Shortness of step-by-step process, rigid
- Personalization vs. “standard motion”

https://www.youtube.com/watch?v=xynE-43trQg

Compared with traditional therapies, robot-based methods hold clear advantages, such as **precisely controlled** force-feedback, objective and **quantifiable measure** of subjective performance. (Hsieh et al., 2014)

… improved accuracy and reduced variance, which means the **reduction** of requirements on the **size of targeted subjects**. (See et al., 2013)

Robotic devices can be controlled **remotely**, enabling one therapist to conduct rehabilitation for two or more patients at the same time, resulting in a significant improvement of **efficiency**. (Huang et al., 2016)

Hsieh YW, Lin KC, Wu CY, Lien HY, Chen JL, Chen CC, et al. Predicting clinically significant changes in motor and functional outcomes after robot-assisted stroke rehabilitation. Arch Phys Med Rehabil 2014;95:316–21.
See J, Dodakian L, Chou C, Chan V, McKenzie A, Reinkensmeyer DJ, et al. A standardized approach to the fugl-meyer assessment and its implications for clinical trials. Neurorehabil Neural Repair 2013;27:732–41.
Huang, X., Naghdy, F., Naghdy, G., Du, H., & Todd, C. (2017). Robot-assisted post-stroke motion rehabilitation in upper extremities: a survey. International Journal on Disability and Human Development, 16(3).

Aim

- To make an artificial limb program implementing personal preferences without body-implanted detectors
- Abound the 'motion database' to benefit human studies
- Enable people to record a personal accommodated backup in case of accidents

Prototype focus: specified on representative motion – **to drink water**, and demonstrate in virtual condition

Prediction impacts

True positive

DEMO: Reach the bottle successfully & deliver it towards your mouth, slant in proper angle to make sure you can drink it comfortably

APPLY: Record the motion completely and add it to the collection to refine output motion

False negative

DEMO: Fail to hold the bottle / drop it before your drinking started

APPLY: Fail to record the whole motion thus unable to refine, keeping the data collection and its output unchanged

False positive

DEMO: Successfully moving the bottle, but pour in a wrong angle and speed, causing the danger of water inhalation

APPLY: Record the whole motion, but has fatal deviation from reality/safety, adding error to the refined system

True negative

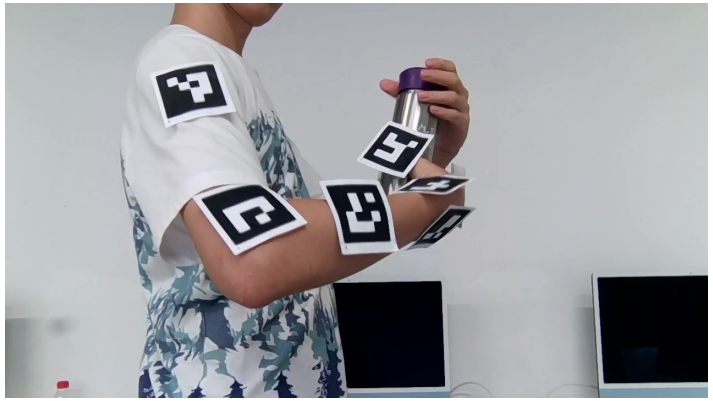
DEMO: Giving the order to hold the bottle for drinking, but instead it did other things like shaking the bottle

