# Apparatus capable of actuating a distal joint and transferring the constraining reactions in an underactuated shoulder exoskeleton

**INVENTORS**: Lorenzo Masia
Antonio Frisoli
Luca Tiseni
Domenico Chiaradia
Michele Xyloiannis
Massimiliano Solazzi

**STATUS PATENT:** Granted

**PRIORITY N° :** 102019000010026

**PRIORITY DATE:** 25/06/2019

**PUBLISHED AS:** IT; PCT

## Invention

The present invention finds application in the field of rehabilitation medicine and human enhancement in the industrial field. Exoskeletons are mechanical structure parallel to the arm, having multiple connection interfaces between human and robot: the greater number of interfaces allows to accurately determining the posture of the human limb based on the posture of the robotic one. The same applies to the torques at the human joints. One of the current challenges is represented the difficulty of obtaining the axes of the active robotic joints correctly aligned with those of the human body joints. In order to obviate to this problem in recent years soft wearable robotic devices have been introduced, i.e. characterized by flexible links, or entirely made of light, flexible materials such as fabrics of textile fibres or typical fibres of composite materials.

The present invention provides an underactivated mechanism for a robotic shoulder exoskeleton suitable for transferring the flexion-extension reaction force generated during actuation of the shoulder joint through an actuator positioned at the shoulder joint of the flexion extension. The patent consists of a passive kinematic chain. Chain links are arranged between two consecutive robotic joints, whose axes coincide with the anatomical center of rotation of the operator.

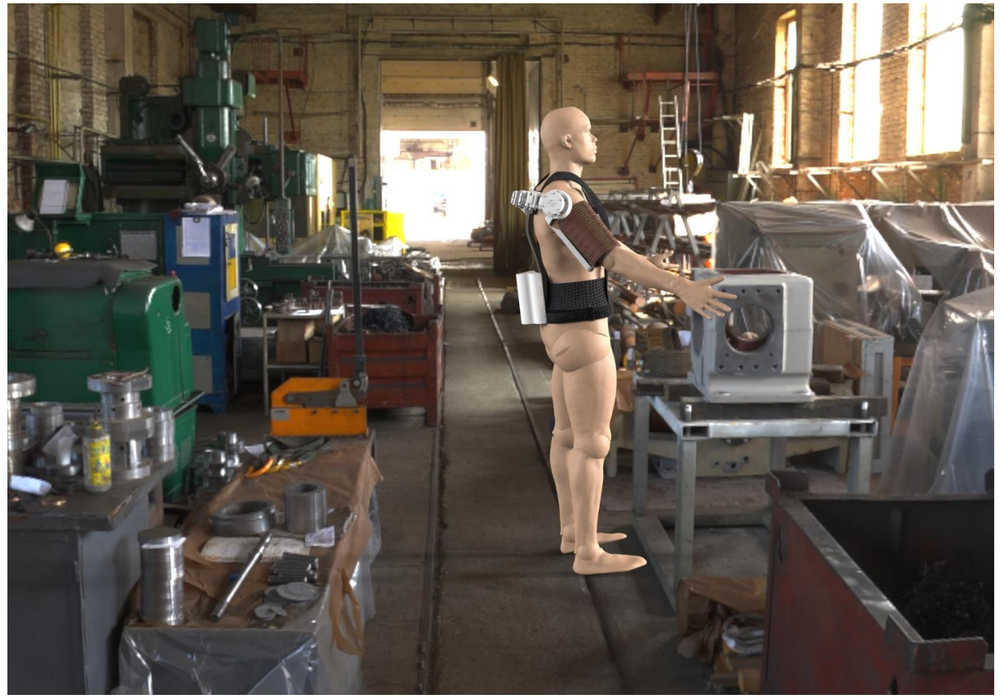
Thanks to this industrial patent, the shoulder exoskeleton has a completely passive degree of abdo-adduction and therefore does not exert any type of binding reaction. Contrarily, it is able to correctly unload the constraint reaction, generated by the flexion-extension of the shoulder, onto the user's bodice.

