Fig. 1: The maxon flat motor keeps the patient's legs in move. © 2012 IRPT

Keeping muscles in shape.

For paraplegic people, rehabilitation is frequently a long process; this is why methods and technology that optimize these measures for the patient are so important. At the Bern University of Applied Sciences, many years of research has led to the development of a recumbent trike with electrical stimulation. The patient's movements are supported by a maxon flat motor.

Cycling with a recumbent trike can partially restore lost motor functions of patients with spinal cord lesions. Furthermore, it provides the patients with a very practical and successful basis for cardiopulmonary and muscular training units. The paralyzed leg muscles are reactivated by means of functional electric stimulation (FES) combined with controlled training.

At the Institute for Rehabilitation and Performance Technology (IRPT) at the Bern University of Applied Sciences, scientists and students perform research to further develop the rehabilitation method. The core competencies of the IRPT are cardiopulmonary and neurologic rehabilitation after strokes or spinal cord injuries, as well as feedback systems, automation and control of modern training devices. Procedures and systems are developed in an interdisciplinary team in cooperation with Swiss industrial companies and rehabilitation clinics. In October 2009, Kenneth Hunt, Professor for Rehabilitation Technology, became Director of the Institute for Mechatronic Systems at the Bern University of Applied Sciences. At the beginning of 2011, he founded the new Institute for Rehabilitation and Performance Technology. The Scottish-born expert in the field of rehabilitation was co-founder of the “Scottish Centre for Innovation in Spinal Cord Injury” in Glasgow and left his mark on the Centre as inaugural Director of Research. Furthermore he gained first-hand experience in the industry during his five years of working at the Department of Research and Technology of Daimler-Benz AG in Berlin.

Author: Anja Schütz, maxon motor ag

„The recumbent trikes are suitable for persons who suffer from paraplegia, a stroke or childhood-onset cerebral palsy. “We use methods and technology from the field of competitive sport to improve the rehabilitation process of people who suffered accidents or diseases,” explains Kenneth Hunt. FES was already used on the first generation of recumbent trikes, but at this stage no motors were used yet. The new generation is equipped with an electric motor that provides additional power to supplement the FES. FES alone can only generate a low power of 30 to 40 W, which means that the max. power and duration of use is very limited.

Figure 2: Recumbent trike prototype for adults. The power for the flat motor and rear wheel hub is supplied by a battery (red battery pack). © 2012 IRPT

Drive components for effective support of the leg power

The electric motor is needed to support the stimulation at the beginning. This means that the drive keeps the legs of the patient in motion. Furthermore the drive represents the controlled training unit that switches back and forth between brake/generator mode depending on the performance of the patient. The maxon motors are installed in the front section of the trikes, in the pedal bearings.

Accordingly, the requirements to the electric motors are high – both where the size and the power is concerned. The motor and gearhead has to fit between the pedals to keep the system as compact as possible. According to Kenneth Hunt, the maxon motors and the matching gearheads meet these requirements. The brushless maxon EC flat motors are the perfect solutions for many applications, thanks to their flat design. The 90 W flat motor used in the recumbent trike furthermore provides enough power for the application. The power is supplied by a battery that, in addition to the motor, also supplies the rear wheel hub with power.

Drive and brake in one

In the controlled training units, the motor initially moves the legs of the patient, before the muscles are stimulated. The more active the patient is, or the more muscle power is generated by means of the stimulation, the less support is required from the motor. As soon as the muscles generate enough force to move the legs autonomously or to work against a load, the motor acts as brake. For this reason, a 4Q control device is required for switching between motor and brake operation. A brake chopper is used for brake operation to eliminate the generated energy. The interaction between motor/brake and FES is controlled by special software that has been written at the Institute and that runs on a computer or micro controller.

Contrary to customary bicycles, the pedals and drive wheel of the trike are not connected by a chain. Both parts are decoupled from each other, so that such a chain is not required. The pedals and the drive wheel are only “coupled” by means of the control software. This provides a high level of flexibility, as the motion dynamics can be programmed by the software and adapted in real time. Two prototypes of the recumbent trike have already been completed for research purposes: One system for adults and one for children. Both systems are already completely functional, but still have to be clinically tested by patients. Large clinical studies conducted with the FES system (without motor) in the past have shown that the fitness of the patients is improved, the bone density in the large leg bones is increased and the paralyzed musculature is built up again.

After clinical testing has been completed, the plan is to commercialize the new generation of recumbent trikes as well, with the assistance of an industrial partner. Furthermore additional modifications and optimizations are planned for the recumbent trikes.