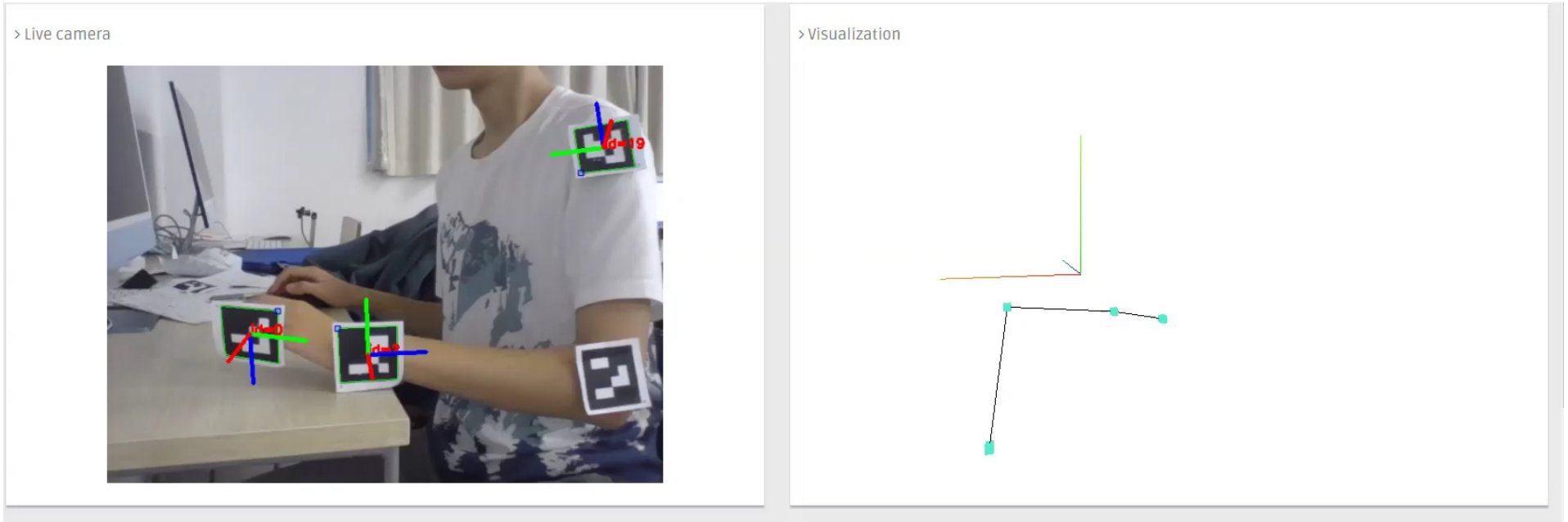
APPLY: Record another motion and add to corresponding dataset, doing no contribution to the target dataset, but no error introduced either

