

Robotics as a Core Technology For Lower-Limb Exoskeletons

Examples & Use Cases

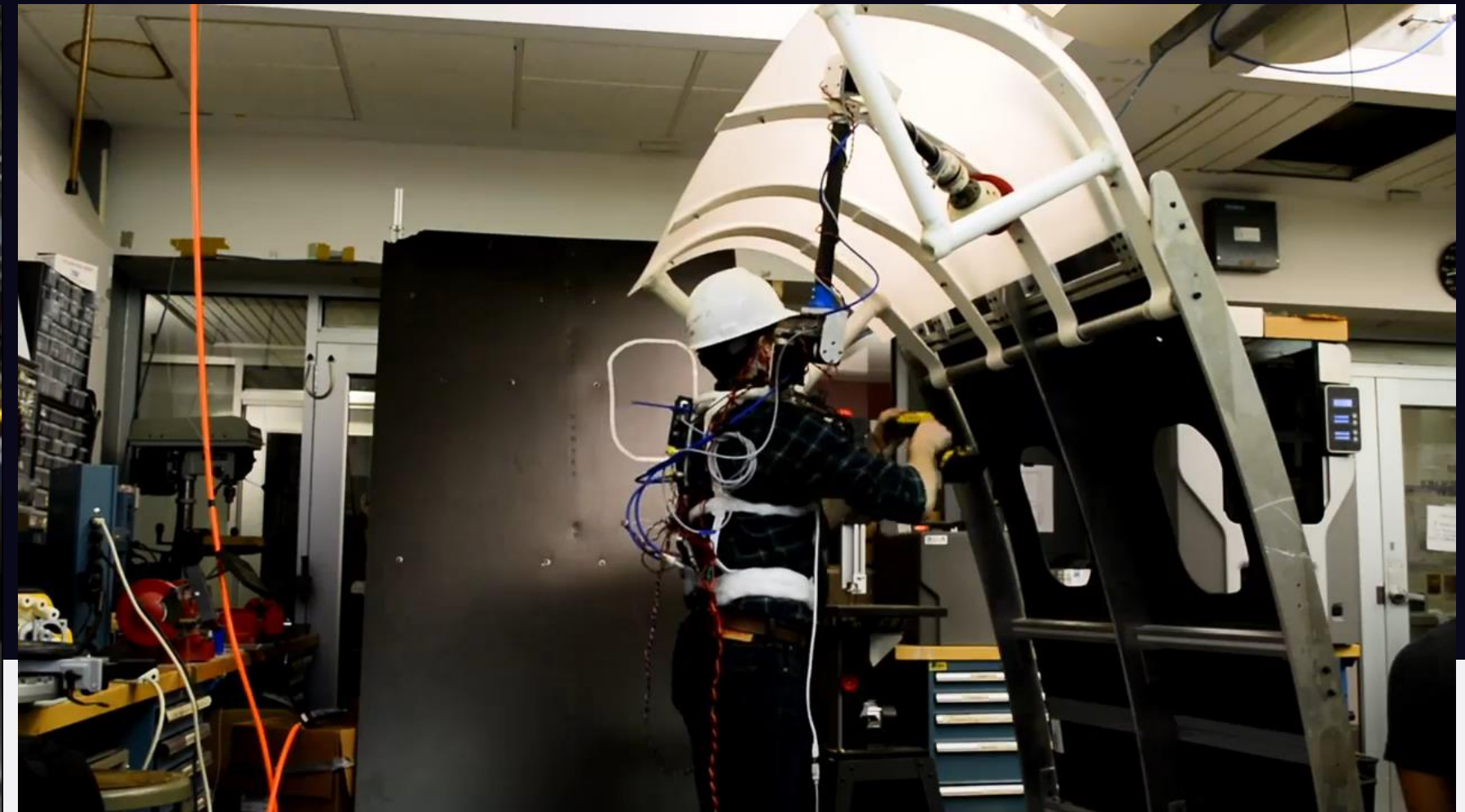
Dr Ing. Mohamed Bouri
Ali Reza Manzoori
REHAssist Group, BioRob, EPFL

General Introduction

Anthropomorphic Robotics



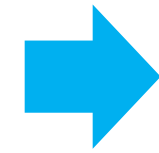
Wearable Robotics



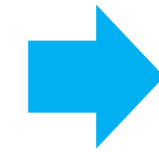
Video: Sarah Crespi, Science Maganize. <http://scim.ag/2uizYzc>

Exoskeletons

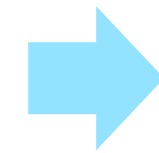
Definition



EXO + SKELETON



External + Rigidly (attached)



