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Press Release

Medical Exoskeleton for Rehabilitation

The company Harmonic Bionics' was responsible for the design and construction of the Harmony SHR™ bilateral upper extremity exoskeleton. The main goal is to empower patients and care providers by creating sophisticated technology that facilitates a data-driven therapy procedure for dealing with neurological and musculoskeletal movement deficits.

Intent-based therapy, functional repetition, and early intervention are all made possible with Harmony SHR™, giving users the chance to enhance the effectiveness and efficiency of upper-body rehabilitation. Harmony SHR™, which has been designed to be force sensitive and to be controlled by force inputs from users instead of the position setpoints typical of most robotic arms.

The robot has been built with compliance in mind, meaning that even minor forces can trigger it to move out of the way, slow down, or stop altogether. With this function, the robotic exoskeleton is quite safe to use and be around.

The standard robotic actuators had to be redesigned due to this force sensitivity. A load cell that is mechanically isolated from any additional loads is used in Harmonic Bionics' revolutionary robotic actuator. As a result, each load cell is able to perceive the force applied by just the joint of the robot to which it is mounted, while being separated from the forces being applied to other joints. This maximises the load cell's sensing accuracy. The ESCON controllers made by maxon were compact in size and easy to integrate electrically and physically. (see Figure 2).

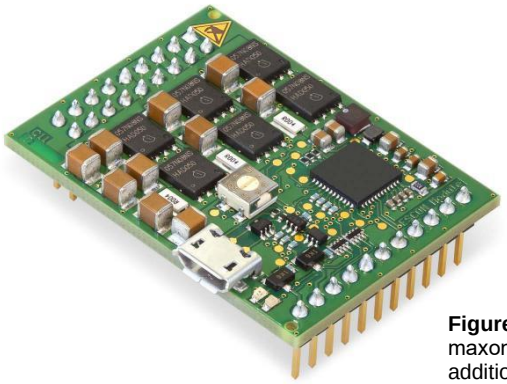

Figure 2:
maxon's ESCON controller a compact and powerful addition to the Harmony SHR exoskeleton.

Actuators used in the Harmony SHR exoskeleton are either rotary actuators with torque and angle sensing output used to assist with patient motion, or linear actuators with position feedback used to resize the robot to fit a patient. The exoskeleton is designed to provide objective assessment of a patient's movement capabilities. The system incorporates over 80 sensors that record measurements 2,000 times per second, allowing it to precisely measure multiple parameters, including range of motion, force generation, and number of repetitions.

The motion system uses several motors designed and manufactured by maxon. maxon was able to supply motors that satisfy a wide variety of unique needs of the system. For example, EC Flat motors provided the high torque output needed in a compact package that fit the exoskeleton's compact size (see Figure 3). The flat motors could also be supplied with angle sensors.

Figure 3:
maxon EC 60 Flat motor provides high torque in a compact package.

An EC 60 Flat motor was selected because the outer diameter was similar to that of the harmonic drive and because they are axially compact. The shaft of a maxon EC 60 DC Flat motor is attached to a wave generator of a size 17 harmonic drive, which was selected for its compact axial size and high torque capacity. Harmonic drive gear reducers offered the high reductions, low backlash, and high torque capacity the company needed for the design.

The stator of the maxon motor is mounted to the circular spline of the harmonic drive. The flex-spline of the harmonic drive is attached to an output shaft supported by a crossed roller bearing, which supports all loads that are not the torque output of the actuator. Because the crossed roller bearing supports the other loads, the only load that acts on the load sensor is the torque output of the load sensor.

The maxon motor, output shaft, and harmonic drive assembly are free to rotate in the crossed roller bearing. A bracket is attached to the circular spline of the harmonic drive and to the stator of the maxon motor. A load sensor is attached to the bracket so that output torque of the overall assembly can be measured through the load sensor.

The alignment of the harmonic drive to the shaft of the maxon motor is very critical to the life of the actuator. Even a minor misalignment can cause premature wear or failure of the mechanism. Therefore, the machined components are manufactured to be parallel to within about 20 microns while concentricity is maintained within about 30 microns to align the circular spline to the maxon motor. The overall footprint of the actuators inside the robot is approximately 80 mm in diameter and 90 mm in length. The machined components that go into each actuator are made from various fatigue resistant aluminum alloys, and grade 5 titanium where stresses are high.

The output torque of the overall actuator is approximately 30 Nm, and the actuator can output over 100 Nm peak. The actuator is attached to an extremely sensitive load cell, which has a resolution of less than 10 mNm. Each actuator is designed to have a life of over 3 million revolutions.

Conclusion
The actuators used in the Harmony SHR are of a mature design and are expected to need few improvements in the future. According to the company, it is unlikely that they will be changing any of the COTS components during future revisions, particularly the maxon components. maxon's DC motors were easily customized, plus the company offered low backlash versions of gear reducers for use in the rotary actuators, as well as small diameter brushed dc motor + planetary gearbox combinations to create compact rotary actuators. The company's leadscrew gear reducers were also available to use in linear actuator applications. All this is to say that maxon was able to supply all the motors and controller needed for the application, providing Harmonic Bionics with a reliable single supplier.

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The press release is available on the internet at: www.maxongroup.net.au

Mentioned products:

EC 60 flat θ60 mm,
brushless, 200 W,
with Hall sensors and
cables

ESCON Module 50/5,
4-Q Servocontroller
for DC/EC motors,
5/15 A, 10-50 VDC

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The Swiss specialist for quality drives

maxon is a developer and manufacturer of brushed and brushless DC motors. as well as gearheads, encoders, controllers, and entire mechatronic systems. maxon drives are used wherever the requirements are particularly high: in NASA's Mars rovers, in surgical power tools, in humanoid robots and in precision industrial applications, for example. To maintain its leadership in this demanding market, the company invests a considerable share of its annual revenue in research and development. Worldwide, maxon has more than 3000 employees at nine production sites and is represented by sales companies in more than 30 countries.