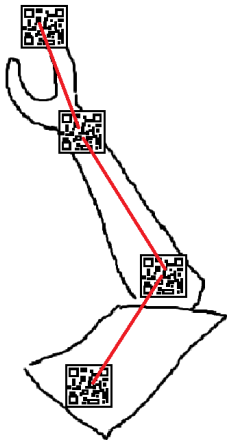
Data collecting

How to track upper limb

Location QR code & 3d identifying camera

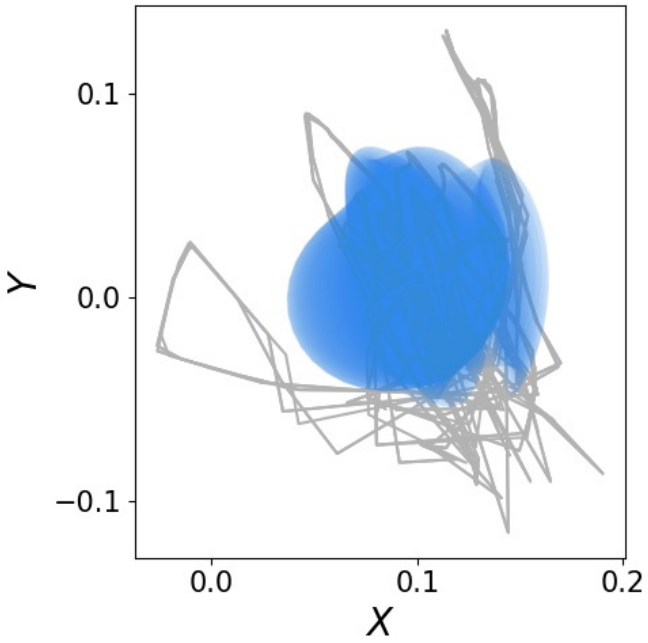


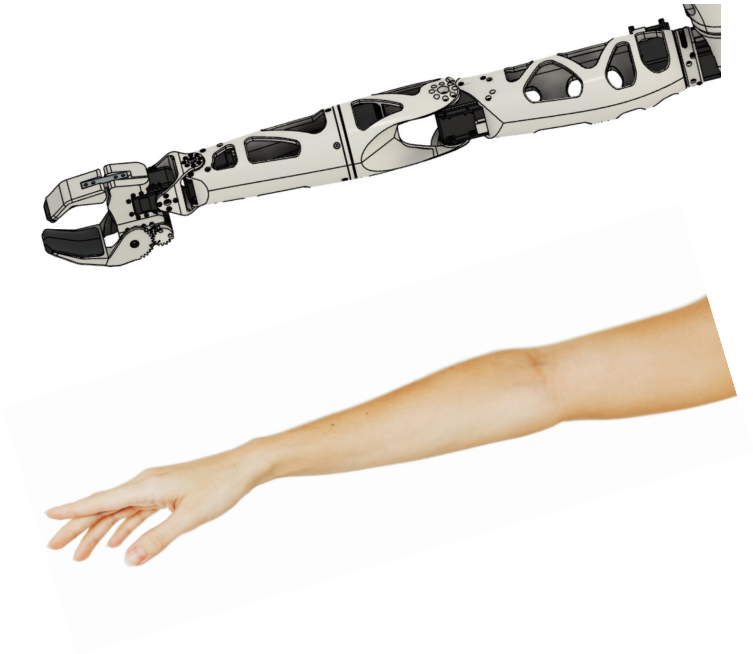




How to track upper limb

- Too many trackers – unable to trace – unable to generate a visible path
- Over vary in depth – does not fit AI model
- Human arm joints mechanism is not in accord with robotic arm