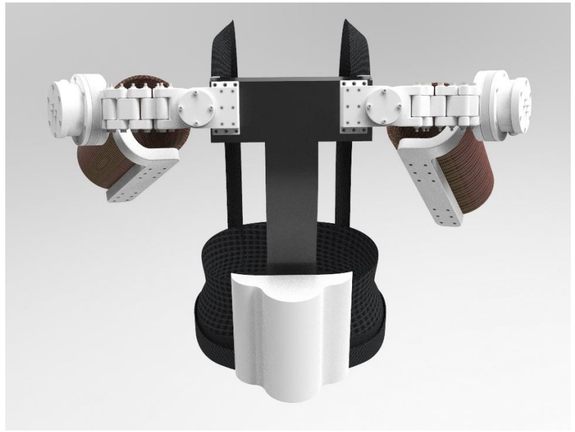
Main advantages of the current technology are:

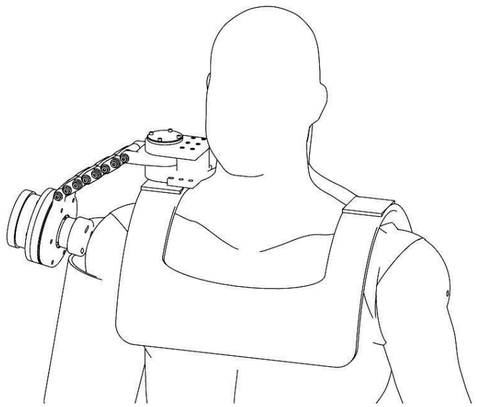
- Simple and not expensive
- High ergonomics
- Enhanced comfort for human-robot interfaces

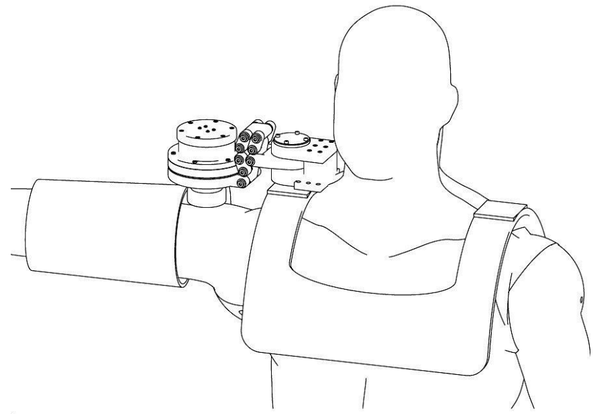
Heidelberg University is a co-owner of the patent.

# Drawings & pictures









# Industrial applications

The field of invention is wearable robotics for rehabilitation and for industrial applications. In the industrial field this patent enables the development of wearable exoskeletons that aim at reducing the risk of the onset of work-related musculoskeletal disease (WMSD) for workers, especially the ones assigned to repetitive tasks that imply the lifting of light/medium weights.

## Possible developments

Up to now, there is already a functional prototype of the device, developed and tested in laboratory, that was realized mainly using 3D printing production technology. The prototype validates the main functional and technical principles of the developed technology – TRL4. Further developments of the device should be guided by the end users. In this phase, the end users should test device and give feedback about it, in order to improve the design and proceed to a second prototyping phase, which will outputs one or more devices capable of bearing intensive testing sessions in real industrial environments.

For more information:


**Tech Transfer Office of Scuola Superiore  Sant'Anna**

**Headquarteres: Piazza Martiri della Libertà 33, 56127, Pisa**

**Web site: https://www.santannapisa.it/it**

**E-mail: uvr@santannapisa.it**


For more information:


**Ufficio Regionale di Trasferimento Tecnologico**

**Headquarters: Via Luigi Carlo Farini, 8 50121 Firenze (FI)**

**E-mail: urtt@regione.toscana.it**


SANT'ANNA SCHOOL OF ADVANCED STUDIES PISA

REGIONE TOSCANA

urtt Ufficio Regionale di Trasferimento Tecnologico