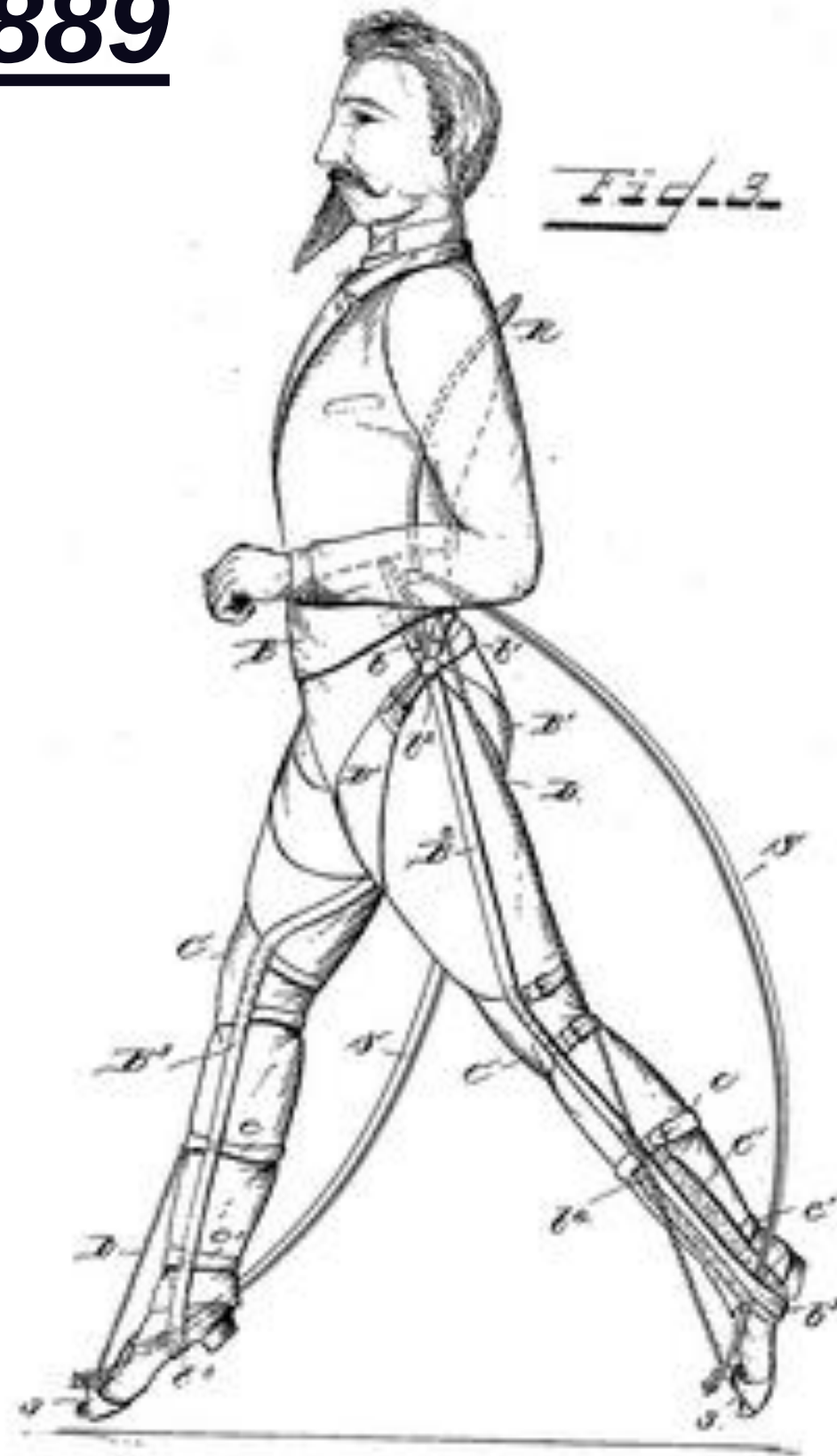
Rigidly interfaced to the limb through **dedicated components** to transmit **motion** or **torques**.



