

Electromyographic Switch Navigation of Power Wheelchairs

The EMG switch employs surface electrodes to sense muscle activity.

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The electrode signal is connected to a microprocessor based signal processor which converts the signal activity into a single switch closure. The switch closure is used to drive a scanning wheelchair control module.



Left to right: EMG Electrode, Reference Electrode, Omni+ Scanner Control Panel, Functioning Wheelchair, Model RRSS EMG Switch front and rear panels (below right).



The Problem

Independently navigating a power wheelchair can become a tremendous challenge for persons with progressive neuromuscular disorders. While muscle weakness and limited range of motion presents the initial challenge, this is exacerbated by diminishing abilities that can make dynamic proportional control systems inaccessible.

EMG activity is used extensively for prosthetic control and recently for computer control, but its use for power wheelchair control has not found wide acceptance.

The Study

This case study demonstrates that EMG control of a switch based scanner control system offers a viable means for persons with severely limited motor movement to independently control a power wheelchair.

The Method

The switch based scanner control system used in this case study is available through PG Drives Technology's Omni+ Specialty Controls Module. The Single Switch Scanner option provides cycling menus that offer control of navigation, seat actuators, and system options.

Menu choices are selected by engaging a single Mode/Stop switch connected to the Omni+ Module via a 3.5mm jack socket. In this study, the Tinkertron Model RRSS EMG switch available through Emerge Medical was used as the single switch, and a 3.5mm cable provided the interface between the modules. The Model RRSS EMG switch is designed to sense EMG signals and convert the signals into a switch closure output. The device is completely self contained and operates on internal batteries which helps reject transient signals from the large currents associated with the motors in the power wheelchair.

Key Issues

- Through the Omni+ Module, any one of five profiles can be programmed to offer variations in speed, acceleration, deceleration, turning speeds, and latched vs. momentary control. With these profiles pre-programmed, a single-switch scanning user has the needed flexibility to navigate in all possible environments and conditions.
- A critical link in the system is the identification of the most effective and most comfortable placement of the electrodes.
- Key to the success of single-switch scanning navigation is the availability of a "cutoff" switch accessible to the user for emergency stopping. Having the cutoff switch available allows the user to drive more naturally and aggressively in latched mode without fear of losing control.

Benefits

- All seating and positioning considerations can focus on stability and comfort.
- With the EMG switch and single-switch scanning, the user could (for the first time) use all seating actuators for changing positions while also being able to independently return to a driving position.
- EMG switches which stick onto the surface of the skin stay in place no matter what position changes the person makes.
- The user tolerated colder temperatures for extended periods of time without noticing any reduction in ability to engage the EMG switch.
- Steering corrections require insignificant muscular effort sparing the user from fatigue.

In Conclusion

This work indicates an EMG switch is an effective alternative to other single-switch methods, and offers significant benefits over the traditional sip-and-puff switch systems. The device has been used continuously for 6 months and is now the preferred switch method for the user.

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TABLE 1: Five-Profile System for Single EMG Switch Scanning

Functional Title	Profile #1	Profile #2	Profile #3	Profile #4	Profile #5
Latched/Momentary	Cruise	Proximity	Cruise	Crawl	Crawl
Latched F	Latched F	Momentary	Latched F/R	Momentary	Latched F/R
Acceleration	10	10	10	10	10
Deceleration	20	60	20	60	20
Forward Speed Max.	90	40	90	25	25
Forward Speed Min.	38	10	38	25	25
Reverse Speed Max.	50	40	50	25	25
Reverse Speed Min.	25	10	25	25	25
Turning Acceleration	20	20	20	20	20
Turning Deceleration	20	60	20	60	20
Turning Speed Max.	20	30	20	30	20
Turning Speed Min.	5	10	5	10	5

EMG SWITCH SETTINGS	
Click Duration	200ms
Click Holdoff	200ms
Reen Enable/Disabled	Disabled

Table shows the parameter settings for each of 5 profiles of the Omni+ Module used during this investigation. Also included are the EMG switch parameter settings. The Click Duration was set to 200ms. Click duration is the time that the switch closure remains closed after the EMG signal increases above the threshold setting. The Click Holdoff was also set to 200ms. Click Holdoff is the amount of time between activations before another switch closure can occur. Click Holdoff prevent double clicks as the EMG signal drops below the threshold for activation.

References

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