Knowledge in Motion

SCI Education Series

The Future is Here: What Can Robotics Do for Individuals with Spinal Cord Injury

Paolo Bonato, PhD

Harvard Medical School,
Spaulding Rehabilitation Hospital

MGH Institute of Health Professions,
Harvard Medical School

Wyss Institute for Biologically Inspired Engineering,
Harvard University

PM&R, Harvard Medical School
Spaulding Rehabilitation Hospital

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Biologically Inspired Engineering

THE FUTURE IS HERE: WHAT CAN ROBOTICS DO FOR INDIVIDUALS WITH SPINAL CORD INJURY

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DISCLOSURE

Dr Bonato serves as a member of the scientific advisory board of Hocoma AG. Dr Bonato does not receive compensation for this position.

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TECHNOLOGY TO SERVE HUMANITY

IEEE
Advancing Technology for Humanity

Engineers are working for you …

Are engineers doing a good job?

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THE TECHNOLOGY IS "BROKEN"

"Humans are not disabled. A person can never be broken. Our built environment, our technologies, are broken and disabled. We the people need not to accept our limitations, but can transcend disability through technological innovation."

Hugh Herr

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THE TECHNOLOGY IS "BROKEN"

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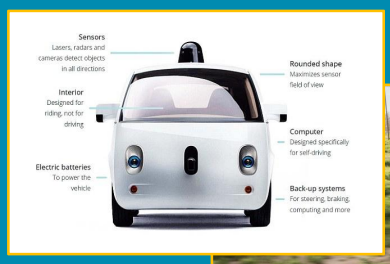
THE FUTURE IS HERE …



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THE FUTURE IS HERE …

Homayoon Kazerooni
UC Berkeley

Gregoire Courtine
EPFL

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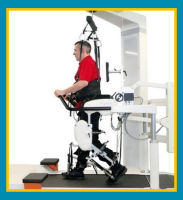
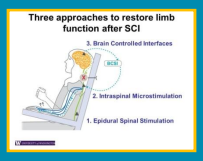
Understanding Rehabilitation Robotics

Retraining



Augmenting

Restoring



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Retraining Upper Limb Motor Function

[Video Clip]

Barrett Technology

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RETRAINING UPPER LIMB MOTOR FUNCTION

Armeo Power, Hocoma

Robert Riener
ETH

MIT Manus

Neville Hogan
Igo Krebs
MIT

Pros

- Efficacy data in many populations.
- Advanced control techniques.

Cons

- Limited efficacy data in SCI.
- Current use marked by low dosage.

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RETRAINING LOWER LIMB MOTOR FUNCTION

Northeastern University and
Spaulding Rehabilitation Hospital

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Retraining Lower Limb Motor Function

Lokomat, Hocoma

Gery Colombo
Hocoma

GEO, RehaTechnology

Stefan Hesse
Univ Berlin

Pros

- Good efficacy data in SCI.
- Progress in control techniques.

Cons

- Training does not challenge balance.
- Current use marked by low dosage.

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The Robotic Gym

Toward the implementation of high-dosage interventions …

Courtesy of Hocoma

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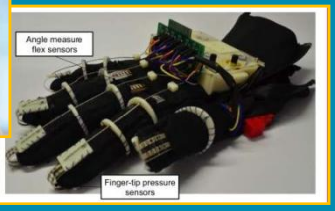
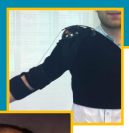
AUGMENTING UPPER LIMB MOTOR FUNCTION

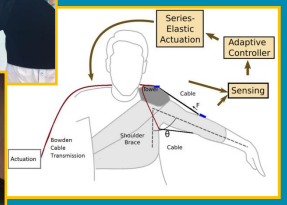
Myomo

Harry Asada
MIT

Gregory Fischer
WPI







Robert Howe
Harvard Univ

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AUGMENTING LOWER LIMB MOTOR FUNCTION

[Video Clip]

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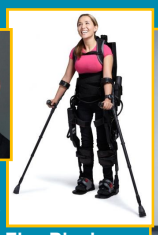
AUGMENTING LOWER LIMB MOTOR FUNCTION

Cyberdine

Homayoon
Kazerooni
UC Berkeley



EksoBionics

SuitX Phoenix

ReWalk

Indego

Michael
Goldfarb
Vanderbilt

Conor Walsh
Wyss Institute

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WEARABLE ROBOTS IN THE FIELD

Monitoring the use of wearable robotic systems in the home and community settings is of paramount importance. It is essential to assure users' safety and to gather data to continue to improve the reliability of such systems.