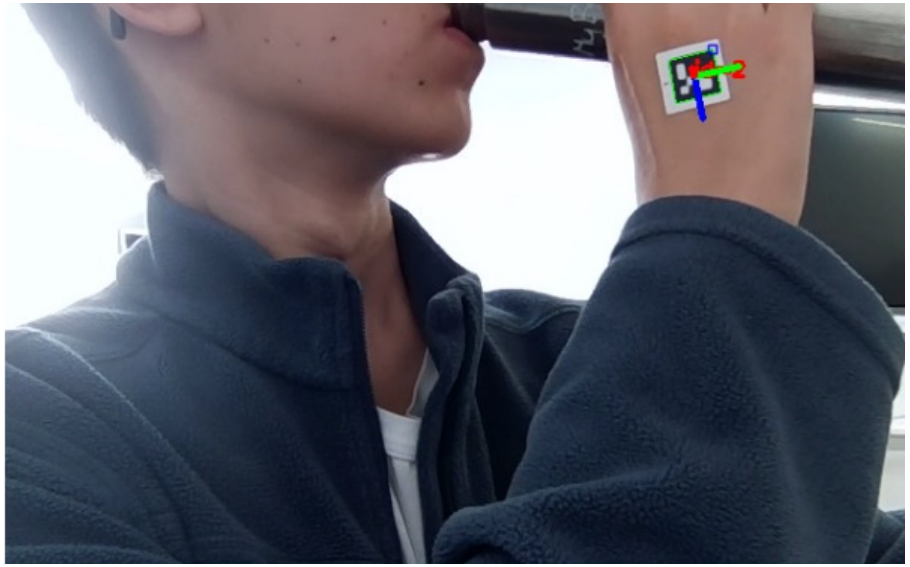




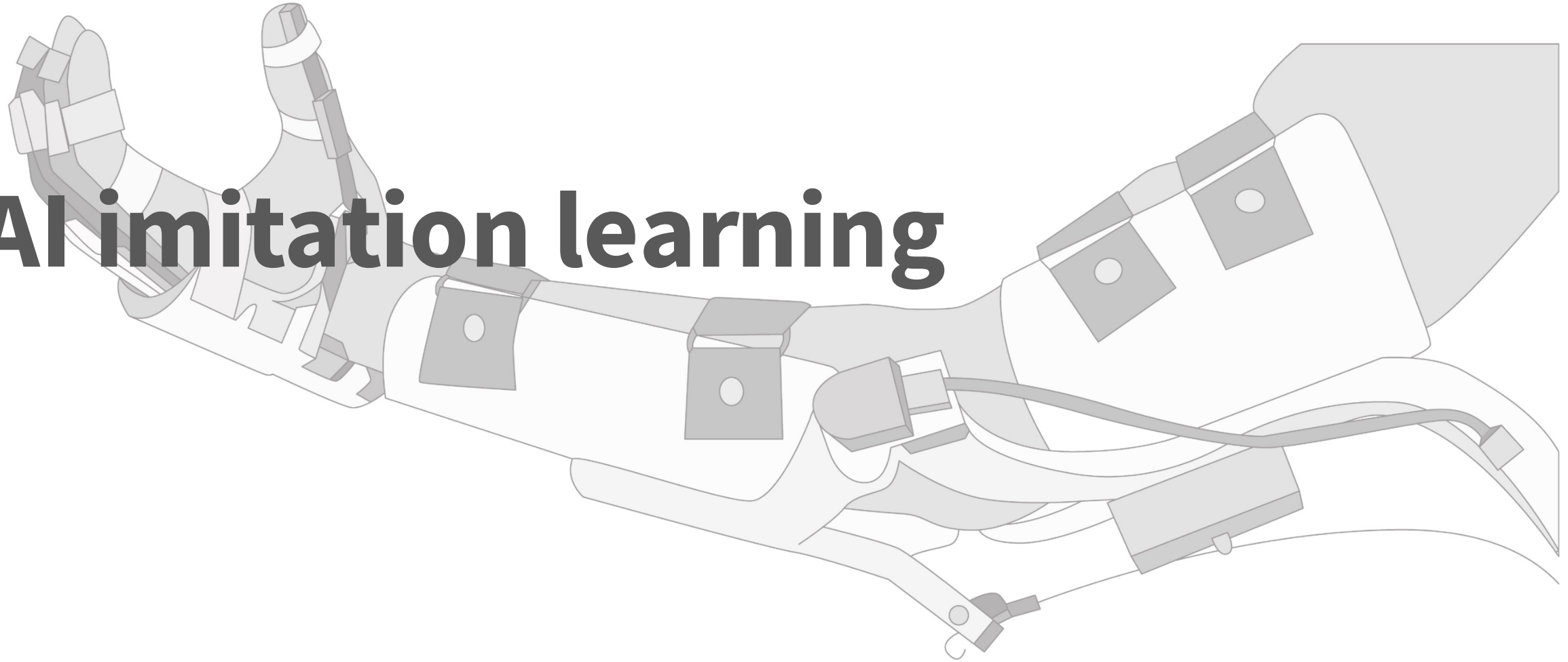
Alter

The motion can be measured by the location of hand, as the endmost destination of arm movement to reach objects.

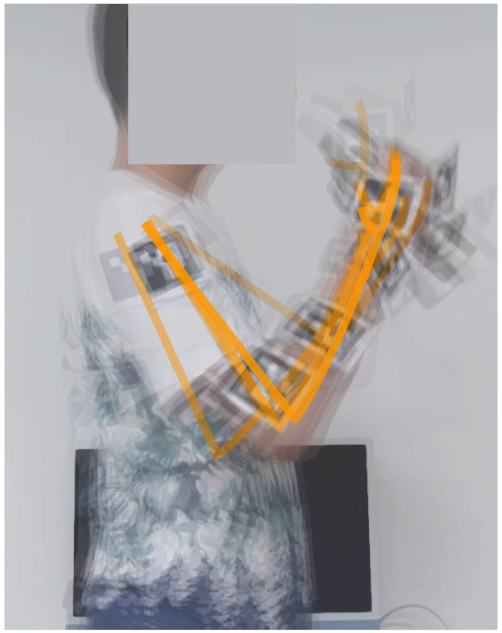
-> Use only 1 tracker to guide.