Exoskeletons

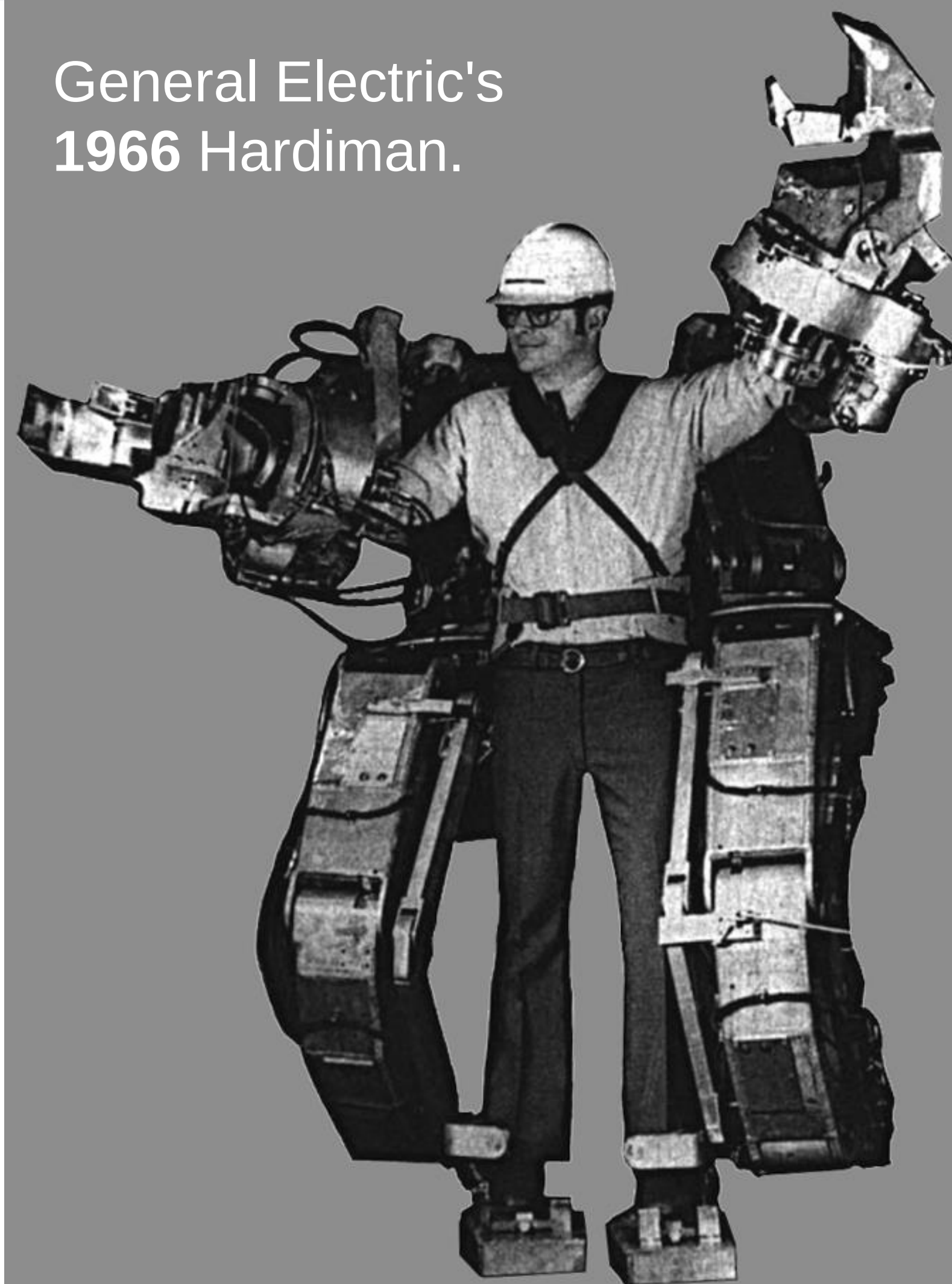
The Origins

1889



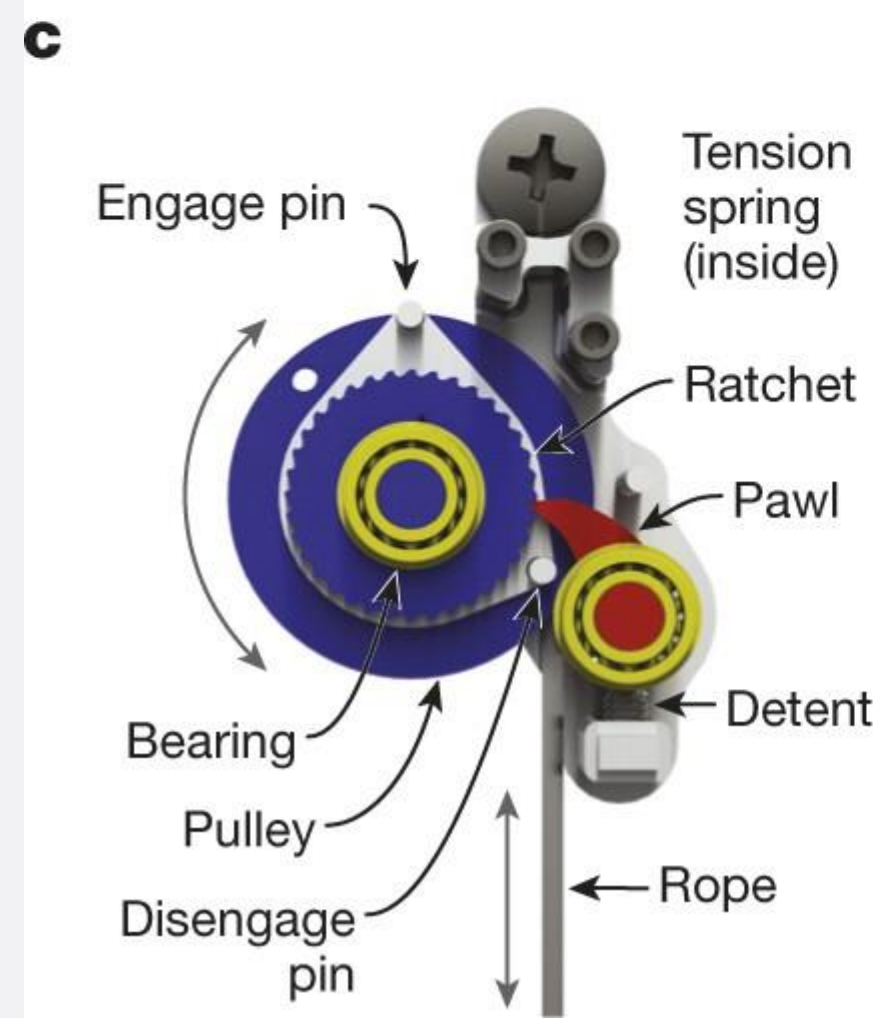
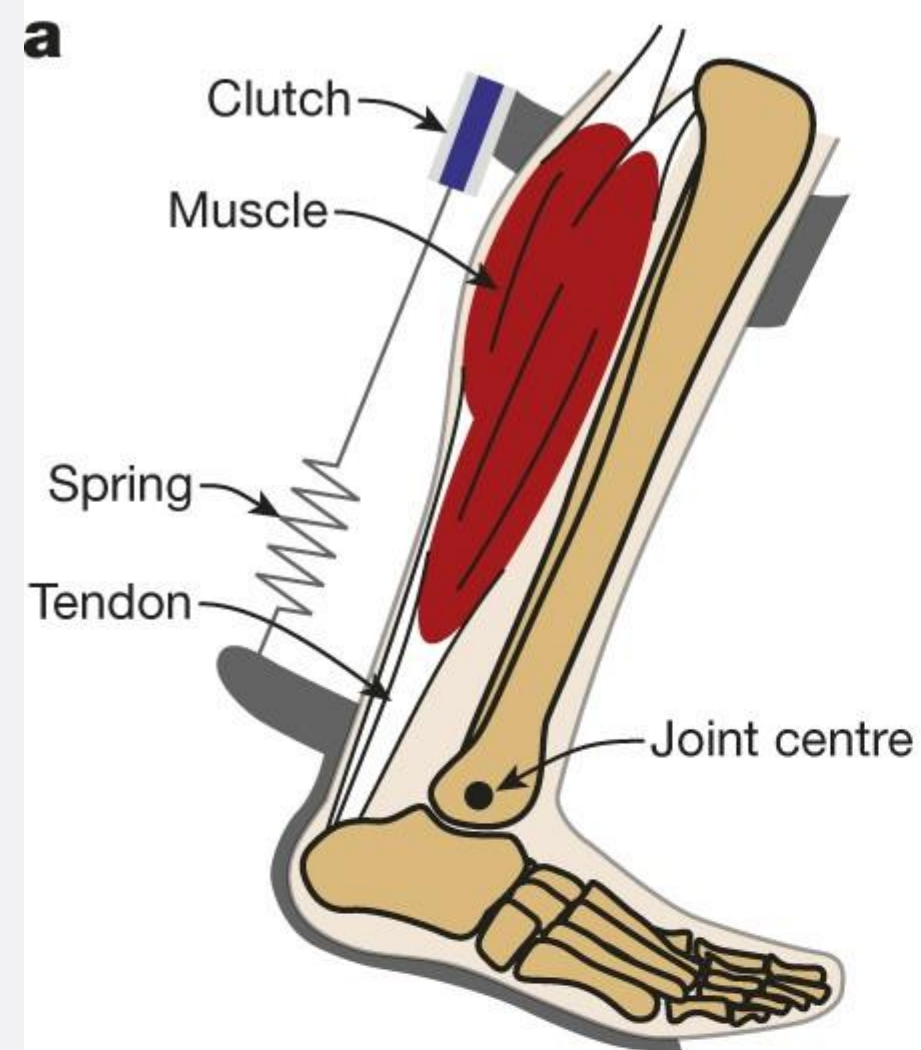
Yagn's "apparatus for facilitating walking"
(Nicholas Yagn/USPTO)

