

# Service robots and Exoskeletons: Part III

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# Agenda: Part III: 11. 3. 2021

Lecture: Medical exoskeletons

Interview with Taina Jyräköski (guest physiotherapist)

- - - BREAK 10 minutes - - -

Indego exoskeleton demoing with Taina Jyräköski

Quiz

Discussion and wrap-up

*Service robots and exoskeletons*

# Medical exoskeletons

This amazing feat shall revolutionize the way in which paraplegic Scientists continue their honorable work in the advancement of Science! Even in this modern day and age, some injuries cannot be healed. Even with all the Science at our command, some of our learned brethren today are without the use of their legs. This Device will change all that. From an ordinary-appearing wheelchair, the Pneumatic Bodyframe will transform into a light exoskeleton which will allow the Scientist to walk about normally. Even running and jumping are not beyond its capabilities, all controlled by the power of the user's mind. The user simply seats himself in the chair, fits the restraining belts around his chest, waist, thighs and calves, fastens the Neuro-Impulse Recognition Electrodes (N.I.R.E.) to his temples, and is ready to go!

José L. Pons: Wearable Robots (2008)

*A concept of a mobility assistant for scientists unable to use their legs was proposed already in 1883 by Prof. H. Wangestein.*

# Medical exoskeletons

## Rehabilitative

The user will improve after using the wearable device. After a supervised training regimen set, the user will no longer need to use the rehabilitation exoskeleton.

Used in clinical setting.

## Augmentative

The user will not get better after undergoing rehabilitation and they will rely on the wearable device for the rest of their lives.

Used at home setting.

# Medical exoskeletons

- Fixed, supported or mobile
- Upper body
- Lower body
- Single joint or multiple joints
- Usually active (powered) exoskeletons
- Can be combined with task-specific activities in patients' daily activities or with gaming solutions and virtual reality.



Armeo Spring by Hocoma



MyoPro by Myomo



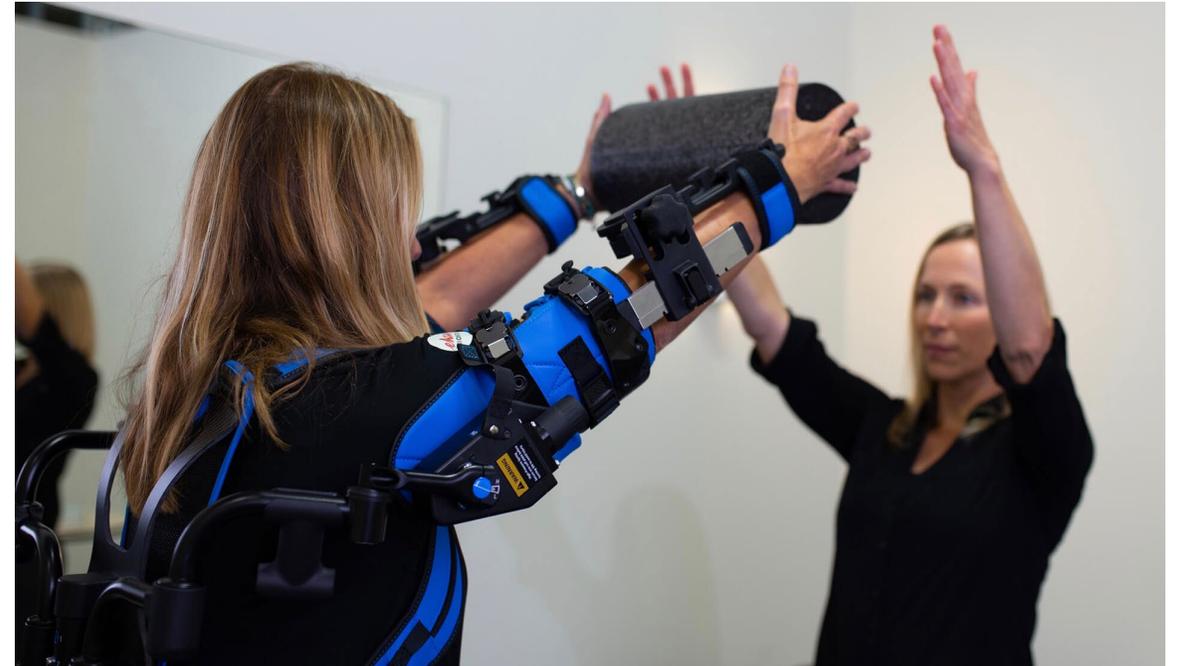
Lokomat by Hocoma



Indego by Parker Hannifin

# Upper limb exoskeletons

- in physiotherapy and occupational therapy
- upper limb paralysis or weakness
- reduce the gravity load on one or both arms during sitting, standing or walking
- wider active range of motion
- higher endurance
- more intense therapy



