

# Robotic Exoskeleton with Thermal Stimulation for Gait Rehabilitation

INTERNATIONAL PATENT PCT/IB2020/055260 EUROPE-USA-CHINA EUROPEAN PATENT NO. EP3982901 ITALIAN PATENT NO. IT202019000001812

DESIGN REG. NO. 40202000000841-40202000001342

TRADEMARK REG. NO. 302019000053934

#### **PANDHORA®: INNOVATION AND EXCELLENCE IN ROBOTIC REHABILITATION**

**About Us:** Founded in 2016, Pandhora is a pioneering entity in the field of biomedical technology, specializing in the design, production, and distribution of cutting-edge devices for rehabilitation. Our journey begins with a dream: to revolutionize the world of rehabilitation through robotics, offering solutions that tangibly improve people's lives. At Pandhora, our mission is steadfast: to continually advance innovation in the rehabilitation sector, enriching the lives of millions of people worldwide.

**Our Vision:** We believe in a future where advanced technology and humanity seamlessly integrate, creating a healthcare ecosystem that is more efficient, accessible, and humane. Our mission is to be architects of this change, working tirelessly to develop innovations that raise the standard of rehabilitative care, making it more effective, efficient, and comfortable for patients.

**Experience and Innovation:** Our expertise in the fields of robotics and precision mechanics is the foundation upon which we build the future of rehabilitation. Through our deep knowledge in kinematic simulation and robotics, we have brought to life unique devices that are setting the standard for Robotic Rehabilitation. Our multidisciplinary approach, combining engineering and medical skills, enables us to tackle and solve complex challenges, significantly enhancing the effectiveness of rehabilitative therapy.

**Prestigious Collaborations and Research Support:** Thanks to the support of ENTOPAN, the largest business incubator in Southern Italy, and backed by CDP Venture Capital as well as prestigious investors such as the Giomi Hospital Group and Santo Versace, we are at the heart of an exceptional network of excellence. This enables us to always be at the forefront of research and innovation projects in the biomedical and engineering sectors, thanks to our team of highly qualified experts.

**Prestigious Collaborations and Research Support:** Thankstothe support of ENTOPAN, the largest business incubator in Southern Italy, and backed by CDP Venture Capital as well as prestigious investors such as the Giomi Hospital Group and Santo Versace, we are at the heart of an exceptional network of excellence. This enables us to always be at the forefront of research and innovation projects in the biomedical and engineering sectors, thanks to our team of highly qualified experts.

> Ph.D. Ing. Stefano Troncone CEO & Founder

### LI-WALK<sup>®</sup>

#### Infrared Thermal Stimulation, Robotic Exoskeleton, and Full Sensory Immersion and Kinematic Analysis

Li-Walk<sup>®</sup>, the cutting-edge system that combines advanced technologies to optimize the recovery journey of patients affected by stroke, trauma, and other motor conditions. With a unique combination of robotic exoskeleton and infrared thermal stimulation, Li-Walk<sup>®</sup> sets a new standard of excellence in rehabilitation. This pioneering device is designed to offer innovative support in lower limb rehabilitation pathways, laying the groundwork for a new direction in treatment and physical recovery.

#### Device for Walking Training with Infrared Thermal Stimulation and Autonomous AI Learning Capabilities.

Li-Walk<sup>®</sup> is a robotic exoskeleton used primarily for motor rehabilitation of patients with lower limb disabilities due to stroke, spinal cord injuries, or other neurological conditions. It is essential in gait therapy as it supports the patient's weight and guides their steps in a controlled and repetitive manner.

Mounted on a treadmill, it features a body weight support system to reduce the load on patients, facilitating walking even in those with severe motor impairments.

Using sensors and dedicated software, Li-Walk<sup>®</sup> ensures that leg movements follow a natural walking pattern, which can be personalized to fit individual patient needs. Infrared rays warm and prepare the muscles for exercise, increasing biofeedback and comfort during therapy.

Li-Walk<sup>®</sup> projects the patient into realistic scenarios via a curved monitor and a directional audio system with subwoofer that realistically reproduces This sounds. immersive step combination boosts motivation and makes the rehabilitation experience engaging effective. more and Robotic therapy like this allows for a high number of step repetitions, fundamental for motor learning and improving the ability to walk independently.

#### Innovation and Efficiency: Quick and Custom Fitting System in the Exoskeleton

Li-Walk<sup>®</sup> features a fast and advanced connection system, ideal for adapting efficiently to different patients. The leg length adjustments are fully motorized, allowing fast and precise calibration to each patient's unique needs. Additionally, the leg attachment systems include sliding guides that automatically adapt to the patient's femur and tibia dimensions. This mechanism not only reduces therapy setup time but also enhances patient comfort, ensuring a perfect fit and optimal support distribution during rehabilitation.



#### **Multisensory Stimulation**

Scientific evidence shows that targeted multisensory stimulation significantly improves rehabilitation outcomes. Simultaneous engagement of sight, hearing, touch, and proprioception promotes neuroplasticity, enhances biofeedback, and boosts patient motivation. Li-Walk<sup>®</sup> integrates these stimulations synergistically, offering an immersive and personalized rehab experience that accelerates recovery and increases awareness and durability.