General Electric's
1966 Hardiman.



Exoskeletons

Not Always Active



Exoskeletons

Different Target Limbs



RELAB ETHZ

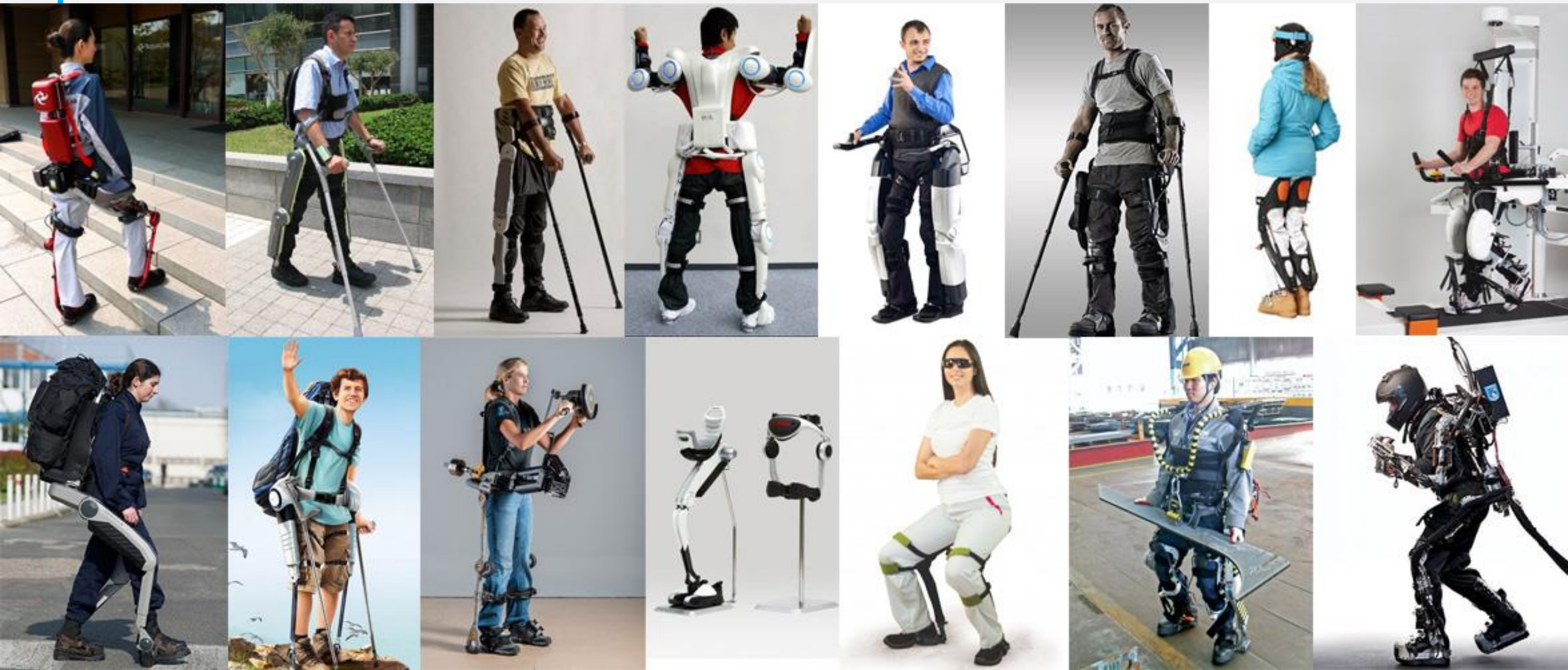


SMS lab, ETHZ



ekso Bionics

Several solutions – several needs



Assistance

Augmentation

Rehabilitation

REHAssist



TWICE, Vouga, ICORR 2017
Baud, ICORR 2019
Fasola, ICORR 2019



HiBSO, Olivier et al. Rob & Aut Sys, 2015