EksoUE by EksoBionics

# Medical lower limb exos - user applications

Multiple Sclerosis

Traumatic Brain Injury

Parkinson's Disease

Cerebral Palsy

Spinal Cord Injury

Balance disorders

Muscular Dystrophy

Stroke

Geriatrics

# Common features and differences: motors



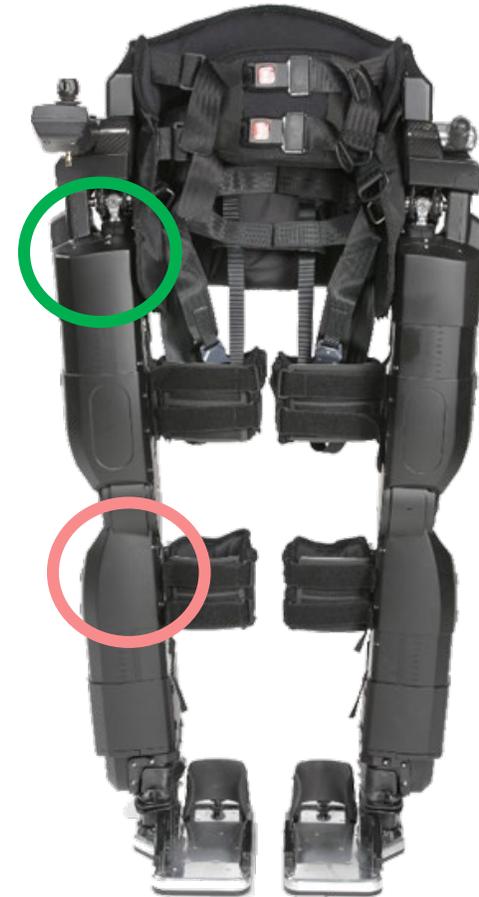
Indego



EksoNR



ReWalk



REX

# Common features and differences: foot plates



Indego



EksoNR



ReWalk



REX

# Common features & diff.: core & battery



Indego



EksoNR



ReWalk



REX

# Common features & diff.: control mechanism



Indego



EksoNR



ReWalk



REX

# Common features & diff.: assistive device?

YES



Indego

YES



EksoNR

YES



ReWalk

NO



REX

# Common features

- attached around the pelvis and legs, provide robotic assistance to the user to move overground
- used as a rehabilitation tool (therapeutic), some as an assistive device
- assistive aid (walker, rollator, crutches) is required for balance during exoskeleton use (except Rex)
- powered at hips and knees; ankles are passive
- achieved speed depends on user's functional ability, 0.2 m/s – 0.7 m/s
- weight of the exoskeletons: 12-20 kg
- usually stepping occurs with user's weight shifting forward or sideways
- computer-controlled motors assist standing, walking, and standing up / sitting down

# REX exoskeleton



[www.rexbionics.com](http://www.rexbionics.com)



- Self-balancing
- Fully automated forwards, backwards, sideways and turning movements
- Can climb stairs



- Heavy (38 kg)
- Slow
- Bulky



# Advantages of exos in gait rehabilitation

- Decreased physical burden on the therapists
- Fewer therapists on-site
- More repetitive and intensive motions
- High number of repetitions promotes neuroplasticity



# Advantages of exos in gait rehabilitation

- Promote lower limb muscle activity during walking
- Promote more symmetrical gait
- Support motor recovery and allow for more accurate progress measurement and tracking
- May offer secondary benefits related to upright position and weight-bearing: healthy bone structure, bowel and bladder management, improved blood circulation, cardiorespiratory benefits, decreased muscle tone/spasticity, lower pain, improved general well-being and quality of life



