Advanced Manufacturing Alert (TechVision)

Robotic Exoskeletons for Industries

Wearable robots that simplify tasks in industries

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Contents

Innovations in Industrial Robotic Exoskeletons

Guardian GT- Big Arm

Sarcos Corp, USA

Tech Profile

- Guardian GT-Big Arm system is a robotic exoskeleton designed and made by Sarcos Corp to aid humans in heavyweight lifting.
- The robotic technology behind Guardian GT will enable users to lift weights ranging from 40 pounds to 400 pounds in various industrial and first responder environments.

Innovation Attributes

- Agile tracked vehicle base
- Weight lifting up to 400 lbs.
- 7 foot arm with 7 degrees of freedom
- Master-slave tele-operation system
- Diesel fueled engine capable of movement at 4 mph.

Market Opportunity

Guardian GT- Big Arm is a gigantic robotic exoskeleton capable of performing rather large tasks that would require a lot of human power. This robot has been commercialized and is seen as a very effective robot in various industrial applications for lifting, inspection and maintenance, welding ,grinding and many other applications.

Competing Aspects

- Heavy Material handling including metal sheets
- Minimal training required to operate
- Very useful in the petroleum industry, construction industry and heavy equipment manufacturing

Company Profile

Sarcos Corp has been developing advanced robotic systems for industry, entertainment and medical purposes and for unstructured environments. They have successfully designed robotic exoskeletons that have been tested and used by the US Army. Sarcos was acquired by Raytheon in 2007. In 2015, Sarcos LC completed the acquisition of the Raytheon Sarcos unit, enabling Sarcos to focus on commercializing past innovations.

Wide-scale Adoption

Guardian-GT is a giant of an exoskeleton. Nevertheless, its uses are many and is expected to see wide-scale adoption in construction, heavy machinery and in the military.

Technology Convergence

Guardian GT- Big arm is a product of convergence of various technologies. Mechanical movement and motion control sensors play a vital role in the design of Guardian GT. Other technologies that are used include pressure sensors and Internal combustion engine technology that makes Guardian-GT a 'heavy' weightlifting robotic exoskeleton.

Hybrid Assistive Limb® (HAL®)

CYBERDYNE Inc., Japan

Tech Profile

- Hybrid Assistive Limb® (HAL®) is touted as the world's first cyborg-type wearable robot. HAL improves the motion/movement capabilities of the user. It provides support for various body functions and often enhances many of those functions.
- HAL® is available in various forms for medical and non-medical uses.

Innovation Attributes

- HAL system also aids in motor learning of cerebral nerves.
- Feedback to the brain
- Highly autonomous

Market Opportunity

HAL is a unique robotic exoskeleton, perhaps the first one with cognitive abilities. HAL is available in the market in many developed countries. As CYBERDYNE has customized HAL for different applications, HAL has immense opportunities in the field of medicine, physiotherapy, industrial manufacturing, welfare and community development.

Competing Aspects

- Capable of reading bio-electric signals (BES) from the human body.
- BES detection helps in recognizing the motions intended by the user.
- Helpful in therapy for patients with limb injuries and amputees.

Company Profile

CYBERDYNE Inc. is a robot venture company established by Yoshiyuki Sankai, a professor in cybernetics at the University of Tsubaka. The intention of the company is to use the power of robotics, based on cybernetics (integration of human, robot and information systems), to help humans in various areas such as medicine, caregiving, welfare, labor, heavy works and so on.

Wide-scale Adoption

The number of application areas of HAL exoskeletons in medical care and industrial manufacturing promises wide-scale adoption in these industries.

Technology Convergence

Convergence of various technologies is central to HAL, including advanced sensors to read bio-electric signals to feedback mechanisms that help in motor learning of the cerebral nerves. HAL® incorporates a wide range of technologies to achieve its purpose.

FORTIS™ Exoskeleton

Lockheed Martin, USA

Tech Profile

FORTIS™ is a robotic exoskeleton produced by Lockheed Martin. It is designed to help users to use heavy tools with ease. FORTIS™ works by transferring the load through the exoskeleton to the ground underneath in kneeling or standing positions.

Innovation Attributes

- Lightweight design
- Increases wearer's strength and endurance
- Adapts to different body types and height
- Helps in effortless holding of heavy tools and equipment

Market Opportunity

FORTIS helps simplify tasks in the industrial environment. The capability of FORTIS™ to enable a user to lift and operate heavy equipment and tools can make this robotic exoskeleton very useful in industrial production environments, including ship building/ship maintenance.

Competing Aspects

- Compact
- Advanced ergonomic design
- Lightweight
- Increased productivity in industrial environments

Company Profile

Lockheed Martin is a well established global security and aerospace company. Most of its business is with the US Defense Department and other US Federal Government agencies. Lockheed Martin develops unpowered robotic exoskeletons for military and industrial applications.

Wide-scale Adoption

With the plug-and-play feature, FORTIS will contribute to increased productivity in industrial environments. This can eventually lead to wide-scale adoption of FORTIS in various industries.

Technology Convergence

FORTIS is a passive exoskeleton that has not relied on motors or sensors. It leverages key technologies enabling robot exoskeletons such as a mechanical assist arm that can make tools virtually weightless.

Robo-Mate

Robo-mate Consortium, Europe

Tech Profile

- Robo-Mate is a robotic exoskeleton developed by the Robo-Mate consortium.
- Robo-Mate is designed for lifting purposes and for usage in static postures.
- Robo-Mate is intended to decrease manual handling work in different industries.