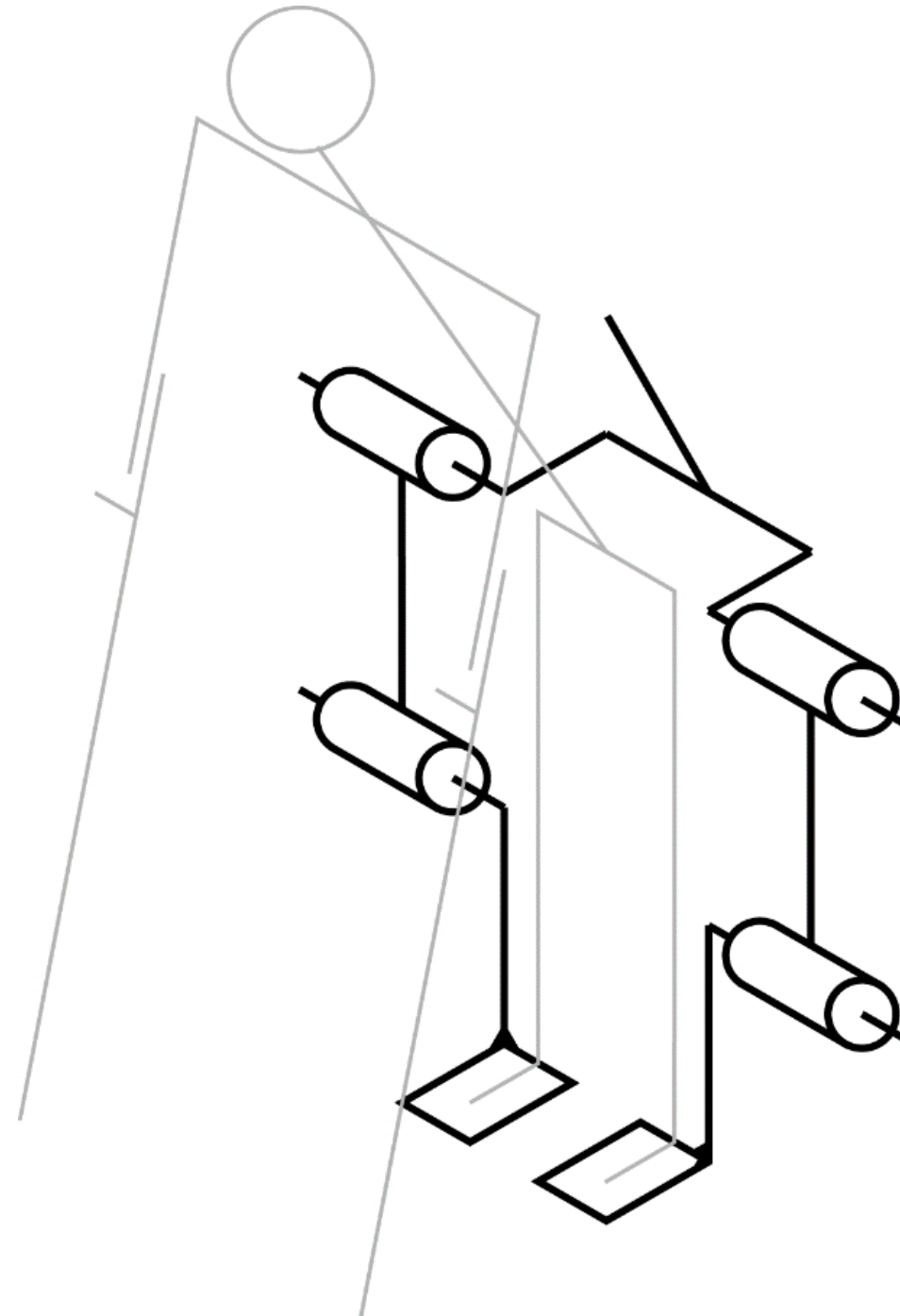
Autonomyo, Ortlieb et al, ICORR 2017

TWICE

A lightweight exoskeleton for paraplegics



September 2016



Tristan Vouga, Romain Baud , Julien Pache, Jemina Fasola



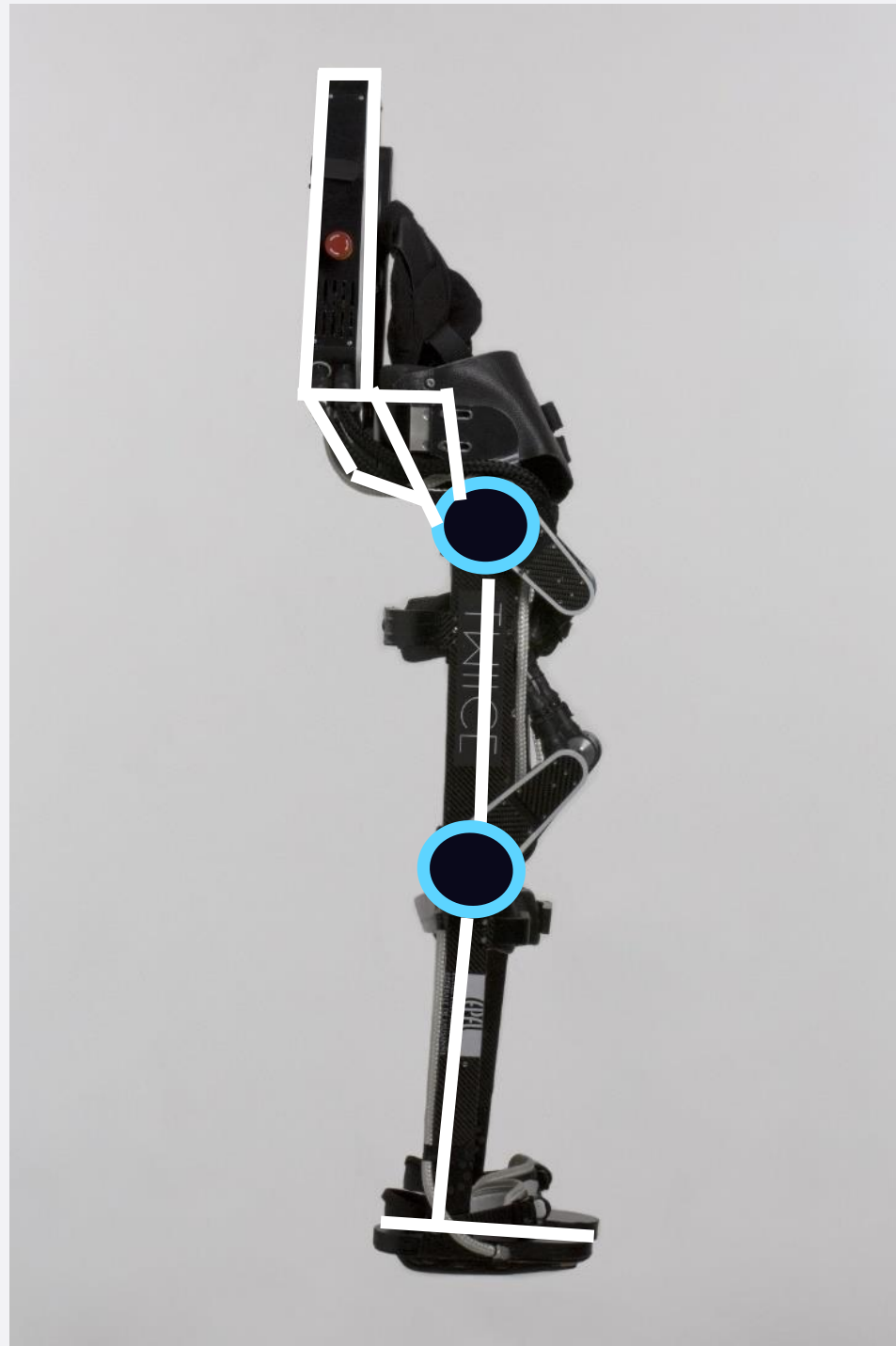
Page
10

August, 2015



TWICE

2016





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Testing in Real-Life Situations & Contexts



