Indego Exoskeleton: The Advancement of Human Motion Control

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Parker Hannifin creates robotic lower limb orthotic device with intuitive torque power

When it comes to wearable robotics and exoskeletons, the engineers behind the Indego Exoskeleton are striving to be at the forefront of this emerging technology. Parker Hannifin [1], with the cooperation of Vanderbilt University, created an exoskeleton with one primary goal in mind—to create a useful, well designed, user friendly, empathetic product that would improve the lives of its users. There is certainly no shortage of wearable robotic products in the industry, but what makes the Indego different is its user-friendly design. The Indego allows people dealing with paralysis the ability to walk again. Since the whole purpose of the mechanism is to give those confined to a wheelchair

greater mobility, the engineers sought a practical, yet empathetic approach to the design process. They wanted to create a device that was durable, yet lightweight. They felt that it was important to make the end product intuitive enough for people to use with ease and comfort.

How Indego Works

The Indego exoskeleton is a robotic-powered, lower limb orthotic device, specifically designed to provide assistance to those with spinal cord injury. It also assists stroke patients by providing torque to the hips and knees. The orthotic device provides the significant joint torque necessary for patients to walk and climb stairs, and includes a custom-made embedded system powered by a lithium polymer battery, which gives it up to four hours of continuous walking time.

The Shepherd Center Clinic is currently testing Indego. Based on their evaluations, they noted several advantages over other exoskeletons on the market. In particular, Indego promotes user independence, due to its light, ergonomic design, which also helps make for easy transport. The design also offers several advantages for use in rehabilitation, as the level of robotic assistance automatically adjusts to the user’s level of muscle control.

Indego is the only wearable exoskeleton that incorporates functional electrical stimulation (FES) as a proven therapeutic technology. This specialized form of electrical therapy applies small electrical pulses to the muscles, which cause them to contract and relax, thereby improving the patient’s muscle ability. FES is particularly helpful for those with incomplete paraplegia. For those with complete paraplegia, Indego provides the FES necessary to improve circulation, prevent bone loss and density, and reduce muscle atrophy.

Indego weighs in at 27 lbs, making it nearly 50% lighter than other exoskeletons, and it is capable of supporting the patient’s weight, unlike other designs. This basic maneuverability allows patients to walk for longer periods of time, without getting fatigued. A slim profile, without the typical footplates or bulky backpack components, enables the user to wear the device while sitting in their wheelchair. The exoskeleton is designed to be worn with an off-the-shelf lightweight ankle-foot-orthosis to stabilize the foot. Further, the exoskeleton’s modular design allows it to be easily assembled and disassembled for transportation. These advantages provide the kind of independence patients desire.

Designing Indego

The original design team was quite small, which presents its own set of benefits and challenges, says technology lead and co-inventor, Ryan Farris, Ph.D. One benefit is more cohesive communication and collaboration, which also lends itself to an empathetic sensibility. On the flip side, a smaller team means each member must strive to be as effective and efficient as possible, as their individual collaboration is more important. The advanced research necessary for designing orthotic devices makes it a highly specialized field. Therefore, it is important that the design engineers are as specialized as the task.

The engineers at Parker Hannifin were able to overcome these challenges by balancing the clinical perspectives and mechanics of their design. The integration and balancing of clinical trials with technological advancement allowed them to remain true to their original intent. Farris says, “Our goal throughout the design process was to design a device that we would want to use if we were in the position to need it.”

Prototyping an Exoskeleton

With the leadership of Michael Goldfarb, Ph.D., director of Vanderbilt University’s Center for Intelligent Mechatronics, the team began working on concepts in 2009. Since then, a great deal of technological advancement has occurred in the field. Not

only was it a challenge to keep up with the most current technologies, but also in keeping up with the medical science involved in the device implementation. This included advancements in motor, battery, and sensor technology, as well as the advent of additive manufacturing.

In order to test their product, Parker Hannifin teamed up with the Shepherd Center in Atlanta, where they were able to try out their first exoskeleton prototype a mere nine months after the concept phase. The clinical trials gave important perspective that aided them in the immediate design feedback to bring them above the competition.

Indego was well received by both patients and clinicians, and the team of engineers received valuable feedback. During the two years of clinical testing, they were able to develop a successful prototype.

The exoskeleton they improved upon is now able to handle strenuous walking for extended periods of time, as well as climbing stairs. In addition to long hours and a great engineering team, it was this clinical perspective that ensured they would end up with a successful device.

Parker Hannifin is now in the product commercialization process with a targeted product launch by late 2014. Since the producers believe the process is ongoing, they are continuously making improvements and changes as technology advances. Currently, they are in the “hardening process” to improve the device’s overall durability and resilience.

An Empathetic Solution

The testament to Indego’s empathetic design can be found in the positive testimonials from its users: "It gives me freedom from my chair," says Michael Gore, a T10 complete paraplegic.

For those who suffer from paralysis, the exoskeleton is life changing. It gives them the independence and mobility they have longed for. This design approach is important for any consumer device, but especially for those in the medical field. It is apparent that Parker Hannifin’s engineers invested a great deal of time in understanding the needs of the patient, while striving to use the most advanced technology possible. Though Parker Hannifin acknowledges that exoskeleton technology has a long way to go, they are proud to be making meaningful contributions in the field.

For more information about the Indego Exoskeleton and Parker Hannifin, visit http://Indego.parker.com [2].

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[1] http://www.parker.com/
[2] http://Indego.parker.com