AI imitation learning

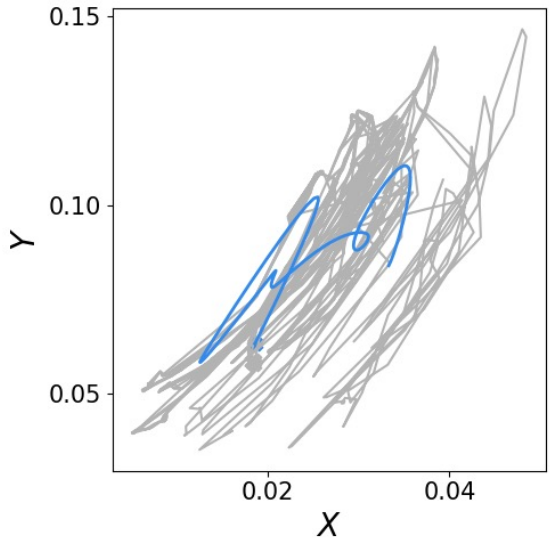


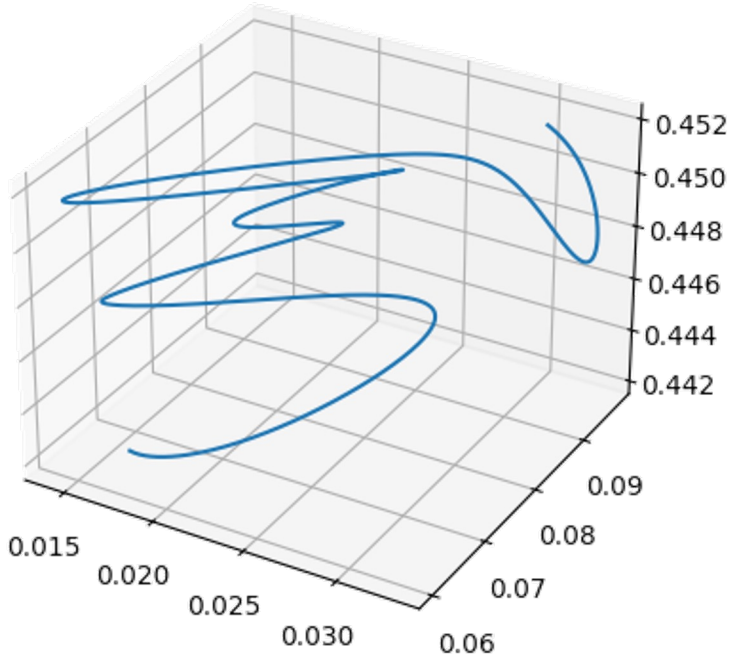
Outcome

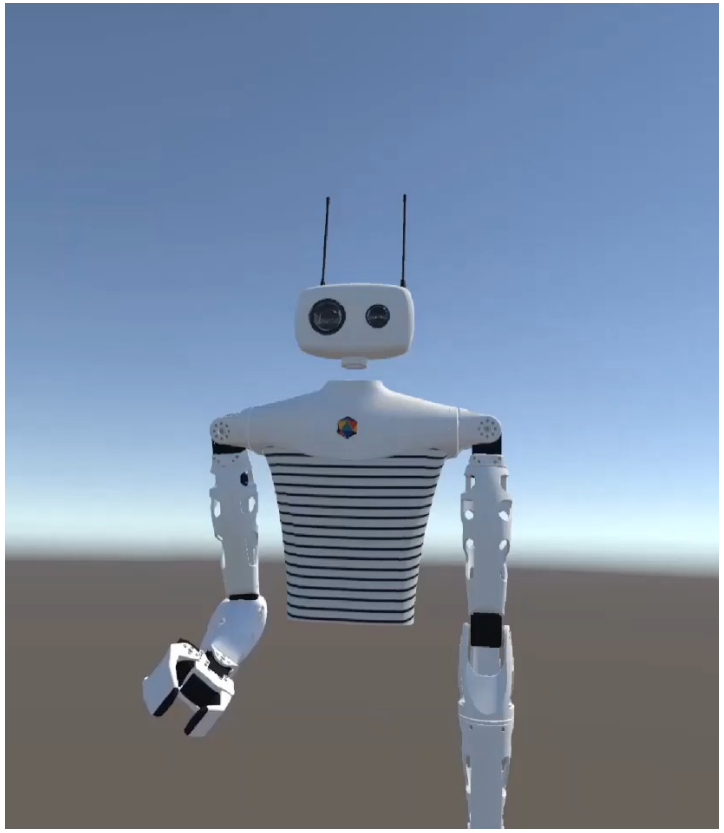


I.
Multiple trails
(indicating learning)

II.
Gaussian learning outcome (6-d,
3 spatial and 3 rotational)