Architecture and Components

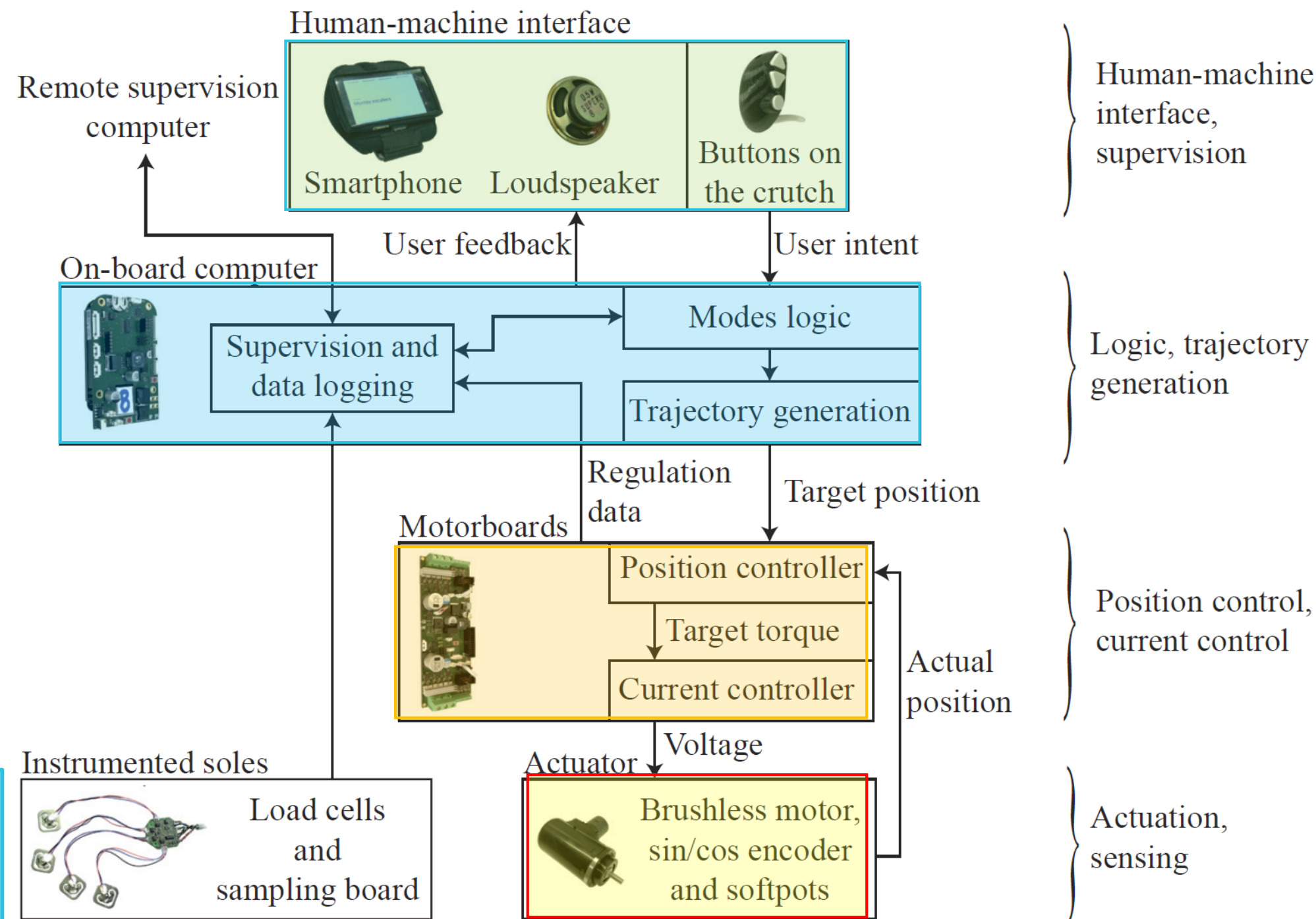
