Robotics in Healthcare

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Advanced Robotics Centre

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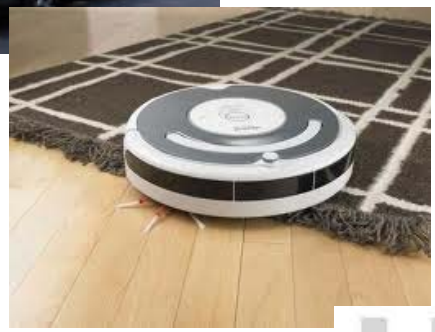
Moment of Great Opportunities



2000s

1980s, 1990s

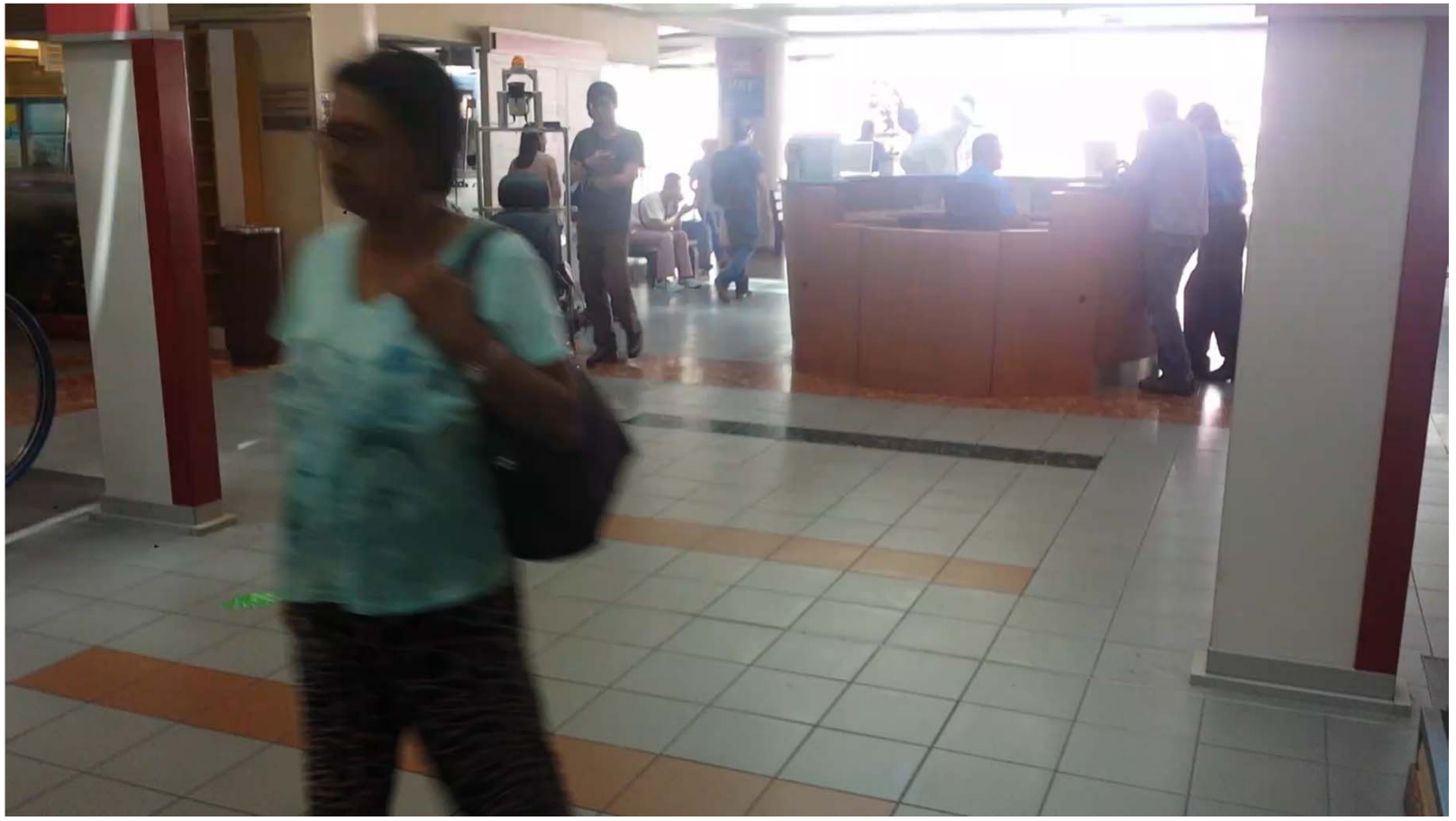
Toward Everyday Robotics

- Structured Environment
- Human-Robot Separation

- Unstructured Environment
- Human-Robot Interaction

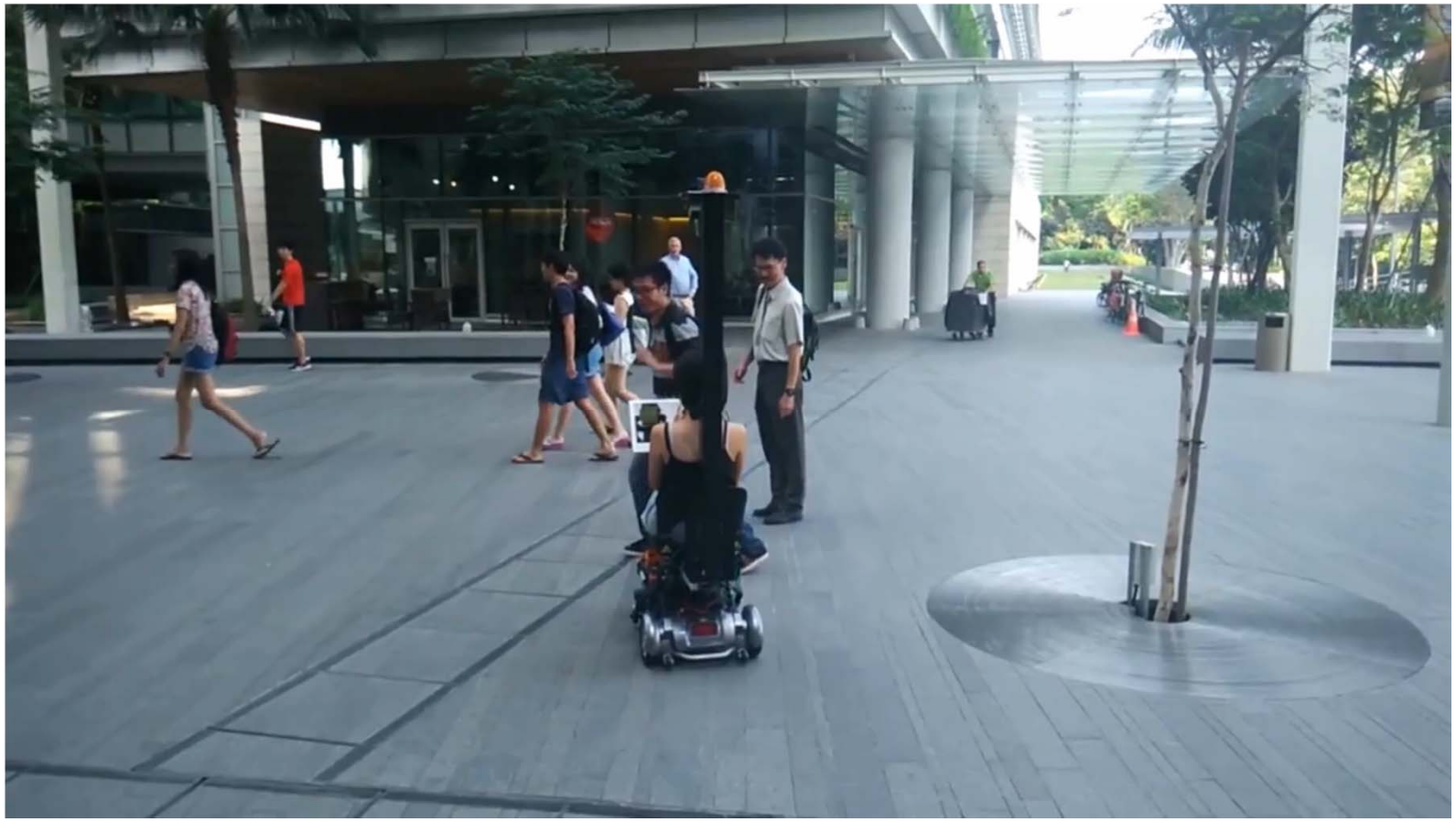
Factories designed for robots

Intelligent Robot Adapting to Spaces Designed for Humans



Autonomous Wheelchair in a Hospital Environment

Local Planning – our mobility scooter



Critical Needs

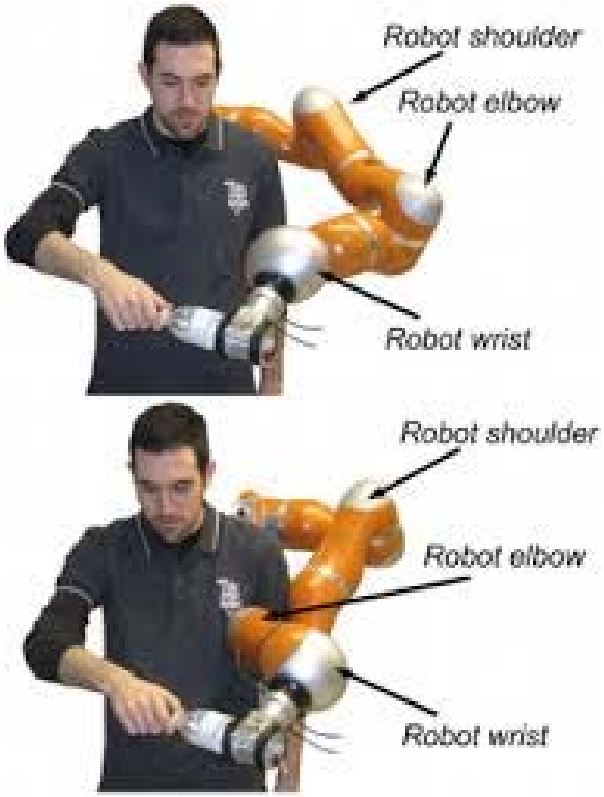
- ✧Improving Productivity
- ✧Ageing Population
- ✧Manpower for Higher Value Added Services

→ Robotics is a Key Solution

↳ The 5 D's

Human-Centered Collaborative Robotics

- Develop the generic scientific foundations, technologies and experimental platforms that enable natural interaction and collaboration between robots and humans