#### **Infrared Thermal Stimulation**

Li-Walk<sup>®</sup> uses the therapeutic power of infrared rays to activate skin thermoreceptors, stimulating the nervous system and promoting neural plasticity. This allows therapists to engage in continuous dialogue with the patient about stimulus perception, enabling real-time therapy adjustments. This approach enhances motor function recovery—especially in stroke and trauma patients—and provides added benefits like muscle relaxation, pain reduction, and improved circulation.

#### **Auditory Stimulation**

With every step, Li-Walk® provides 3D sound feedback via directional speakers that realistically simulate walking sounds. This auditory input reinforces motor learning, improves movement awareness, and makes the overall experience more rewarding, contributing to more effective rehabilitation.

#### LIGHT FEEDBACK

Illuminated rings positioned at the hip and knee joints provide immediate visual feedback to the therapist: the brighter the light, the lower the patient's active participation. As the patient begins to contribute to the movement, the brightness decreases—turning off completely when the movement is performed autonomously.

#### **Immersive Visual Experience**

The integrated curved monitor creates realistic virtual environments synchronized with the patient's movements. This visual stimulation improves walking quality and strengthens the mind-body connection, leading to higher motivation and active engagement in the rehabilitation journey, with a positive impact on treatment effectiveness.

#### **Full Immersion**

An integrated camera projects the patient's image directly into the virtual environment, making them the protagonist of the rehabilitation setting. This complete immersion increases the sense of realism and enhances emotional and cognitive engagement during walking, making rehab feel more natural and stimulating.

This device is the result of years of research and development in collaboration with universities and centers, research representing pinnacle rehabilitation the of technology. Each component is designed to operate in perfect harmony, offering patients the opportunity best for recoverv and an exceptionally engaging rehabilitation experience.



### HOW DOES LI-WALK<sup>®</sup> WORK

#### BIOFEEDBACK

Patients, immersed in realistic virtual scenarios featuring their own projected body, receive visual, thermal, and auditory stimuli. These inputs activate a neurophysiological response that alters the robotic exoskeleton's control.

#### PATIENT PERFORMANCE ANALYSIS

The system processes the patient's biofeedback in real-time, analyzing responses to multisensory inputs. Collected data is used to send adaptation commands to the exoskeleton, personalizing the rehab experience based on patient needs.

#### **GAIT CONTROL INTERACTION**

The robotic exoskeleton dynamically adjusts its motion based on patient behavior, promoting active and conscious step control and aiding motor function recovery.



#### PERSONALIZATION AND ADAPTABILITY

Li-Walk<sup>®</sup> adapts to each patient's abilities and goals through real-time gait parameter adjustment and an intuitive interface for therapists. Each session can be tailored based on motor, cognitive, and motivational levels, making the device effective in both acute and chronic rehabilitation phases.

#### **PROVEN CLINICAL BENEFITS**

Li-Walk<sup>®</sup> is based on an evidence-based approach and integrates advanced technologies to support rehabilitation in patients with neurological and motor disorders. The integration of multisensory stimulation, biofeedback, and dynamic exoskeleton adaptation ensures a faster, targeted, and longer-lasting recovery. It is ideal for post-stroke, traumatic brain injury, spinal cord injury, and neurodegenerative condition treatments.

## **TECHNICAL SPECIFICATIONS**

| <b>VOLTAGE</b><br>CA 220 V 50Hz<br>3,1 kW      | <b>TRAINING SPEED</b><br>0.1 ~ 3,5 km/h  | <b>INFRARED RAYS</b><br>Short waves with variable<br>intensity                         |
|--|--|--|
| <b>SPASM MONITORING</b><br>3 adjustable levels | WEIGHT SUSPENSION<br>Load adjustment on the legs   | CUSTOMIZABLE<br>REHABILITATION PARAMETERS<br>Real-time display of resistance<br>curves |
| USER SPECIFICATIONS                            | WEIGHT: Less than 135 kg<br>HEIGHT: Less than 200 cm<br>LEG LENGTH:<br>Femur: 34 ~ 46 cm<br>Shinbone: 30 ~ 40 cm | ARTICULAR MOVEMENT ANGLE:<br>Hip joint:<br>30 ~ 50 °<br>Knee joint:<br>50 ~ 80 °       |

### WHO CAN USE LI-WALK®

Li-Walk<sup>®</sup> can be used primarily in patients with the following conditions: stroke sequelae, stroke, traumatic brain injuries, paraplegia, cerebral palsy, multiple sclerosis, Parkinson's disease, and orthopedic indications.



Average session time: 25 minutes, with 5 minutes for positioning the patient on Li-Walk and 20 minutes for the session.

- Intensive Therapy: 3 individual training sessions weekly over one month.
- Maintenance Therapy: 2 times a week for 3 weeks, to be repeated during the course of the year.
- Customized Treatments: Depending on patient cooperation and stage of the condition.

The duration of therapy is determined by the attending physician. Prescriptions are validated by specialized personnel following a detailed interview, tests, and patient analysis at the beginning and end of training.

### € SESSION COSTS

- Average cost per session: 100 300 €
- Average package: 20 sessions from 2,000 to 6,000 €

Costs vary depending on the duration and the rehabilitation center.



Infrared Robotic Rehabilitation

Via Pizzone, 11/7 - 84085 Mercato San Severino Salerno, Italy Phone: +39 089 820 15 04 E-mail: info@pandhora.it www.pandhorarehab.it



Project co-financed by the European Regional Development Fund