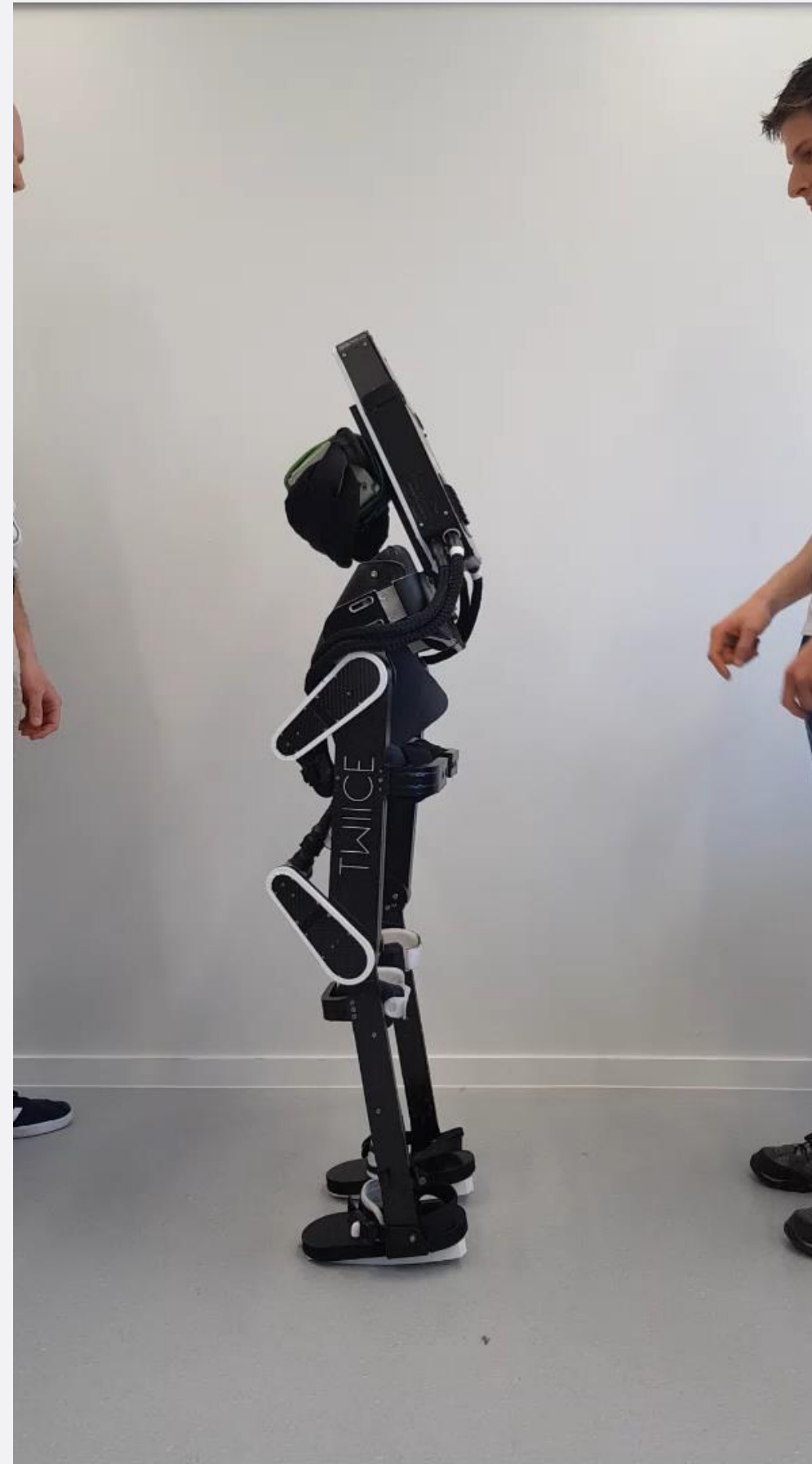
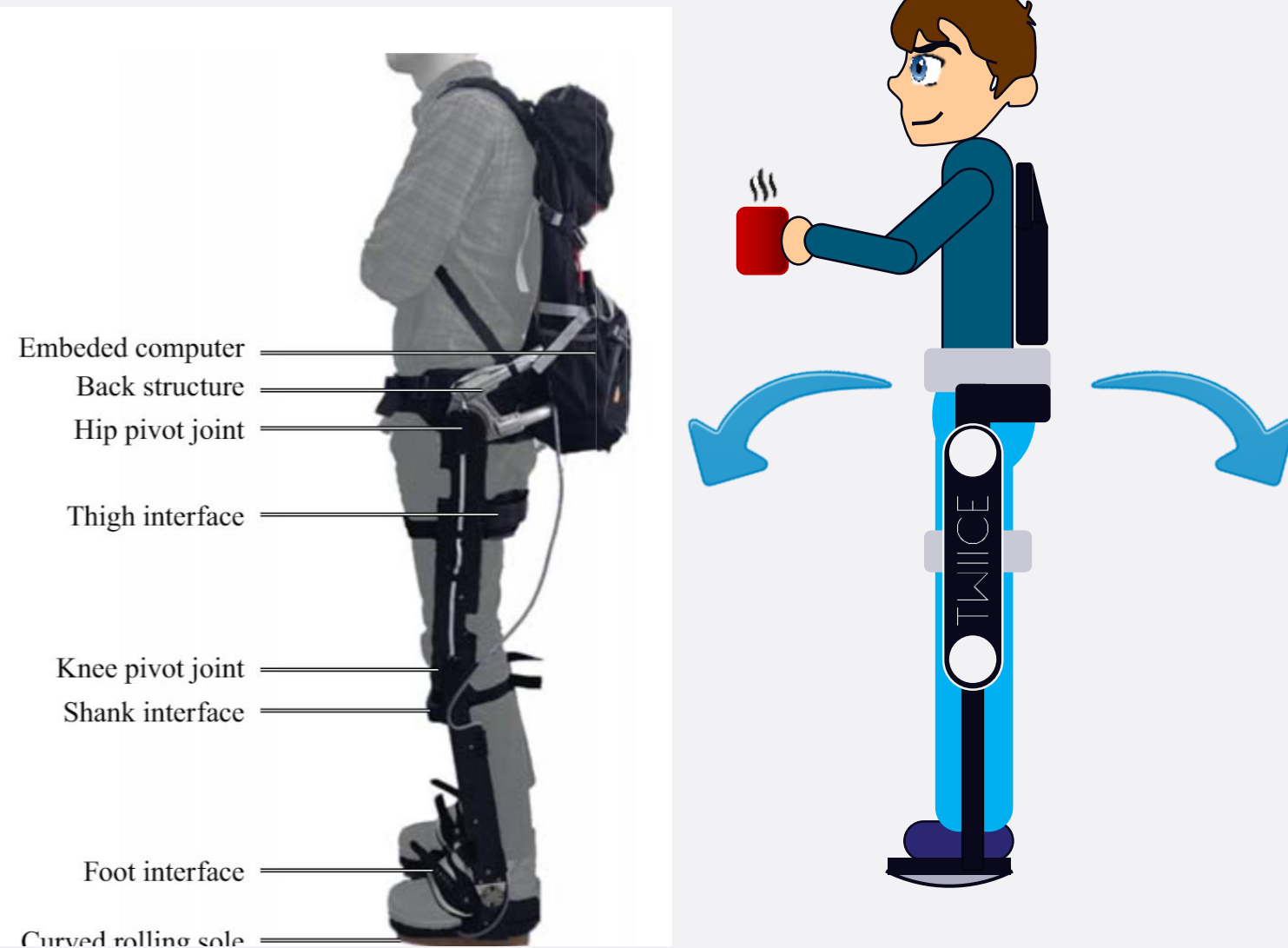


