NEW CLINICALLY-USEFUL CONTROL STRATEGIES MADE POSSIBLE BY THE VARIGRIP II™ MULTI-DEVICE CONTROLLER

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ABSTRACT

The VariGrip II™ Controller can operate up to three variable speed motors. For inputs it uses two, three, or four variable voltages and one on-off switch. This makes a large number of control strategies available, but not all are clinically useful. To date the most popular controls have used two myoelectrodes to control two or three devices. The controller has been used with the two VASI elbows and the Hosmer and Boston elbows to solve clinical problems that were heretofore intractable. The system also permits proportional control of two-motor devices such as the Bock 2000 hands, the Steeper Gripper, and the Centri UltraLite hand. We will discuss a number of the strategies that have proven clinically useful.

Many devices can be controlled.

Since the VariGrip II system is designed to provide direct proportional control of electric motors, it follows that the devices controlled should be the manufacturer’s device without any electronic circuit. Listed below you will find the one and two motor devices that have been successfully controlled. In the lists below the synergetic prehensor has two motors, but they are wired in parallel and drive like one. The VASI hands are also available with the controller built into the hand when no other device is to be controlled.

1-Motor Gripping Devices
Bock 8E37 hands
Bock 8E32 greifer
Steeper series 200 hands
Hosmer Michigan Electric Hook
Hosmer NU-VA Synergetic Prehensor
NYU Hosmer Prehension Actuator
VASI Linear Actuator
VASI Childrens electric hands
Bock SUVA hand

2-Motor Gripping Devices
Centri UltraLite Hands
Steeper Powered Gripper
Bock 2000 Hands

Wrist Rotators
Bock 10517 Electric Wrist Rotator
VASI VR Series Electric Wrist Rotators

Elbows
VASI 38 Small Childs Elbow
VASI 812 Large Childs Elbow
Boston Elbow II
NYU-Hosmer Electric Elbows

Other Devices
VASI Linear Actuator
Steeper Electric Lock Elbow
Liberty Electric Actuator for Shoulder

New Single-Input Capabilities.

A patient with a single good myoelectric site has always been a challenge. A single poor site is even worse. The VariGrip II system programmed with Bloorview-MacMillan’s MyoMicro™ program offers new clinical choices.
The most popular choices for one-muscle control are the cookie crusher and quick-slow strategies. A third choice, the UNB dual-threshold or level control which is no longer available except as offered in the MyoMicro system, gives fixed speed control only. Each strategy has its limitations. Cookie crusher is perfect for a toddler, but its full-force closure is unsuited to an adult user. The Bock quick-slow circuit cannot be adjusted to suit the user, and finally the UNB level control only permits fixed speed operation. These three strategies are all offered with MyoMicro with the added advantage that delay times and other parameters can be set for the particular patient when the default value is not suitable. Further, the VariGrip II and VASI proportional hand circuits permit setting the extra gain that will accommodate a user who generates as little as a 5 μV maximal contraction.

Because even the three strategies above may not suit all patients, a new strategy has been added to the MyoMicro system called Alternate. With this strategy every other contraction closes the hand while alternate contractions open it. A default can be set to always make the next contraction open the hand after a waiting period. Several practitioners have used alternate with their patients either alone or in combination with more complex strategies.

**Differential control**

Differential control has been used by Liberty and Motion Control for over thirty years. It is the default control scheme with MyoMicro. Simply, differential control subtracts one muscle signal from the other and uses the resultant signal to control motion. To work well, differential control requires the rejection of inadvertent signals from either muscle using a “dead band” or “noise floor” setting. Thereafter, the strength of the two signals is adjusted until the user feels that generation of the two signals requires equal effort. Differential control is recommended whenever a weak muscle can only generate a signal with some cocontraction of the agonist present. With suitable gain adjustments the inadvertent cocontraction can be ignored using differential control.

**New mode selection schemes**

To use two myoelectric sites to control more than one device requires a selection strategy. Mode selection was introduced by Motion Control with the Utah Artificial Arm and later with the ProControl system. Liberty Technology has also made extensive use of mode selection with the Boston Elbow and now with the VariGrip II. With analog circuitry all of these schemes were limited to what could be easily built into a single circuit. Software control permits the construction of new ways to change control from one device to another.

The most reliable mode selectors are a rapid cocontraction of two muscles or the use of a switch. Neither scheme will cause inadvertent motion of the prosthesis. With MyoMicro it is easy to set up a scheme where slow contraction of either muscle controls one device while a quick contraction controls the second. One can also use a rapid contraction held for a period of time to initiate change. This can be done with just one muscle. In all cases once a mode is selected one can either wait for a second signal to shift back or one can set a revert time to automatically shift back to the default control.

**Unusual clinically-useful strategies**

A recent challenge was a patient who had only one usable upper arm muscle. She did not want to use a switch for mode selection. The quick-slow scheme was first proven to be good for controlling one device. Then several mode selection schemes were tried. The best scheme turned out to be a rapid, strong contraction sustained for a full second. The key element was “strong.” It was necessary to use a level higher than her normal quick-slow control levels. With this scheme, as soon as the signal reaches the “strong” level, it inhibits control of the direction normally selected by “quick.” The hardware used was a VASI 8-12 Elbow and a Bock SUVA hand with the VariGrip II controller.
Another use of the VariGrip II has been to add new strategies to the Boston Elbow. The most obvious addition is the use of cocontraction to shift modes. With MyoMicro software the exact type of cocontraction can be tailored to the user. One can use cocontraction to select two or three devices and can also add automatic reversion to the default device. Cocontraction to select modes is now considered a standard offering.

The VariGrip II controller also permits any one-muscle strategy to be used with the Boston Elbow. For instance, a patient was recently fit using alternate as the control strategy and a switch for mode selection.

Making setup easy for the practitioner

Setting up a complex control scheme is work best left to people with a background in electronics, computers and control systems. Liberty Technology in the USA, VASI in Canada and a few trained practitioners all have the required expertise. For the average practitioner all that is required is the ability to evaluate the patient and to define the clinical challenge. New challenges will lead to new control schemes. Fortunately, once a scheme has been tried on one patient it is permanently available for use with others. At present the library of control schemes has at least 55 variations in it. An ongoing challenge will be to publish these schemes using vocabulary that is clear to the clinician rather than to the technical people who conceived of them.

Figure 1  This elaborate MyoMicro screen is used to program the Varigrip II to control both a hand and elbow with one muscle. Mode selection uses a quick, strong, sustained contraction. There is no need for the prosthetist to learn how to set up the scheme. This is the manufacturer's job.