displayed in projections

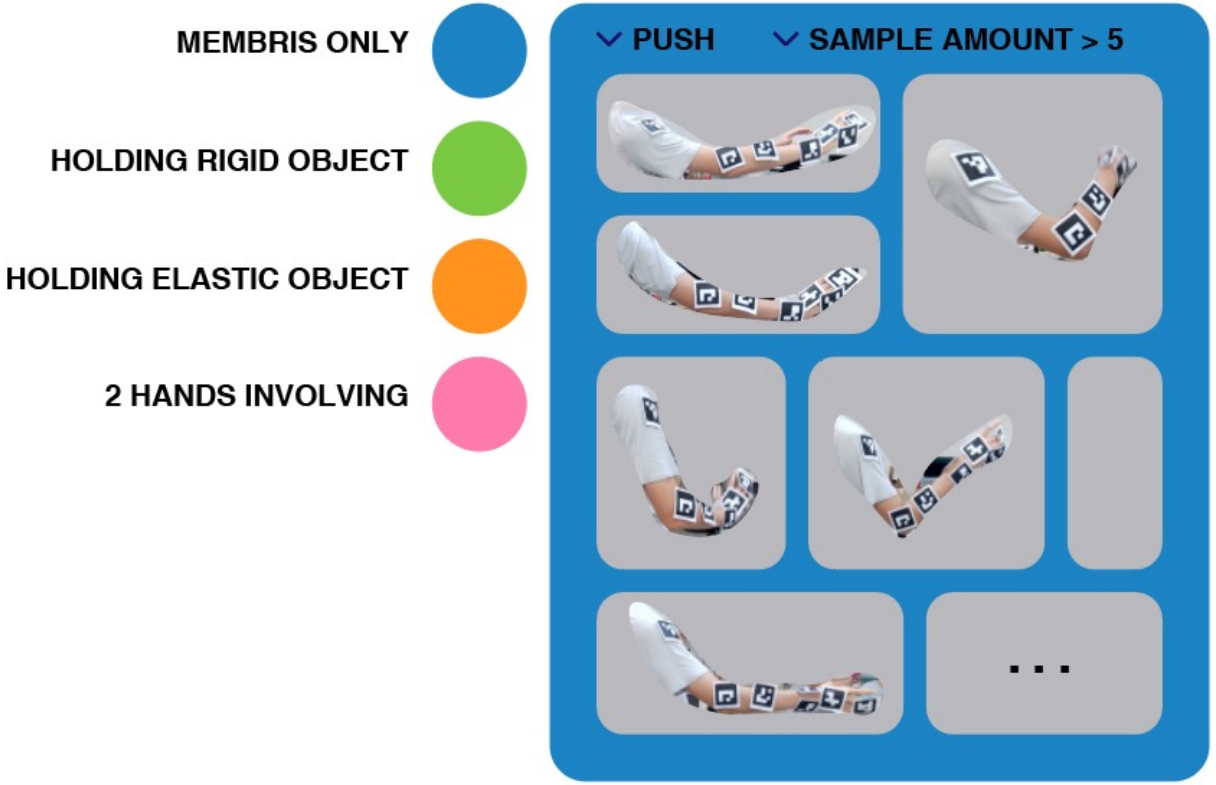




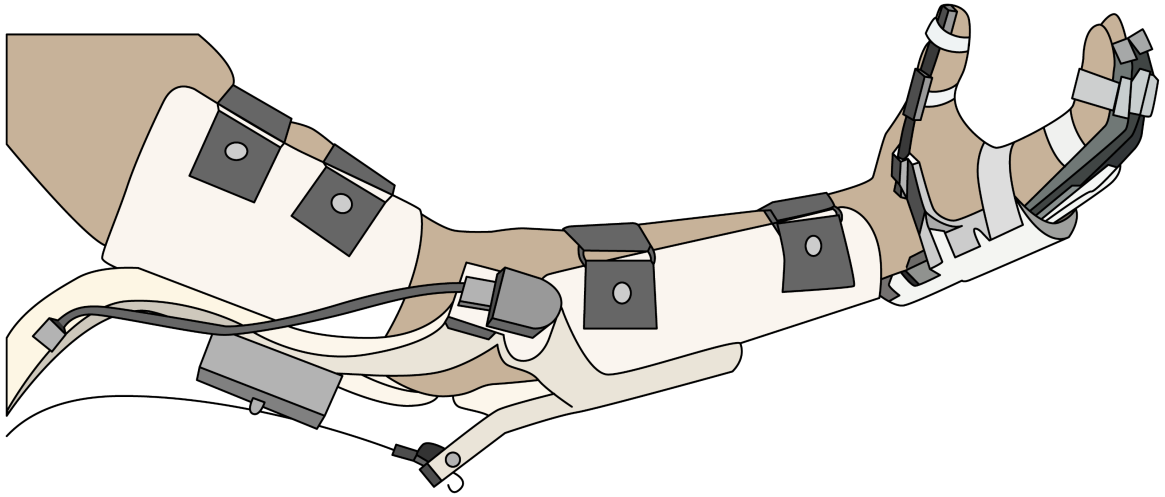


III.
Applied in Unity simulation
using Python SDK

How to display the dataset?



Be sure no personal info could be accessed without the uploader's permission.