  - What is the right level of autonomy?
  - How best to interact and collaborate?
- Apply them to compelling areas
  - high societal and economic impact



Industrial Robots: From Structured Environments to Unstructured & Human Environments

- ✧Is Precision Motion Control Enough?
- ✧What is the role of Force Control?
- ✧Do we need new Design of Robots?
- ✧Do we needed higher forms of intelligence?

Robotics in our daily lives

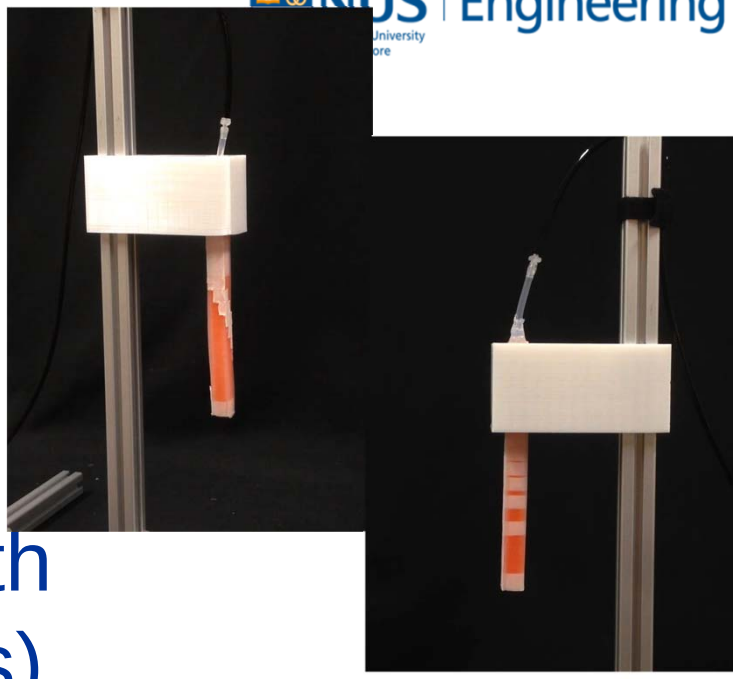
- Activities of Daily Living
- Social companionship
- Assistive Devices
- Exercise Devices
- Anytime, anywhere
- Hospital → Community → Workplace → Home

What's needed?

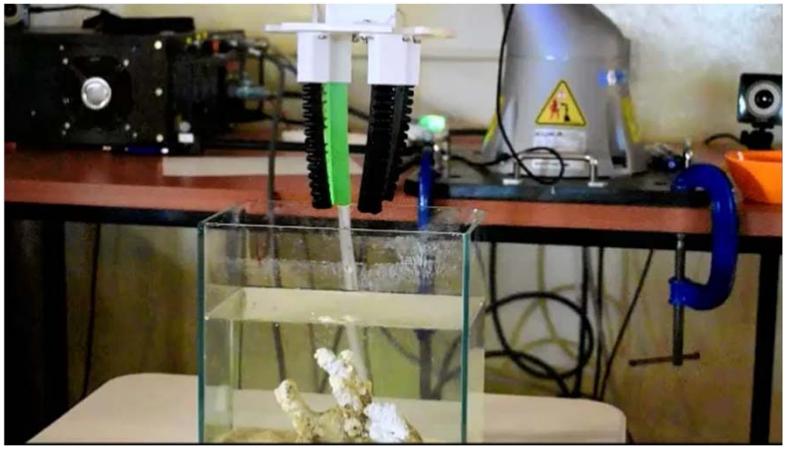
- Robotic Mechanisms
  - Inherently safe
  - Friendly
  - Easy to use
- Intelligence
  - Sensing and perception
  - Intelligent decisions and actions
  - Learning from experience (continuously)