Innovation Attributes

- Maximum flexibility and reactivity
- Integration with RFID (radio frequency identification) tag readers
- Consists of three modules: Trunk module for reducing weight to the lower back, passive arms module for gravity compensation, and active arms module for compensating higher weights in activities such as lifting

Market Opportunity

Robo-Mate's primary purpose is to help humans in lifting activities and usage in static positions. These activities are performed mainly in industrial environments. Europe being one of the world's biggest manufacturing hubs, Robo-mate will find extensive opportunities in various industries in the European region.

Competing Aspects

- Working conditions improvement through HMI bidirectional information flow
- Multi-sensor feedback and vision systems
- Application potential in various industries

Research Profile

The Robo-Mate consortium for development of useful robotic exoskeletons is funded for €4.5 million (about $4.95 million at the current exchange rate) by the European Union's Seventh Framework Programme for research, technological development and demonstration. The duration of the project is January 2013-January 2016.

Wide-scale Adoption

The Robo-Mate exoskeleton has key opportunities material handling in industrial manufacturing.

Technology Convergence

Convergence of various technologies form the crux of innovation for Robo-Mate. Convergence of various sensor technologies make Robo-mate an efficient robotic exoskeleton. The various sensors used in Robo-mate include multi-sensor feedback and sensor-based guidance.

Strategic Perspectives

Strategic Insights

Competitive Landscape

- Exoskeleton robot research programs from universities and startups funded by government defense departments are on the rise.
- The competition among exoskeleton robot companies is quite low as each of the companies and research projects has different approaches in achieving features that will help users.
- North America takes precedence in exoskeleton robot companies and research followed by the European Union.

Growth Potential

- The number of application areas for robotic exoskeletons that will help humans is increasing over the years. As many technologies are converging to create more interactive and helpful features in exoskeletons, robotic exoskeletons will add to human capabilities in varied industries.
- Many research projects and start-up companies are working on development of robotic exoskeletons. Robotic exoskeletons are also being considered to substitute or complement human soldiers in various armies

Funding Focus

- Funding support by government and venture capitalists is expected to accelerate the commercialization of prototypes and products. Technology developers would be able to bring innovative ideas to the market with financial support.
- While venture capital firms and other funding agencies continue to fund collaborative start-ups, government grants and loans are helping more research and product development in universities and industries in USA and European exoskeleton projects

R&D Focus Areas

Research and development is key to propelling the growth of any technology. Robotic exoskeletons are no exception. Some areas of research that require more attention are

- Cognitive abilities
- Sensory abilities
- Robot navigation capabilities

Appendix

Key Patents–Europe

No.	Patent No.	Publication Date	Title	Assignee
1	**EP 2985008**	17.02.2016	Robotic exoskeleton multi-modal control system	Harris Corp
	System and method for operating a robotic exoskeleton involves using a control system (107) to monitor an output one or more electrical activity sensors (202) disposed on a human operator. The control system determines if an output of the electrical activity sensors corresponds to a predetermined neural or neuromuscular condition of the user. Based on the determining step, the control system automatically chooses an operating mode from among a plurality of different operating modes. The operating mode selected determines the response the control system will have to control inputs from the human operator.			
2	**EP 2957393**	23.12.2015	Robotic exoskeleton with adaptive viscous user coupling	Harris Corp
	A system for preventing discomfort to a user of a robotic exoskeleton (200) determines the existence of an exoskeleton operating condition which has the potential to cause at least one of a discomfort or an injury to a user (204) when the exoskeleton is being worn by the user. Responsive to the determining, an exoskeleton control system (224) selectively controls at least one viscous coupling (208, 210) disposed at an interface location (201, 203) of the exoskeleton where a physical interaction occurs between a portion of the user and a portion of the exoskeleton when the exoskeleton is in use. The control system selectively varies a viscosity of a fluid (216) comprising the viscous coupling to control the stiffness of the interface.			

Key Patents–World

No.	Patent No.	Publication Date	Title	Assignee
3	**WO/2015/190938**	17.12.2015	A rehabilitation exoskeleton and an apparatus for transmitting torque	Auckland Uniservices Limited
	An apparatus (200) for transmitting torque is disclosed. The apparatus comprises a first member (20) for receiving a driving torque, a second member (23), and a resiliently flexible member (22) engaged with the first and second members (20, 23) for transmitting torque between them. The apparatus (200) further comprises measuring means (27, 29) for measuring an angular displacement of the first member (20) relative to the second member (23) when the first member (20) receives a driving torque in use. An exoskeleton robot (100) for use in rehabilitating a patient is also described.			
4	**WO/2015/099858**	02.07.2015	Upper-body robotic exoskeleton	Board of Regents, the University of Texas system
	The present disclosure includes a robotic exoskeleton comprising a back portion providing at least two degrees of freedom, two shoulder portions, each shoulder portion providing at least five degrees of freedom, two elbow portions, each elbow portion providing at least one degree of freedom, and two forearm portions, each forearm portion providing at least one degree of freedom. The present disclosure may also relate to associated robotic forearm joints and robotic shoulder joints.			

Key Patents

No.	Patent No.	Publication Date	Title	Assignee
5	**US 20150272809**	01.10.2015	Robotic device for assistance and rehabilitation of lower limbs	Università Campus Bio-Medico di Roma
	The present invention refers to a robotic device for assistance and rehabilitation of lower limbs, in particular, an exoskeleton for supporting the walking of a human being.			
6	**US 20150134080**	14.05.2015	Wearable robot and method for controlling the same	Samsung Electronics Co. Ltd.
	A wearable robot may include a gear part having an exoskeleton structure to be worn on legs of a user, a sensor part including a first electromyogram (EMG) sensor attached at a first location of at least one leg of the user, and a second EMG sensor attached at a second location, and a controller to detect a walking assist starting point to assist the user with walking, based on a first EMG signal detected by the first EMG sensor and a second EMG signal detected by the second EMG sensor.			

Industry Interactions

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