NeuroTec

http://neurotec.umh.es/

Red Temática de Investigación en Neurotecnologías para la Asistencia y la Rehabilitación

Jornada de lanzamiento

INSTITUTO CAJAL (CSIC)
4 de febrero de 2016

INSTITUTO CAJAL

CSIC

Neural Rehabilitation Group

Cajal Institute (CSIC)

http://www.neuralrehabilitation.org

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Mission

To improve the **motor capability** and health of persons with **movement disorders** derived from stroke, spinal cord injury, cerebral palsy, etc.

Actuations

Studying the **sensory**, **musculoskeletal** and **nervous systems** that allow humans to **produce movement**

Developing innovative **methodologies**, **interventions**, and **technologies**

- to study the **movement production** and **assessment**,
- to promote the **rehabilitation** of the lost motor functions, and
- to **assist** in the motor execution

RESEARCH LINES

Human Locomotion

Topic

- Human locomotion and its neurorehabilitation

Goals

- To design **diagnostic and therapeutic strategies** to improve **gait recovery** processes
- To experimentally demonstrate the **key aspects** to **optimal functional recovery** of gait

Long-term research

- **Optimization of therapies** (biofeedback, robotic, neuroprosthetic and/or pharmacologic) for recovery of gait function
- Undertaking clinical studies (large-scale cohort) to elucidate **effectiveness of individual therapies** to rehabilitate locomotion, addressing the main **limiting factors**: homogenous delivery of innovative therapies, time frame and dose, adequate current and surrogate outcome measures
- Adaptation of **models of human and animal locomotion** from biomechanical research for the use on versatile rehabilitation devices.
- **Translation** of innovative cost-effective treatments through clinical and company-level stakeholders

Pathologies addressed

- Stroke, SCI, Parkinson, and other syndromes that affect human locomotion

Neuromuscular Coordination

Topic

- The **ability** of the central nervous system (CNS) to **control the muscles** in the execution of **multi-limb functional movements**

Goals

- To gain better knowledge on the neural mechanisms at the **basis of neuromuscular coordination** and their biomechanical effects, in healthy and pathologic people
- To **apply** this knowledge to create new **assessment and therapeutic devices** specifically aimed to the **neuro-rehabilitation** of the **neuromuscular coordination**

Methods

- Analysis of physiological and biomechanical properties of the human musculoskeletal system, through **electromyography** and **motion analysis system**
- Development of intervention devices based on **wearable robotics**, **electrostimulation**, and **sensory biofeedback**

Motor functions addressed

- Lower limb movements, namely posture, pedaling and walking

Pathologies addressed

- Prevalently neurological, such as stroke, spinal cord injury and cerebral palsy
- Non-neurological impairments affecting the musculoskeletal system

Multimodal Human-Machine Interfaces

Topics

- **Sensory-motor mechanisms**
- **Multimodal**, human-centered **rehabilitation strategies**, and **assistive technologies**

Goals

- Providing modeling and **multimodal human-machine interfaces** for patient **rehabilitation**, and **assistance** in daily living activities in an easy and transparent manner
- Providing **interfaces** and **metrics** that **clinicians** could use to potentiate their work during the rehabilitation process

Motor functions addressed

- Upper limbs activities: reaching, grasping, manipulating…

Developments

- **Bi-lateral cooperation** with assistive devices for daily living upper-limb activities
- **Fatigue-based adaptive control strategies** for functional rehabilitation of upper limb based of hybrid exoskeletons
- **Upper-limb** motor-disorders compensation
- Attentional demands and mental workload evaluation of sensory feedback systems in prosthetics applications
- Novel control paradigms for hand prosthesis control
- Hand and Arm prostheses dynamical close-loop control

Neuromodulation and Assessment

Topic

- **Conditioning of neural structures** involved in the generation of both volitional movement strategies and spinal reflexes in humans

Goals

- To **understand the movement-related neurophysiological mechanisms** mediating the pathological conditions and recovery potential of the patients
- To develop **noninvasive neuromodulation strategies** to empower **neural rehabilitation** leading to improved motor function

Methods

- Advanced processing and classification technologies based on **EEG** and **EMG** recordings and ways to induce changes noninvasively in neural structures (by means of **peripheral muscular/nerve stimulation** or **transcranial magnetic/electric stimulation**)