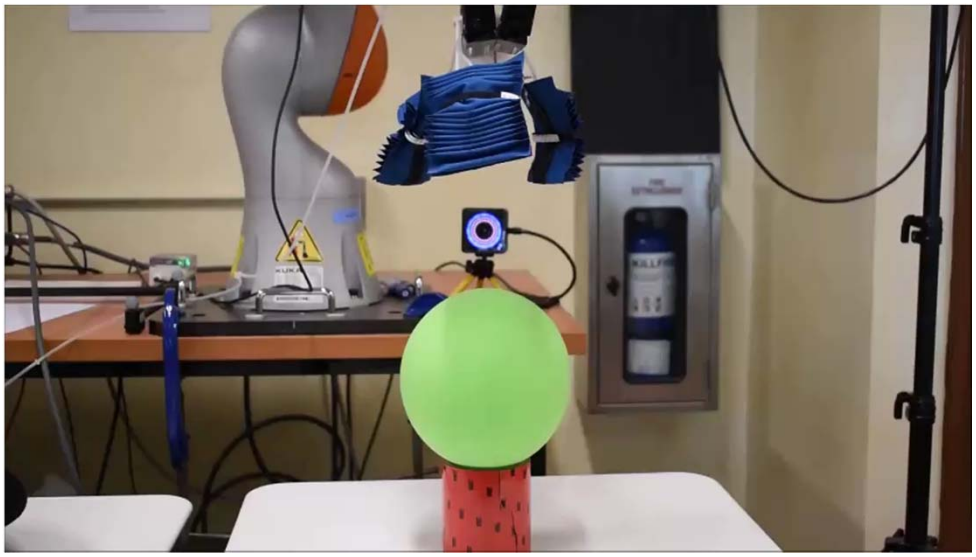
Soft Robotics

Mechanical Intelligence



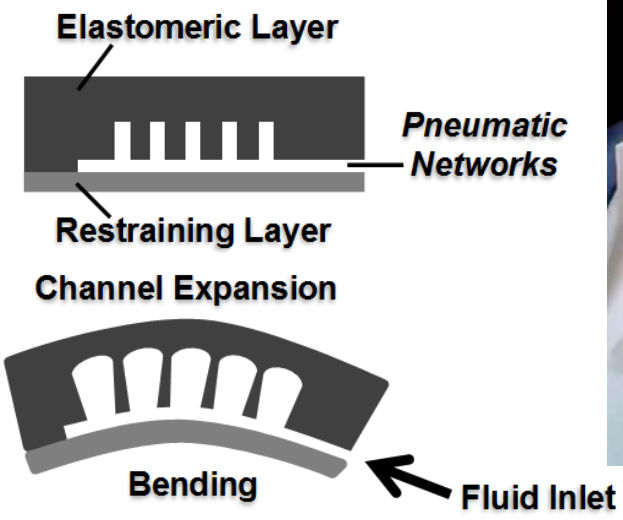
- Physical Embodiment
  - Intelligent Mechanics
  - Physically Soft and Compliant
  - Naturally comply to contact with environment (including humans)
  - Inherently safe



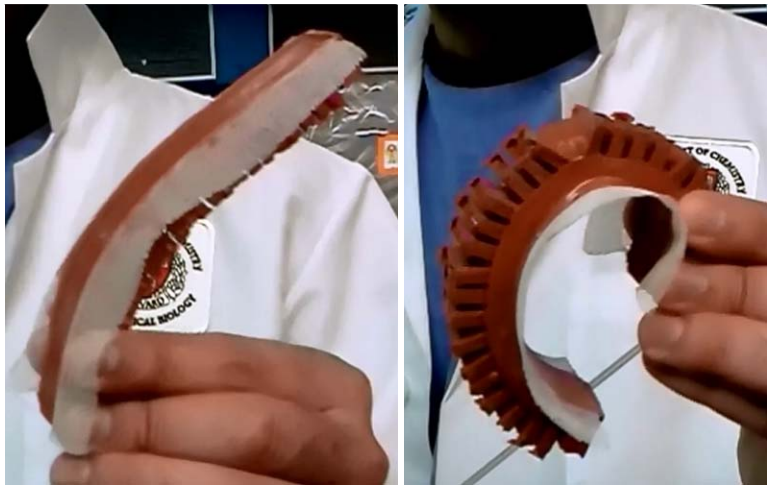


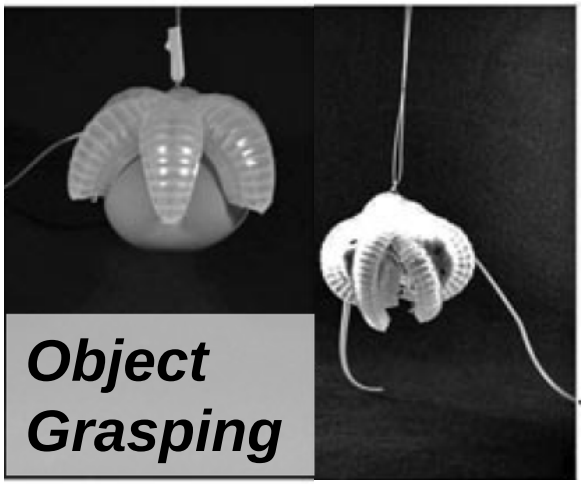
Soft Robotics

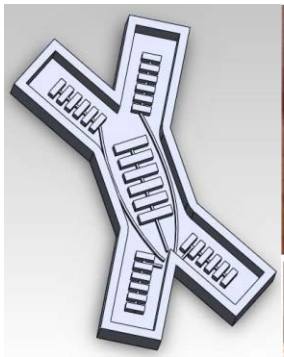
Concept

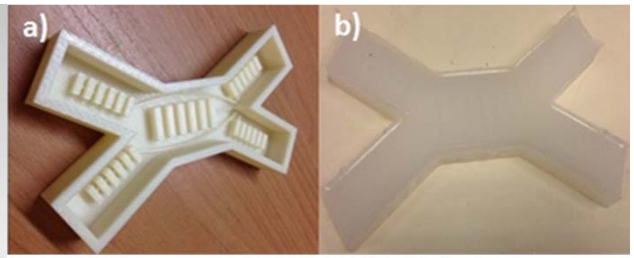


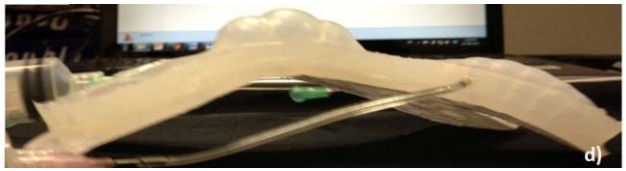
Pressure-based Actuation



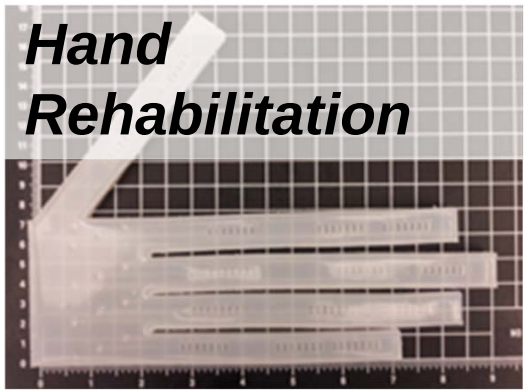


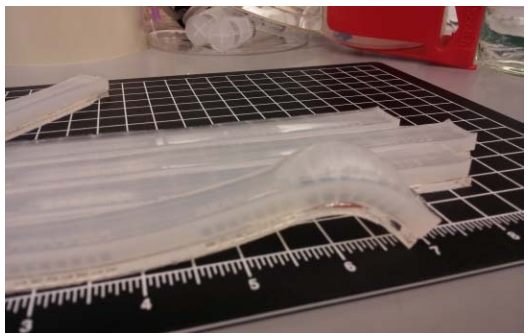






CAD
3D-printing
Mix & Cure





Why?