Fig. 3: Architecture diagram of the exoskeleton controller, including pictures of the most important electronic components. The blocks are laid out to emphasize the layered control structure. The arrows represent an abstracted information flow.

Human-inspired standing balance controller

[Video link](#)

[Video link](#)



Key Principles

Simplicity

Modularity

Versatility

More modularity

A dream comes true



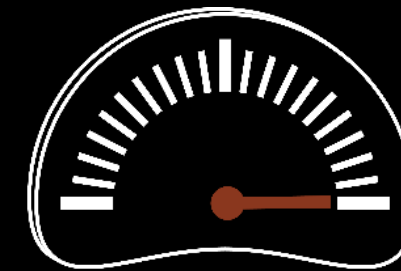


Project "RUNNER"



Transfemoral Amputee

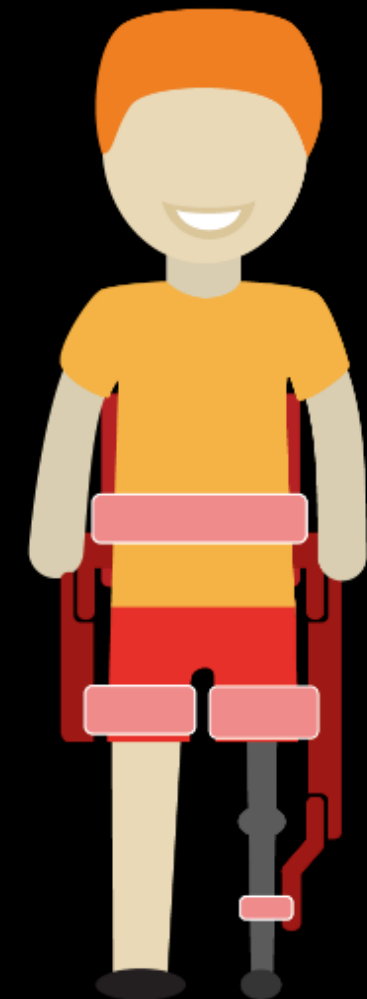
Speed



Assistance



Bulkiness



Conclusion: What Do Exoskeletons Need From Power Electronics?

- Compact and lightweight yet powerful actuation and amplification (high torque density)
- Motor driver circuits with high efficiencies
- High energy capacity to allow longer autonomy
- Reliability, compatibility and safety are vital

TWICE, A Team of Excellence



Thanks to the Inspiring Pilots



Martin



Silke



Bruce