Pathologies

- Stroke, traumatic brain injury, spinal cord injury

Long-term research

- Characterization of cortical changes in pathological states and during the rehabilitation process
- Definition of new metrics to assess the neuromotor function by testing neural pathways
- Development of BCI technologies integrated in multimodal human-machine interfaces
- Development of EEG/TMS/tDCS/(F)ES-based technologies for neuromodulation and conditioning

Cognitive Systems

Topic

- **Computational structures** and **information-processing mechanisms** supporting **cognitive functions**

Goals

- To inquire into the **operational principles** underlying cognition
- To apply them for enabling the **friendly use** of neurorehabilitation devices, such as exoskeletons, through the **autonomous abilities** of **self-learning** and **self-adaptability**

Methods

- Synthesis of cognitive systems by means of: **formal methods**, **knowledge representation**, **cognitive architectures**, **distributed processing**, **dynamical systems theory** …

Motor functions addressed

- Locomotion

Pathologies addressed

- Spinal cord injury

CURRENT PROJECTS

HYPER
CONSOLIDER-INGENIO 2010

Hybrid Neuroprosthetic and Neurorobotic Devices for Functional Compensation and Rehabilitation of Motor Disorders (HYPER)

Research on new **wearable** neurorobotic (**NR**) and motor neuroprosthetic (**MNP**) **systems**, **combining biological and artificial structures** in order to overcome the major limitations of current rehabilitation solutions for the particular case of Cerebrovascular Accident (**CVA**), Cerebral Palsy (**CP**) and Spinal Cord Injury (**SCI**)

The main objectives of the project are to **restore** motor function

- in SCI patients through **functional compensation**, and
- promoting **motor control re-learning** in patients suffering from CVA and CP

Integrative approach for the emergence of human-like robot locomotion (H2R)

The goal of H2R project is to **demonstrate human-like gait and posture in a controlled compliant biped robot** as a result of a combination of the most relevant **motor control and cognitive mechanisms** found in humans

In order to achieve this goal, we adopt a threefold process:

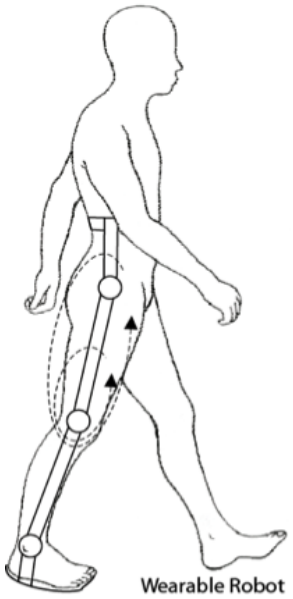
1. **Understanding** the key biological principles from human experiments

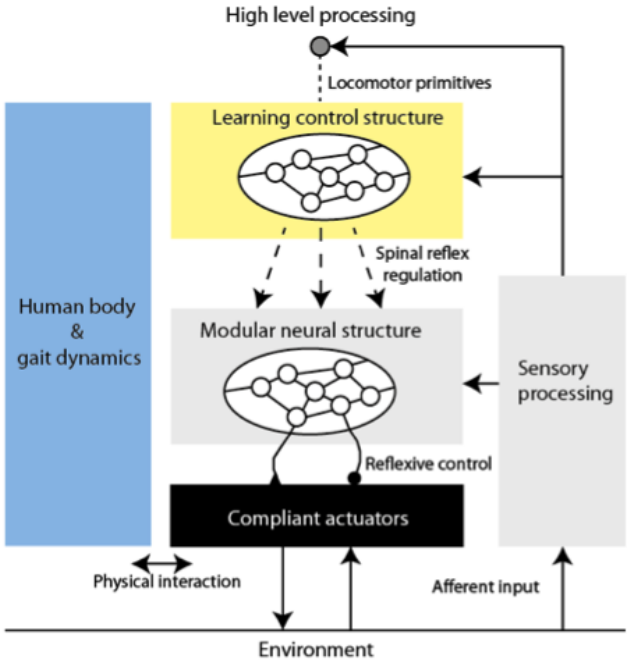
2. **Translating** the formalized concepts into human-like **bipedal robots**

3. Creating new **benchmarking schemes** for validating the robotic performance

Smart Wearable Robots with Bioinspired Sensory-Motor Skills (BioMot)

The main objective of the project is to improve existing **wearable robotic exoskeletons** exploiting **dynamic sensory-motor interactions** and developing **cognitive capabilities** that can lead to **symbiotic gait** behavior in the interaction of a human with a wearable robot.