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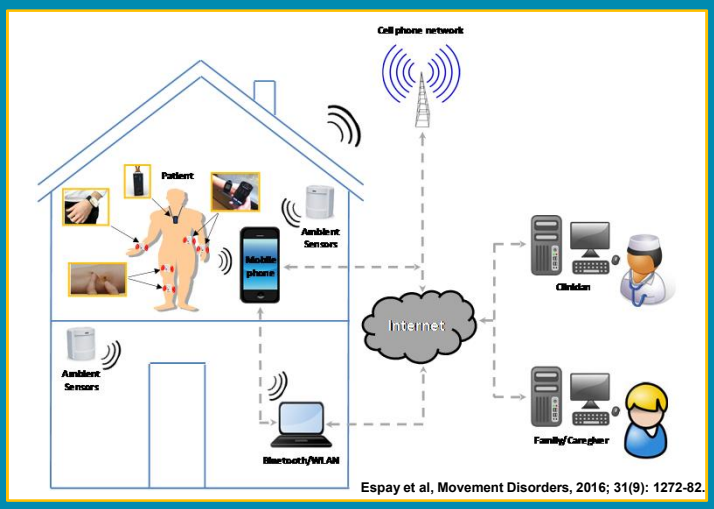
Wearable Robots In The Field



Espay et al, Movement Disorders, 2016; 31(9): 1272-82.

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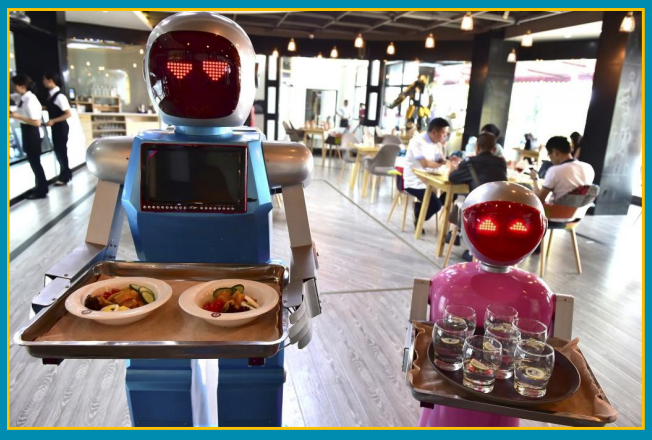
Service Robots



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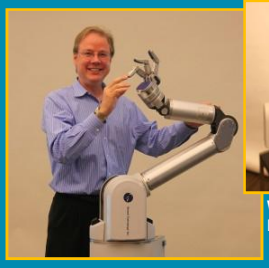
SERVICE ROBOTS

Robert Howe
Harvard Univ

Kinova Robotics



William Townsend
Barrett Technology

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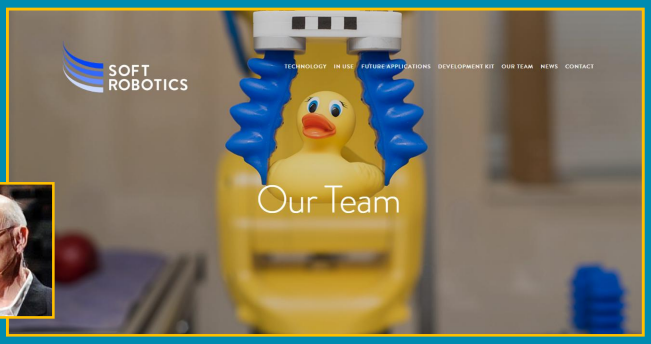