- *Compliant grasping*
- *Various actuations*
- *Scalable*
- *Mass production*
- *Quick fabrication*
- *MRI-safe*

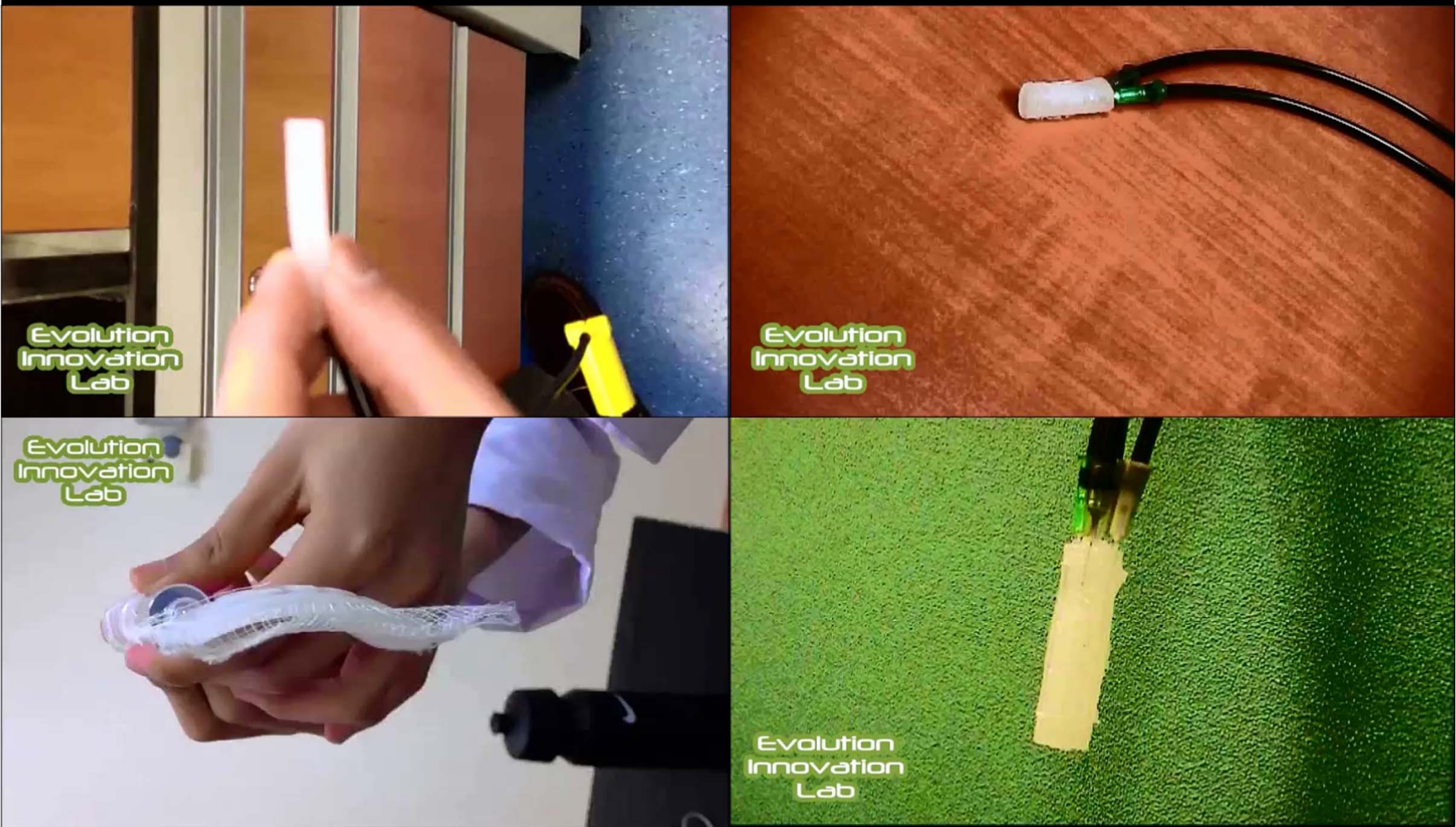
Applications

- *Grasping of organ or tissue structures*
- *Physical therapy*
- *Sensing and haptics*
- *Biodegradable*

Raye CH Yeow (PhD)

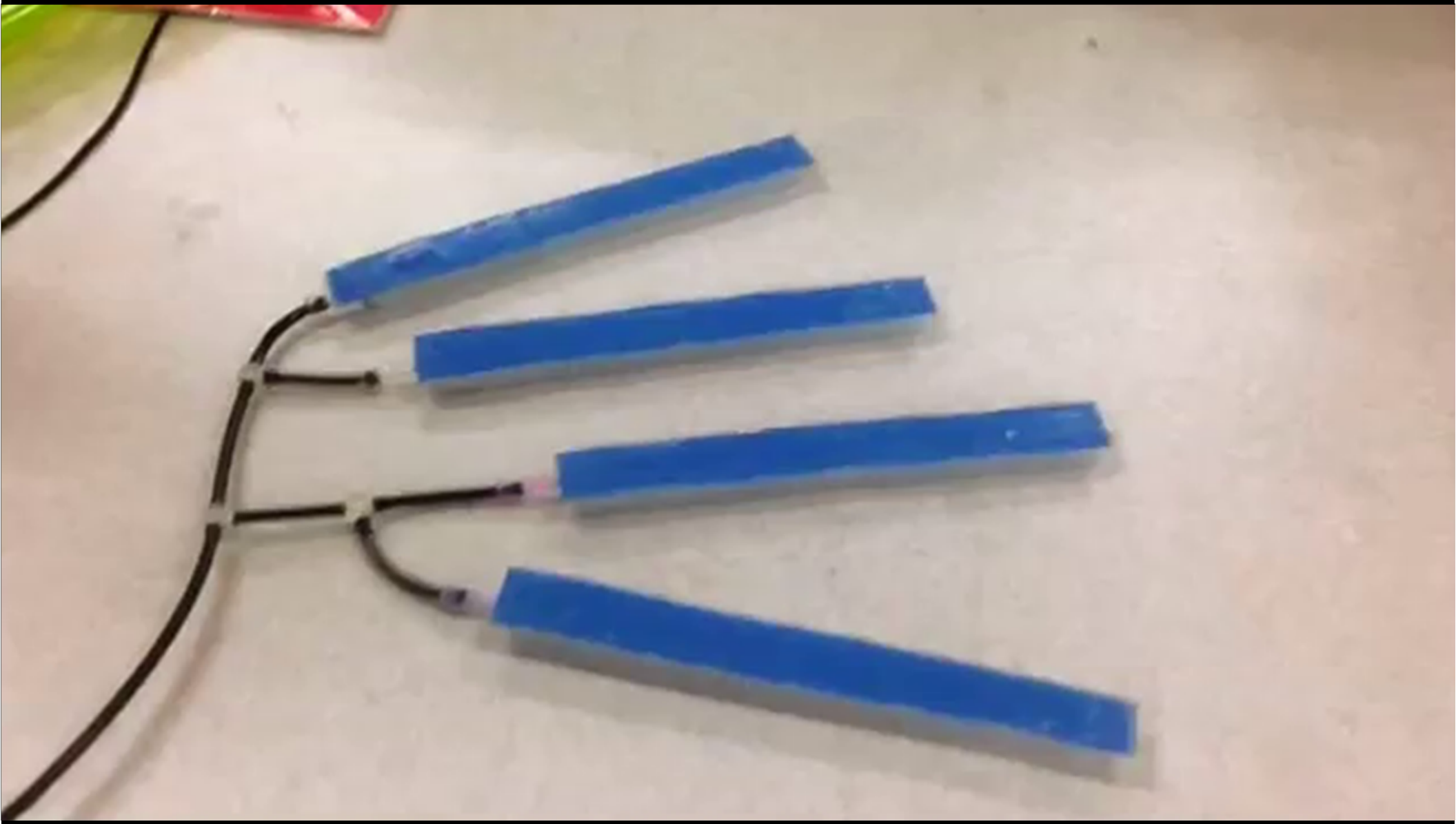
Evolution Innovation Laboratory, Biomedical Engineering/SP-ARC