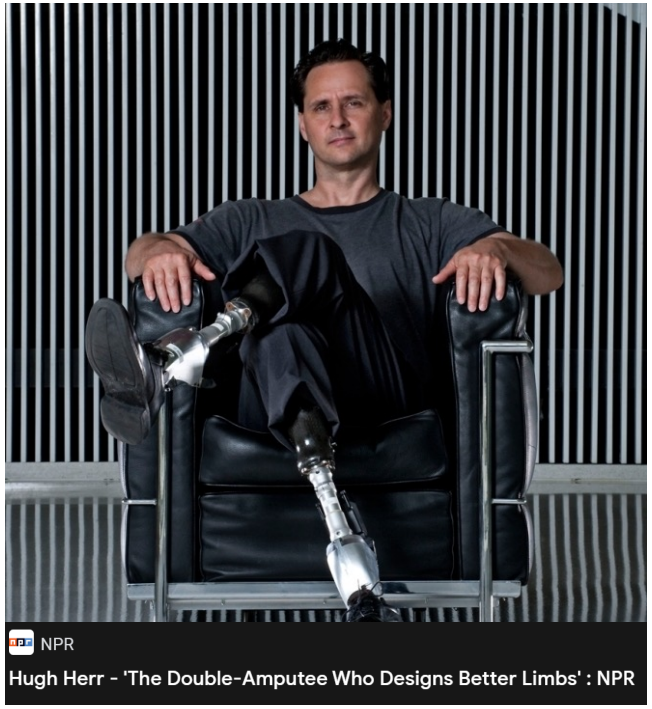


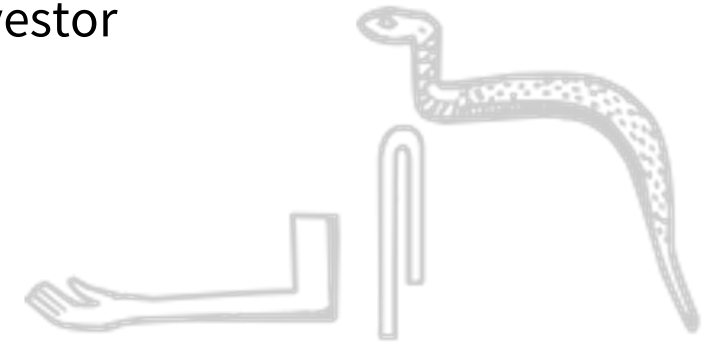
- Equipment is both for data collecting & rehabilitation aiding
- A sharing & progressing collection of body motion behaviors could be utilized for caretaking, rehabilitation and medical devices improvement