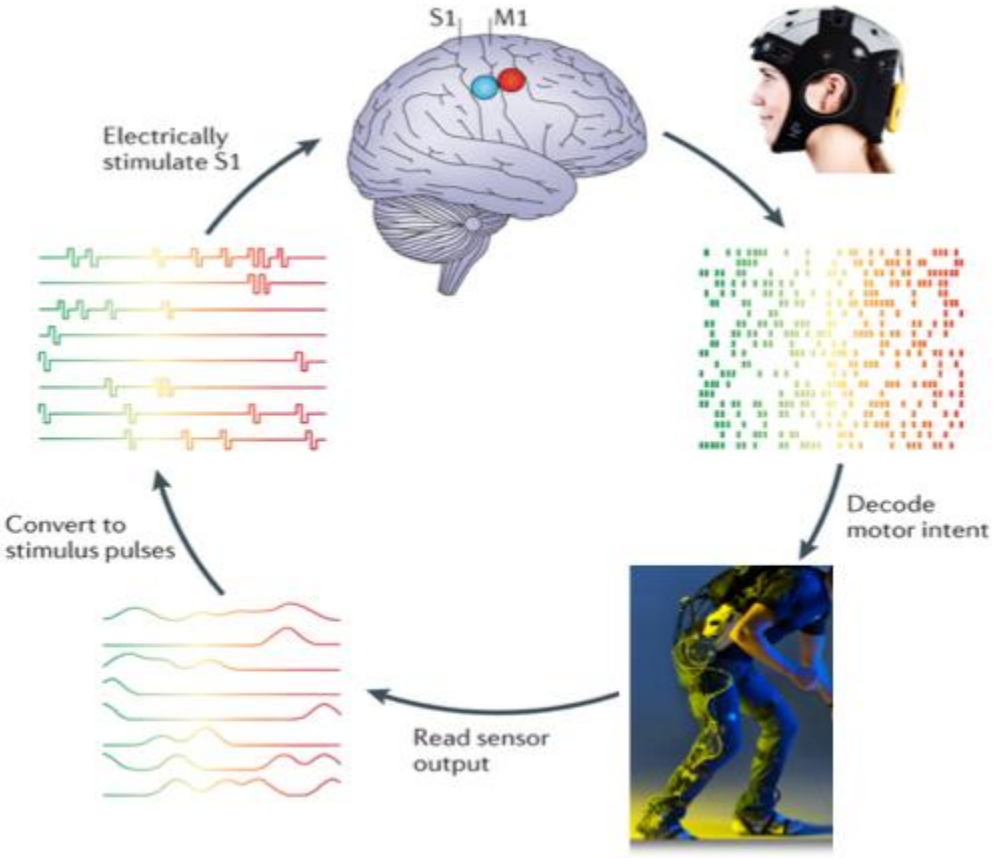




A comprehensive and wearable robotics based approach to the rehabilitation and assistance to people with stroke and spinal cord injury (ASSOCIATE)

The first objective of the project is to validate the effectiveness of a **novel intervention to promote motor control re-learning** in neurological patients by means of an **associated** use of **motor planning** at brain level, **sensory stimulation** at cortical level and **afferent feedback** provided with a wearable lower extremity exoskeleton.

The second objective of the project is to validate the effectiveness of a **novel lower extremity wearable exoskeleton** with embodied intelligence and enhanced **self-learning** characteristics in the **assistance** to locomotion in **incomplete SCI** in terms of **reduced learning periods**, **improved adaptation** and more **versatile** and dexterous operation.



OTHER PROMOTED ACTIVITIES

"School and Symposium on Advanced Neurorehabilitation"

June 6-10, 2016 - Baiona (Spain)

http://www.ssnr2016.org

International Conference on Neurorehabilitation, ICNR 2016

October 18-21, 2016 – Segovia (Spain)

http://www.icnr2016.org

International Workshop on Wearable Robotics, WeRob 2016

October 18-21, 2016 – Segovia (Spain)

http://www.werob2016.org

Unidad Asociada con el Hospital Nacional de Parapléjicos de Toledo