Soft Actuators



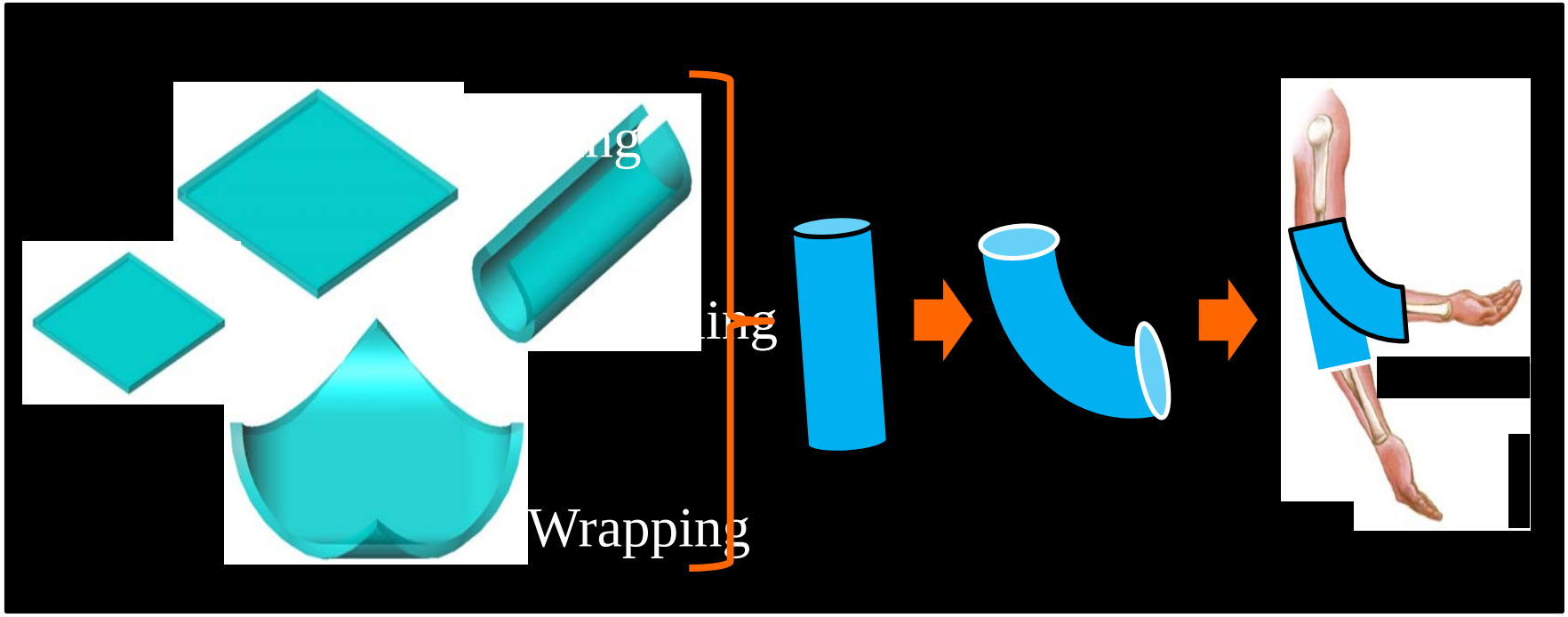
Soft Robotics. Extending.

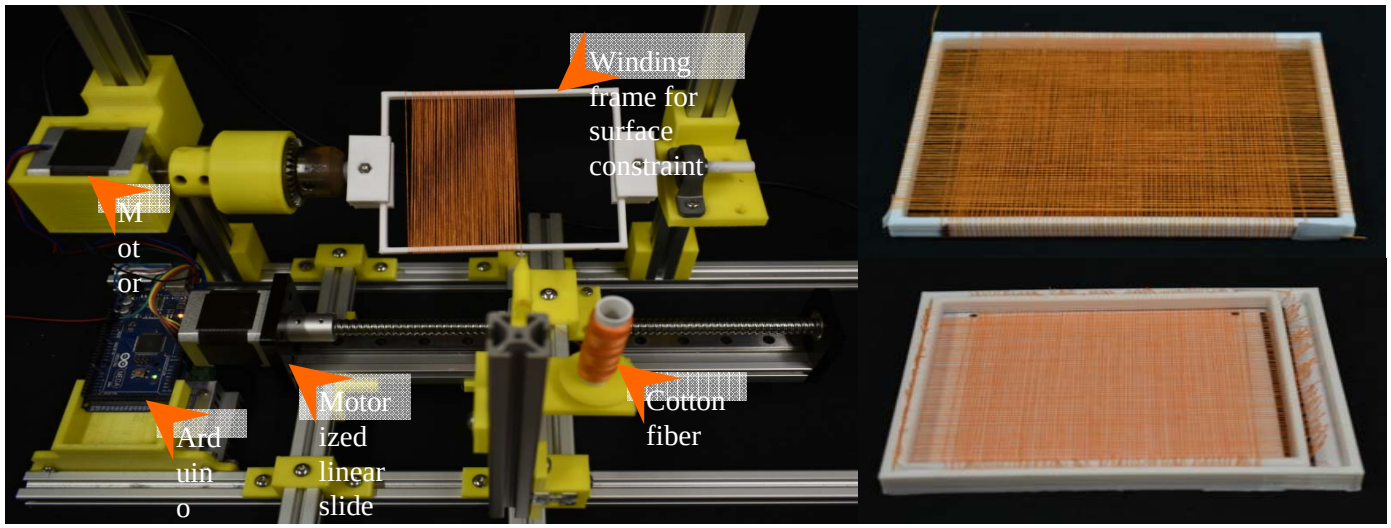
Soft Robotics. Bending.



Soft Robotics. Crawling.