EksoNR by EksoBionics

# Limitations of exos in gait rehabilitation

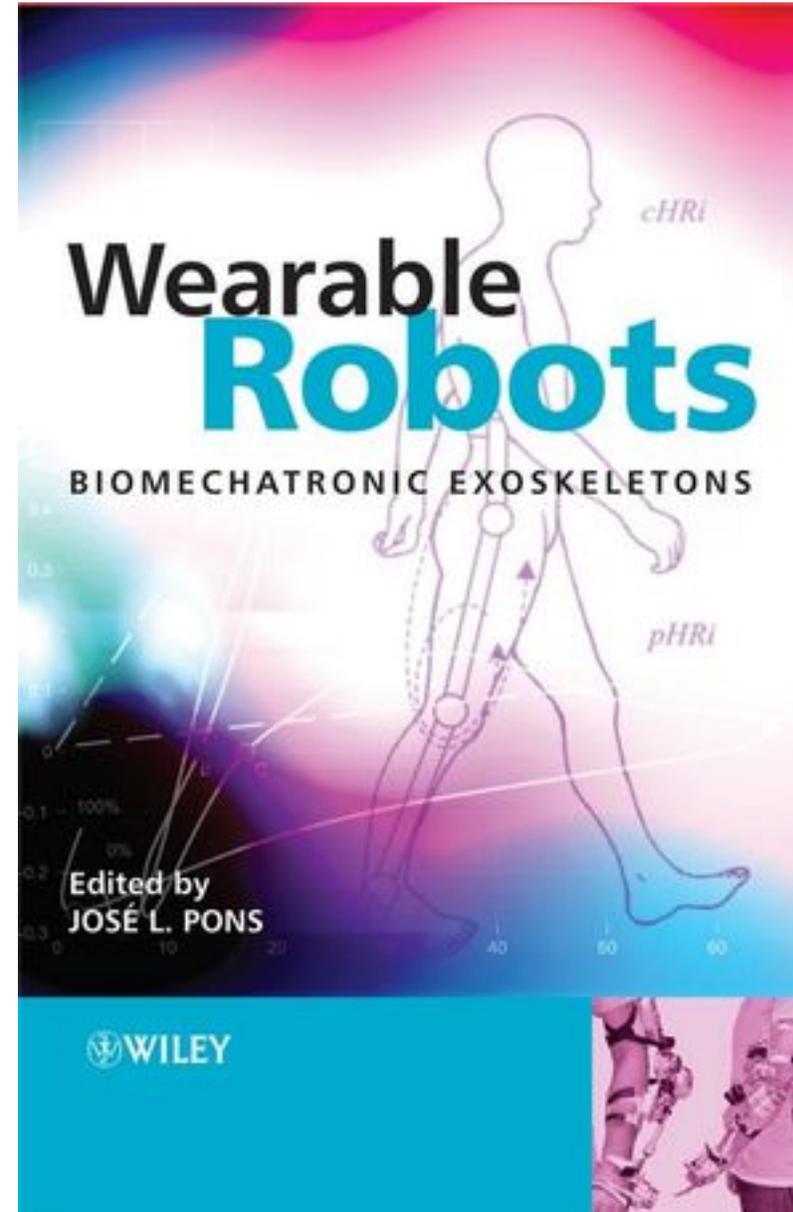
- User suitability
- Comfort
- Ease-of-use (users, therapists)
- Battery
- Price

Criteria	Yes (Met)	No (Not Met)
Height 5' 1" (155cm) to 6'3" (195cm) <i>* May vary depending on femur length</i>	Height: _____	
Weight 250 lbs (113 kg) or less <i>* Consider body type and Indego requirements referenced below</i>	Weight: _____	
Passive range of motion within functional limits for standing at hips, knees and ankles		
Healthy bone density		
Tolerates fully upright standing position without dizziness or other symptoms <i>* Use of abdominal binders or ace wrapping of legs is permitted</i>		
Modified Ashworth Spasticity (MAS) Level 3 or less <i>* Use of standing frame, stretches and/or spasticity medication can be used prior to session</i>		
Skin intact where it interfaces with the device		
Sufficient upper extremity strength to manage stability aid		

# Literature and sources

Jose L. Pons (2008). Wearable robots.  
Biomechatronic exoskeletons.

<https://exoskeletonreport.com/>



# Interview with Taina Jyräköski

# Break – 10 minutes

*NEXT*

# Demoing of Indego exoskeleton

*Quiz*

Use your smart phone and go to

**[www.kahoot.it](http://www.kahoot.it)**

# Different ways of presenting this training's content

Webinar/online lecture

Quiz (Kahoot)

Padlet

Live programming

Live interview

Live demoing of a technology

# One last thing...

Feedback link: <https://forms.gle/PCHY16Ayur7g62C96>

# Upcoming trainings

TALENT JOURNEY



Training	Training period	Learning objectives
Design Thinking	12. 11. 2020	History, main principles, methods and tools in Design Thinking process.
Holistic View of IoT	18. 1., 21. 1. and 22. 1. 2021	IoT state of the art with respect to smart manufacturing, devices and concrete examples.
Robotics	25. 1., 27. 1. and 29. 1. 2021	Robotics state of the art in smart manufacturing, collaborative robots, QA-oriented robots, examples of robots driving manufacturing growth.
Soft Skills	3. 2. and 4. 2. 2021	Problem solving, Critical thinking, Verbal and visual communication.
Digital Twins	8. 2. – 12. 2. 2021	Virtual replicas of physical devices, 3D simulation and optimization in smart manufacturing.
Green Skills	15. 2. – 19. 2. 2021	Sustainability, technical skills, knowledge, values.
Service Robots	8. 3. – 12. 3. 2021	Service robots state of the art, mobile robots driving versatile smart manufacturing and factory logistics, Exoskeletons empowering and supporting workers.
VR, AR and gamification in smart manufacturing	22. 3. – 26. 3. 2021	Virtual and augmented reality tools and gamification in smart manufacturing, application examples, learning by gaming.
IoT	12. 4. – 16. 4. 2021	Applied IoT project.
IoT and data enabled services	26. 4. – 30. 4. 2021	Cloud services, IoT and ERP.
AI	10. 5. – 14. 5. 2021	Data science, data analytics, deep learning, neural networks, AI in Education.
Cybersecurity	24. 5. – 28. 5. 2021	Cybersecurity elements, threats, benefits, challenges.

More information on <https://talentjourney.si/>

# Thank you!

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