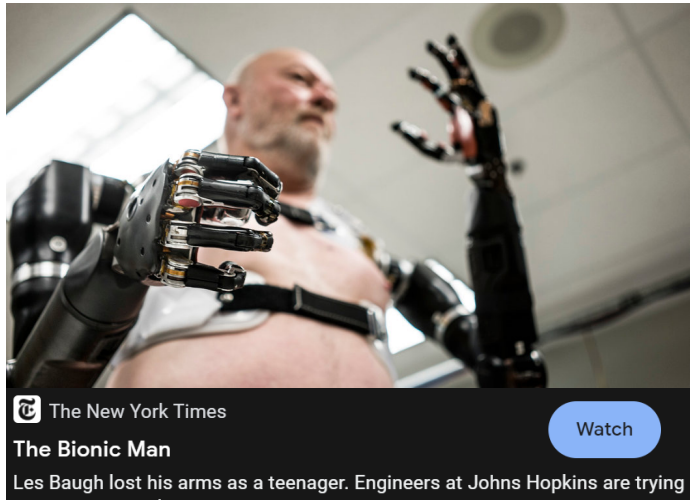
Reflections

The concepts beyond

- Potential neo-insurance investor
- Record yourself
- ‘Theseus man’



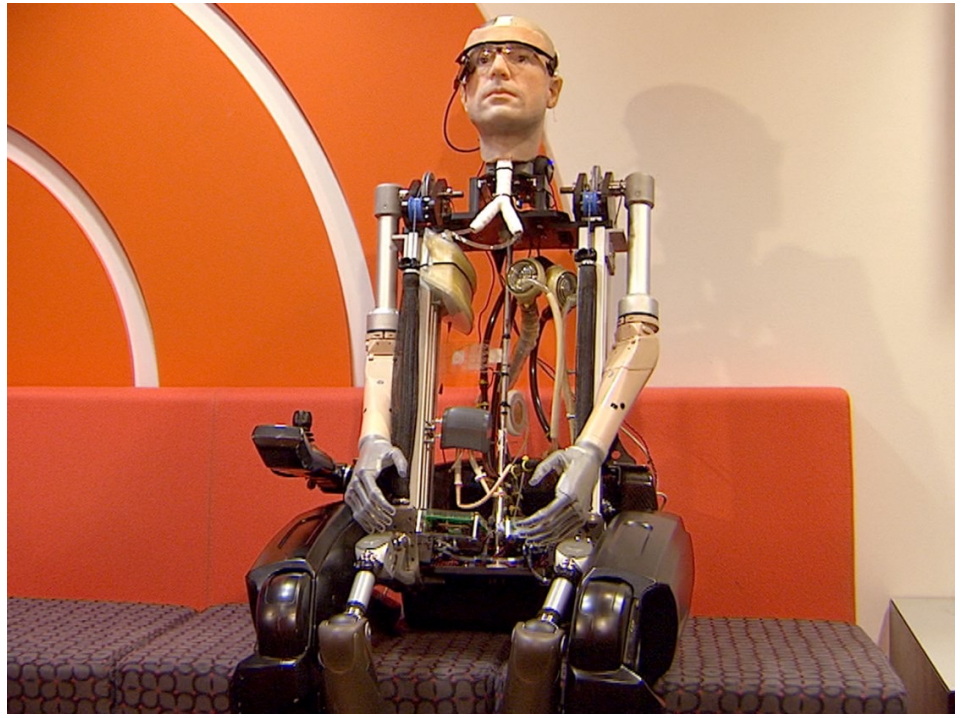




HEALTH & WELLNESS

Meet the bionic man: He's 100 percent prosthetic parts

Assembled completely from prosthetic parts, he has blood pumping to his heart, bionic hands, artificial eyesight and an exoskeleton that allows him to walk. Meet the bionic man, with 28 parts that are already in use in real humans combined together for the first time. He made an appearance on TODAY Tuesday with Dr. Bertolt Meyer, a German social psychologist at the University of Zurich and the h



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https://www.today.com/health/meet-bionic-man-hes-100-percent-prosthetic-parts-8c11395235

Thanks for listening