Soft Active Sheets



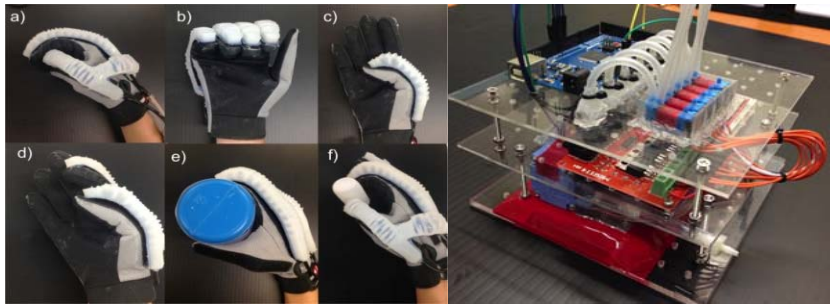


Assist

MyoGlove

Soft Myoelectric Robotic Glove for Assistive Applications

Assist



Assist

MirrorGloves

Soft Sensor-Robotic Gloves for Mirror Therapy

Assist

ExoSock

Robot-assisted Ankle Therapy

NUH National University Hospital

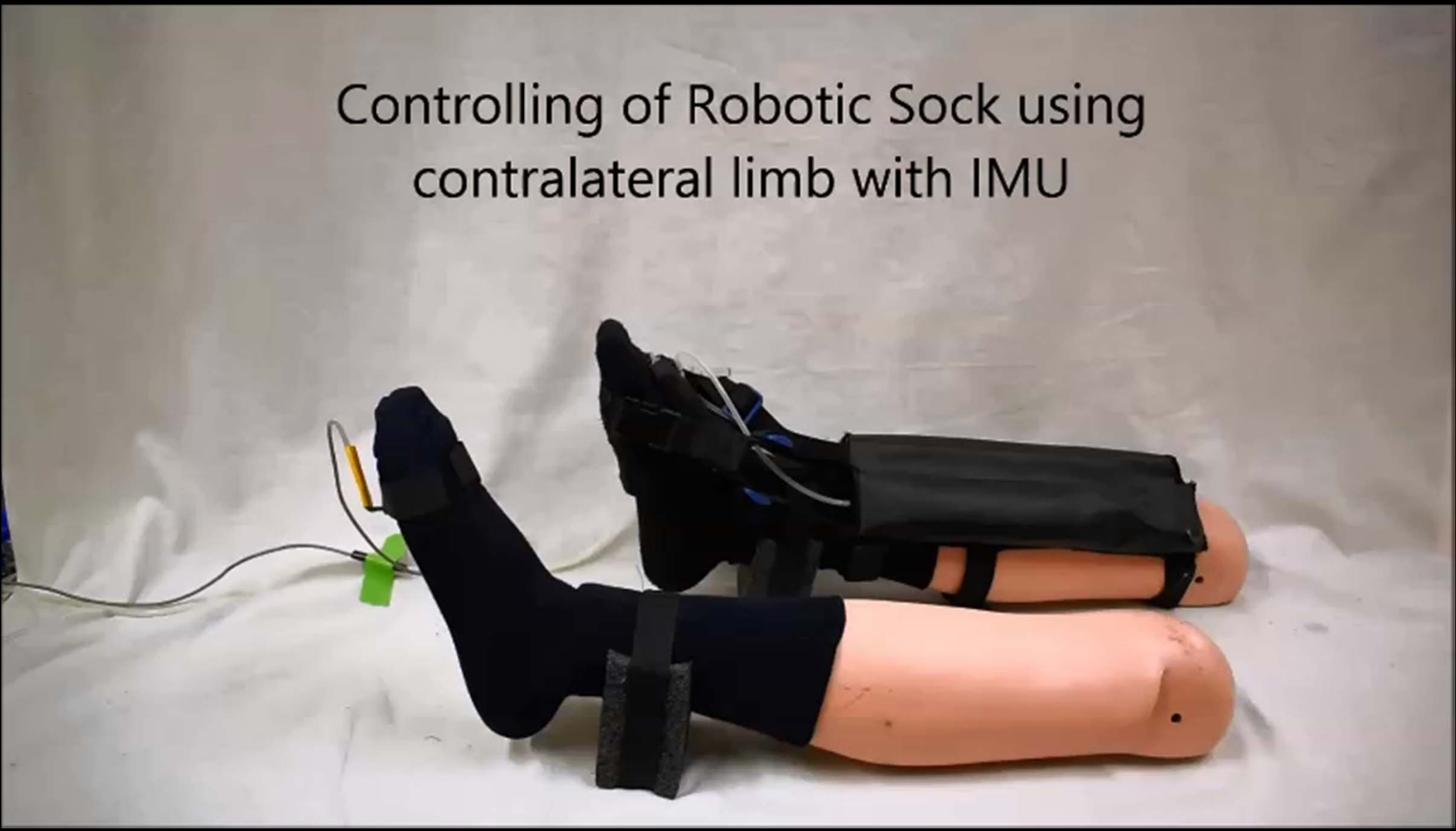
NUS National University of Singapore | Department of Biomedical Engineering Faculty of Engineering

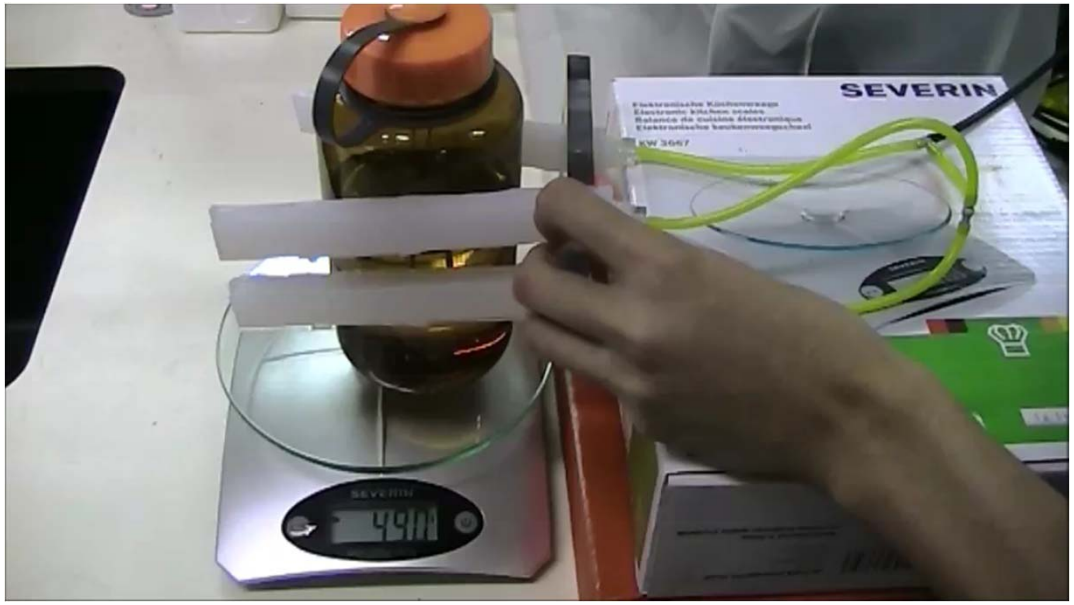
THE STRAITS TIMES

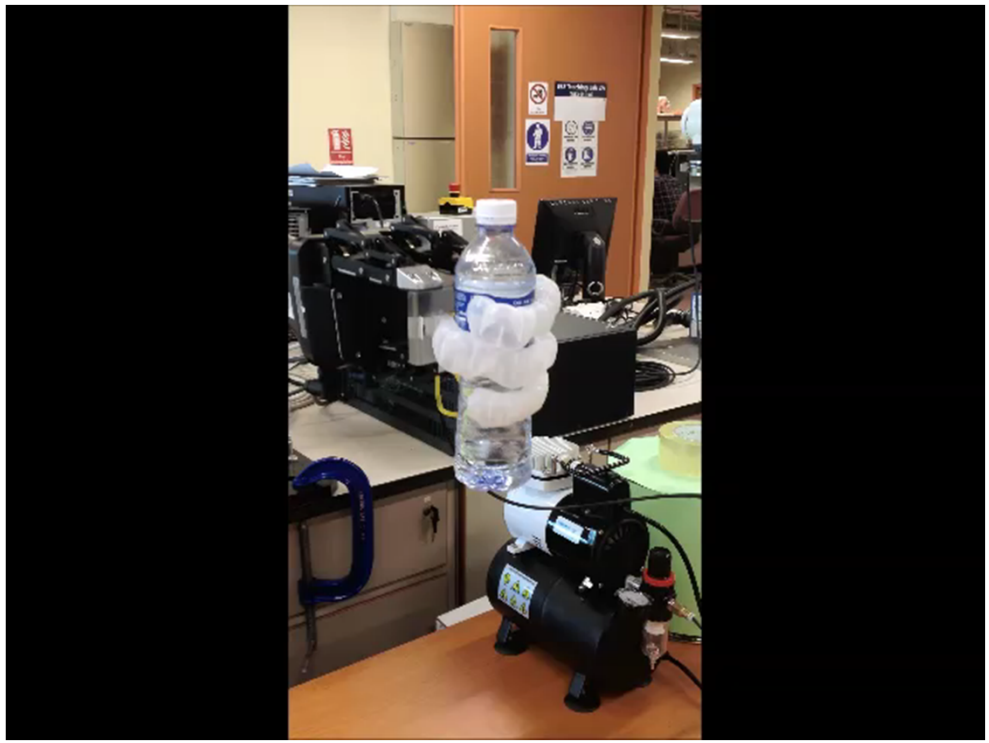
Assist

MirrorSocks

Soft Sensor-Robotic Socks for Mirror Therapy







Soft Grippers

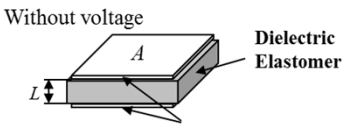
3D Printing – “Ninjaflex”

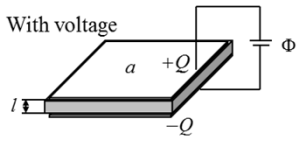
A third Arm?