George
Whitesides
Harvard Univ

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Alessandro
Puiatti
SUSPI

Spaulding Rehabilitation Hospital
SUPSI (University of Applied Sciences and Arts of Southern Switzerland)
Wyss Institute, Harvard University

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Dean Kamen
DEKA (partnership with Toyota)

Jose del Milan
EPFL

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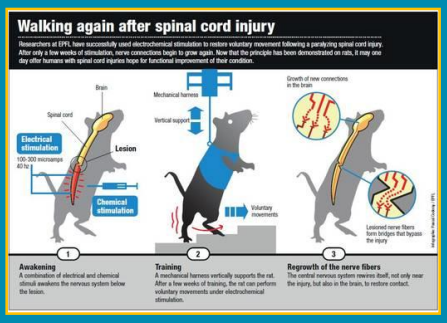

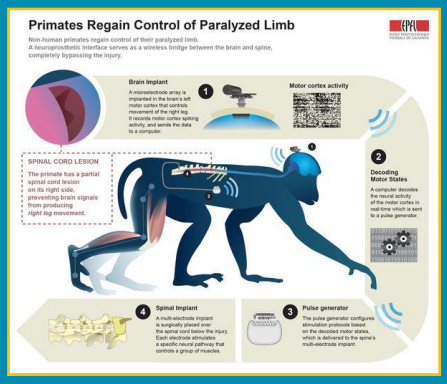

Gregoire Courtine at EPFL is developing techniques in animal models that he hopes to be able to use in patients in the future.

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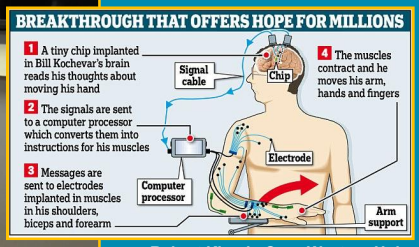

Robert Kirsch, Case Western Univ

Restoration of reaching and grasping movements through brain-controlled muscle stimulation in a person with tetraplegia: a proof-of-concept demonstration

A Bolu Ajiboye, Francis R Willett*, Daniel R Young, William D Memberg, Brian A Murphy, Jonathan P Miller, Benjamin L Walter, Jennifer A Sweet, Harry A Hoyen, Michael W Keith, P Hunter Peckham, John D Simeral, John P Donoghue, Leigh R Hochberg, Robert F Kirsch*

The Lancet
March 28, 2017

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CONCLUSIONS

- Although the technology is "broken" … the future is here.
- Robotic technology provides unique opportunities to retrain, augment, and restore motor function.
- The implementation of high-dosage retraining interventions could be tremendously facilitated by robotics.
- The use of wearable robots for augmentation is becoming reality and safe thanks to sensor-based remote monitoring.
- Many technologies are enabling the restoration of function via "repair" as well as via bypassing spinal lesion areas.

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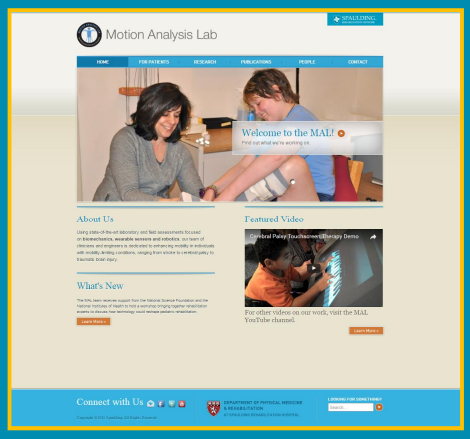

http://srh-mal.net/

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Q & A

The Future is Here: What Can Robotics Do for Individuals with Spinal Cord Injury

Paolo Bonato, PhD
Tim Morris, Consumer
Erick Larson, Consumer
Katie Schramm, DPT
Anne O'Brien PT,
Catherine Adans-Dester, RA

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