Author: Anja Schütz, Editor, maxon motor ag

Application note: 5598 characters, 893 words, 5 figures

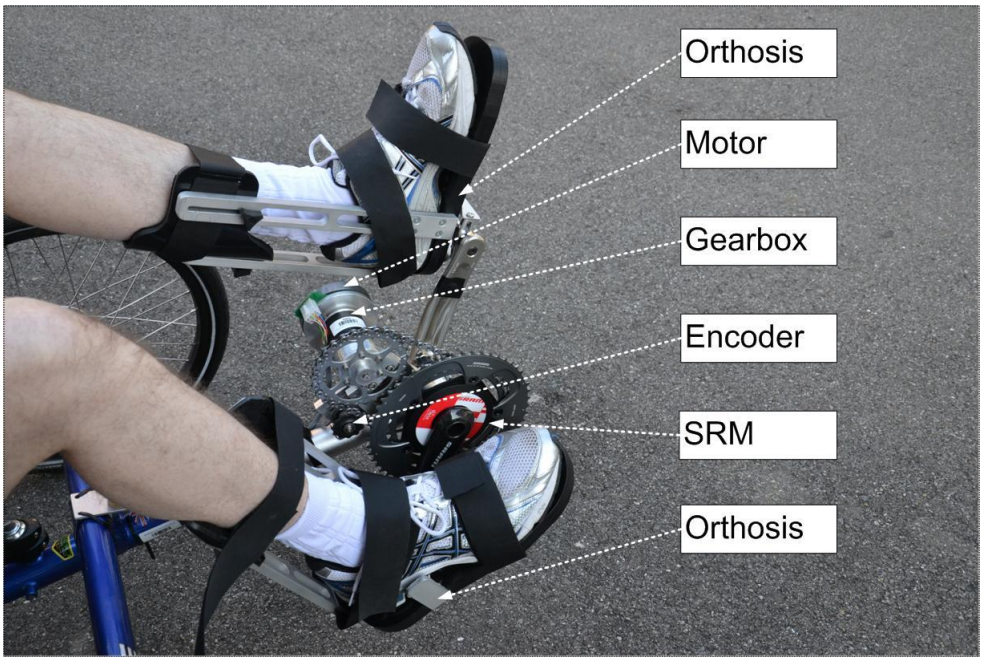

Figure 2: Orthosis, motor, gearbox, encoder and sensor (SRM) are perfectly adapted to each other. © 2012 IRPT

Figure 3: The 90 W flat motor used in the recumbent trike provides enough power for the drive task. © 2012 IRPT

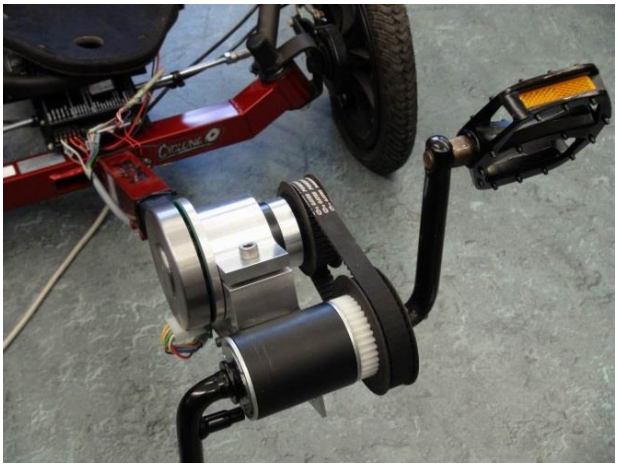

Figure 4: The power for the flat motor and rear wheel hub is supplied by a battery. © 2012 IRPT

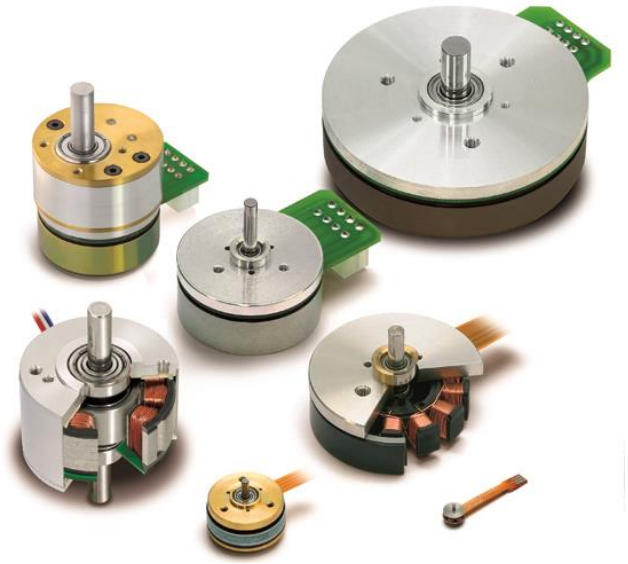

Figure 5: The brushless maxon EC flat motors are the right drives in many applications, due to their flat design © 2012 maxon motor

Video of FES-Cycling

Weitere Informationen erhalten Sie bei:

maxon motor ag
Brünigstrasse 220
Postfach 263
CH-6072 Sachseln

Telefon +41 41 666 15 00
Fax +41 41 666 16 50
Web www.maxonmotor.com

Berner Fachhochschule
Institut für Rehabilitation und Leistungstechnologie
Prof. Dr. Kenneth Hunt
Pestalozzistrasse 20
CH-3400 Burgdorf

Telefon +41 34 426 43 69
Web http://irpt.ti.bfh.ch/