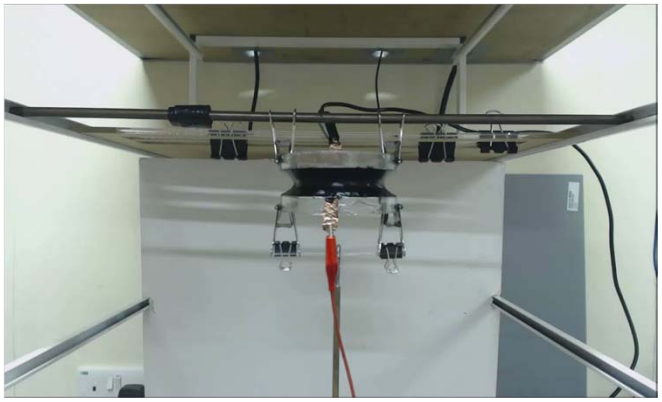
Fully-Fabric **Soft Robotic Tail**

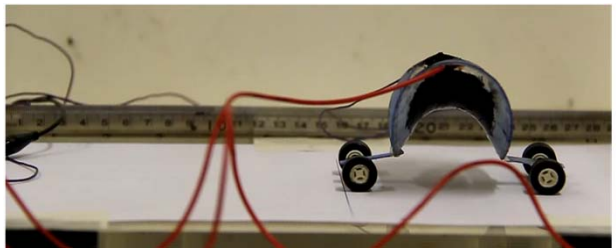
Hardware: Intelligent Mechanics

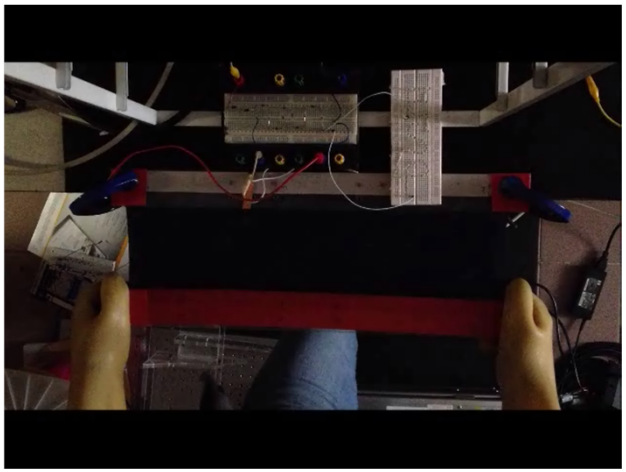
Dielectric Elastomers
3M VHB 9610 (double sided tape)



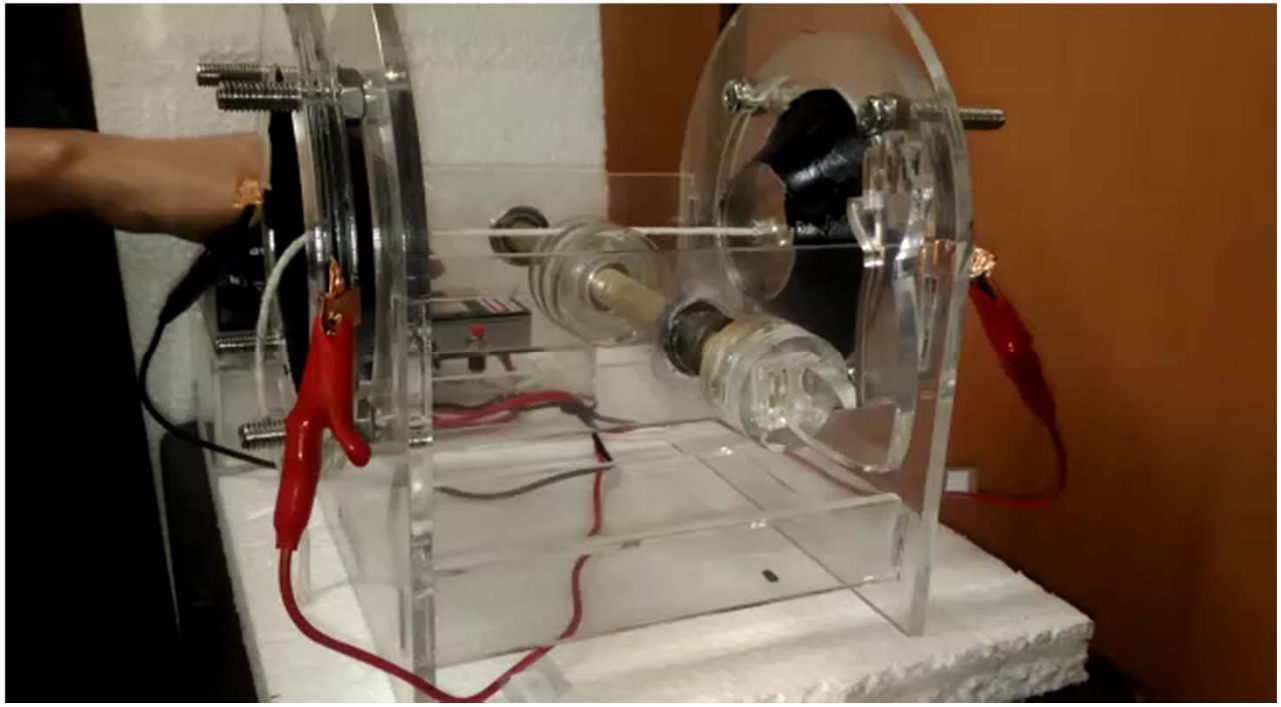




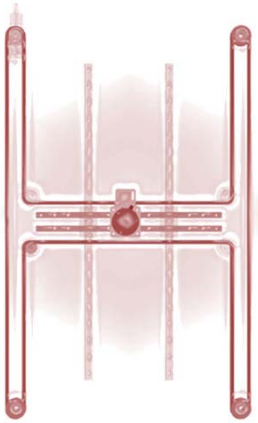




With Zhu Jian and Adrian Koh



with Adrian Koh Soo Jian



-Man

Domenico Campolo
Nanyang Technological University
School of Mechanical and Aerospace Engineering

Simone Krager* and Marcelo H Ang Jr
National University of Singapore
Advanced Robotics Centre

H-Man

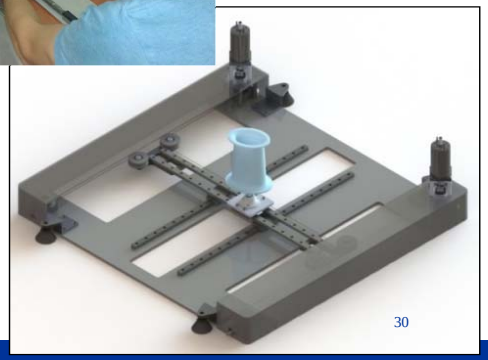
ARTICARES

NUS | Engineering
National University of Singapore

NANYANG TECHNOLOGICAL UNIVERSITY

A novel, compact planar robot for (semi-) independent rehabilitation of upper limb sensorimotor impairments

