POWERED FLEXION WRIST WITH ELECTRIC TERMINAL DEVICE - DEVELOPMENT AND PRELIMINARY CLINICAL TRIALS

Ed Iversen, Jeff Christenson, Harold Sears, Gregory Jacobs, Scott Hosie and Tony Jacobs

Motion Control, Inc.

ABSTRACT

Recent developments in areas as diverse as TMR surgery, pattern recognition, and implantable technologies for muscle and nerve interfaces, have helped to facilitate the feasibility of practical multi-input myoelectric upper limb (UL) prostheses.

Approaching the goal of a multi-degree of freedom (DOF) prostheses, the challenge remains of dependable wrist components for wrist flexion. Components are widely used for wrist rotation – but easily utilized powered flexion is not available.

In a recent study, the kinematics of wrist rotation versus flexion was evaluated through a mathematical model (Iversen, Christenson, 2016). The kinematic analysis shows that a powered wrist flexion/extension device expands the functional workspace.

As part of a U.S. Department of Defense (CDMRP, PRORP program) effort a robust motor-driven wrist flexion component has been developed, beginning with following general targets. The summarized results are in italics:

- Compatible with myoelectric TDs – the project necessarily included new quick disconnect approaches, with the attempt to evolve a new industry standard for a rugged, high strength, and shorter q/d.
- Highly rugged –field trials show the device withstands heavy duty usage, and is water and dirt resistant.
- High torque and speed - at least 2.8 Nm torque has been attained, and may be increased.
- Light weight – a goal of 45 gm has been attained.
- High range of motion (ROM)- 80 deg. of flexion, and 45 deg. extension for both motorized and passive ROM.
- Small scale field trials – three highly active wearers (as of 2/2017) have worn the prototypes as long as four months, in daily use, helping to build the wearer data base.

The Powered Flexion Wrist developments show a positive response to the functionality of the device, specifically:

- Field trial wearers are enthusiastic about the function of the powered flexion DOF for reaching the extremes of their prosthesis ROM with the wrist and TD in a natural position, without awkward positioning of their proximal joints.
- Wearers previously using wrist rotation found that powered flexion adds greatly to function, but does not fully replace the function of wrist rotation.
- The control of multiple DOF of wrist, in a natural manner is a challenge, but existing myoelectric control may be adequate for many wearers, so that additional surgical methods will not be obligatory.
- Exchanging between more than one (or several) terminal devices also will require new hardware developments, for shorter, high strength quick disconnection.