- Light-weight (< 7 kg)
- Max 30 N at the end-effector
- Table top / portable
- Cost-effective
- Easy to control and program
- Assistive/resistive tasks
- Intrinsically safe



The H-Man

Low-cost planar robot for upper-limb rehabilitation in a **safe**, **productive** and **effective manner**, backed by **clinical validation**

Novel Smart Algorithm –Intensity & productivity

Integrated sensors - Continuous Assessment

Safety – Human Centric Design

Low cost – Standard Manufacturing

H-Man in Hospital

NANYANG TECHNOLOGICAL UNIVERSITY

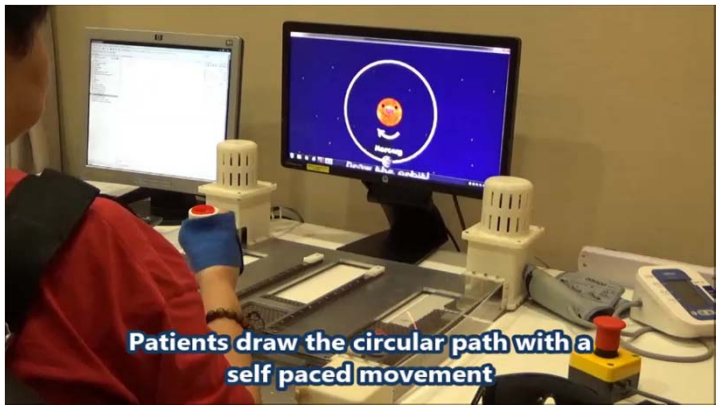
Tan Tock Seng HOSPITAL

Imperial College London

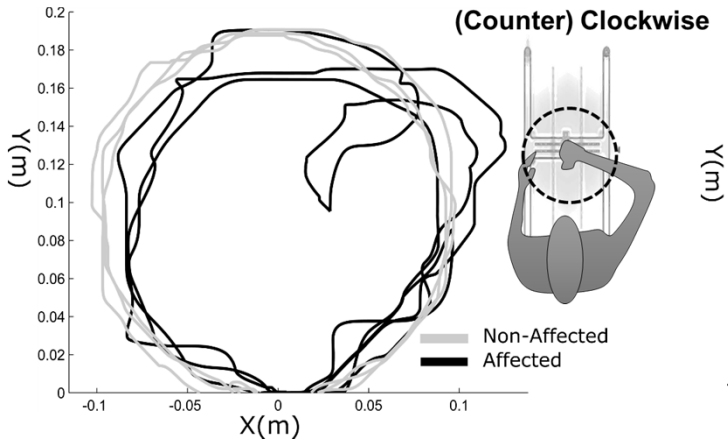
Development → **Clinical validation: Pilot Study (12 stroke patients) + RCT (44 Stroke patients – on-going)** → **In use**

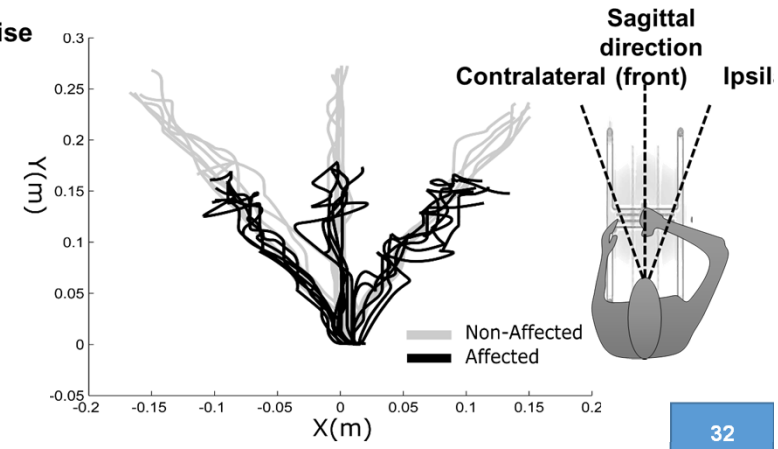
H-Man and Quantitative Sensorimotor Assessment

Coordination



Range of Motion



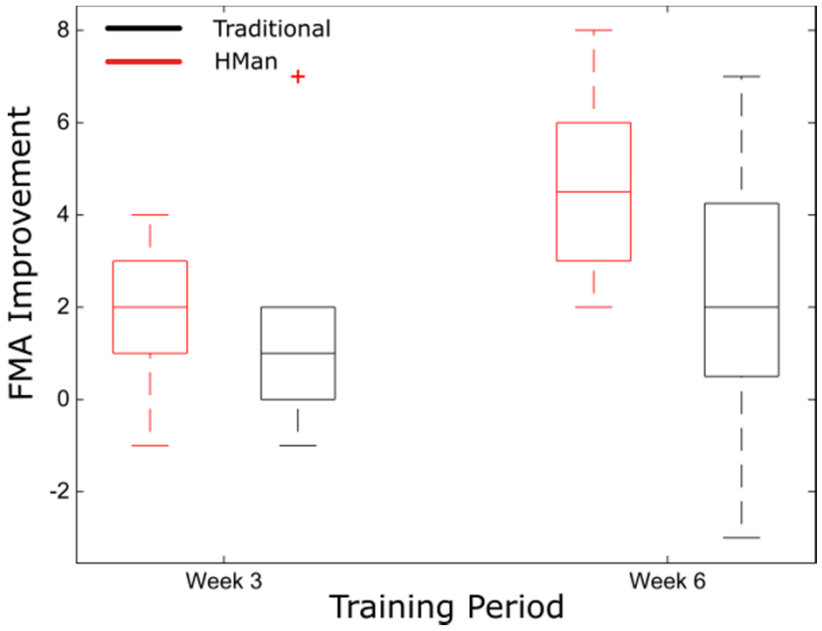


Training with H-Man

- 6 Stroke patients on H-Man
- 7 Stroke patients on traditional 1-1 therapy

- **Equivalent to traditional therapy** after completion of randomized control trial

preliminary results
on 13 patients out of 44



Towards Commercialization

Clinically Validated Pain to Gain

1. Intensive Training
> 6 times more smart repetitions than conventional methods, 50 vs 300.

2. Enhanced Productivity
1 therapist > multiple patients, validated smart algorithm.

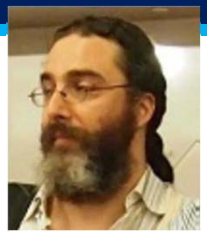
ARTICARES

3. Continuous Assessment
Clinically validated metrics with integrated sensors

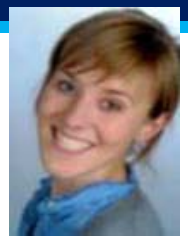
4. Safe & Portable
table top design with clinically validated safety in feasibility study.

5. Low cost
4 times cheaper than MIT-Manus

H-Man Team

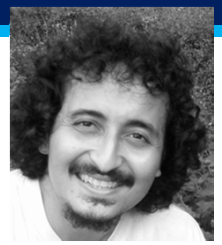


Domenico CAMPOLO

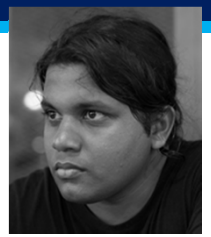


Simone KAGER

Asif HUSSAIN



Muhammad Azhar

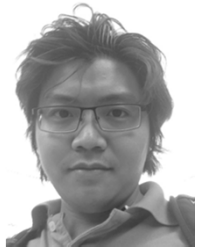


Kumudu GAMAGE

Sara CONTU

Mohammad ESMAEILI

Paolo TOMMASINO



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