شرکت فناوری سامانه های الکترونیک عصبی

NeuroTekTronix, Inc.

ParaWalk®

Model 108

Neural Technology

Standing and Walking in Paraplegic Subjects

Made In IRAN

ParaWalk®

The ParaWalk is a new portable, 8-channel, and menu-driven microprocessor controlled functional neuromuscular stimulation (FNS) that enables complete paraplegic subjects with upper motor neuron lesion and some incomplete paraplegics to stand from a sitting position, walk short distance, and sitting from standing position unbraced with the support of a walker, following a prescribed period of physical therapy training under aggressive assessment and rehabilitation management of subject with spinal cord injury.

The ParaWalk can be also used for a wide range of therapeutic electrical stimulation applications. The purpose of therapeutic electrical stimulation is to improve tissue health or voluntary function by inducing physiological changes that remain after the stimulation is used. In contrast, the purpose of an FNS intervention is to enable function by replacing or assisting a person's voluntary ability.

Functional, Physiological, and Psychological Effects

The ParaWalk® enables complete paraplegic subjects with upper motor neuron lesion and some incomplete paraplegics stand from a sitting position, walk short distance, and sitting from standing position unbraced, with the support of a walker and assistance if required, following a prescribed period of physical therapy training under aggressive assessment and rehabilitation management of subject with spinal cord injury. The functional applications of the ParaWalk® may include:

- ⇒ standing from a sitting position,
- ⇒ walking short distance,
- ⇒ sitting from standing position unbraced








Moreover, the ParaWalk can be used for a wide range of therapeutic electrical stimulation applications. The purpose of therapeutic electrical stimulation is to improve tissue health or voluntary function by inducing physiological changes that remain after the stimulation is used. In contrast, the purpose of an FNS intervention is to enable function by replacing or assisting a person’s voluntary ability. Therapeutic applications of the ParaWalk® may include:

- ⇒ Increase muscle bulk and strength in the lower extremities
- ⇒ Slow osteoporosis and help maintain or increase lower extremity joint range of motion
- ⇒ Reduce risk of decubitus ulcers
- ⇒ Aid bowel and bladder function
- ⇒ Improve circulation in the legs
- ⇒ Improve cardiovascular health
- ⇒ Reduce spasticity
- ⇒ Increase in Physical self-concept and a decrease in depression
- ⇒ Improve fitness

How does Parawalk® work?

In the Parawalk® system, sequences of current pulses excite the intact lower motor neurons, which in turn contract paralyzed muscles. Activation of the lower motor neurons is achieved using electrodes placed on or near the innervating nerve fibers. By changing the parameters of the stimulation signal, the level of contraction can be altered to perform a specific task. To provide functional use of the paralyzed limbs, an appropriate electrical stimulation pattern should be delivered to a set of muscles.

Any arbitrary stimulation pattern can be generated by the ParaWalk. The stimulation pattern can be designed using a graphic user interface (GUI) running on a personal computer (PC) and transferred to the ParaWalk through USB cable. The system uses pulse width modulation to regulate the stimulated muscle force. The ParaWalk provides on-line monitoring of functional operation of the system and electrode lead connection, and appropriate visual and audible alarm indicate the fault condition.

Who can benefit from Parawalk®?

The Parawalk® is designed for standing and walking of some certain paraplegic subjects with a complete traumatic spinal cord lesion between T4 and T12. Before instituting the ParaWalk for any paraplegic subject, certain parameters of his or her physical, mental, and emotional condition must be evaluated.

1. Status: 6 months post-recovery spinal cord injury and restorative Surgery (if any), or as determined by systems.
2. Stable ortho-neuro-metabolic systems.
3. Spinal Cord Injury at a level between T-4 and T-12.
4. Intact lower motor units (lumbar level L-1 and below).
5. Certain incomplete lumbar level SCI patients if the lesion is serve enough to prevent the patient from standing and ambulating.
6. No history of long bone stress fractures, osteoporosis, or severe hip or knee joint disease.
7. No history of cardiac or respiratory problems.
8. Adequate trunk stability so that once quadriceps are stimulated, the patient can hold his upper trunk upright while supporting himself with a walker.
9. Motivation: the patient demonstrates and expresses appropriate desire and commitment to training program.
10. The patient demonstrates appropriate muscle contractions in response to functional electrical stimulation.
11. Minimal or acceptance amount of spasticity.
12. Sensory perception of electrical activity is absent, or if minimal, is non- painful and acceptable to patient.
13. Standing tolerance: The patient has adequate fatigue tolerance to practice and perform standing and walking functions.

12. Balance and trunk control: patient has adequate balance and control skills to independently maintain an upright supported posture.
13. The patient must have adequate hand and finger control to manipulate the system control.
14. Sufficient upper body and arm strength to lift oneself and grasp chair when stimulation is stopped for any reason.
15. It is noted that patients with very labile blood pressure are subject to vertigo when practicing with FES, as stimulation contracts muscles in lower part of the body that are otherwise paralyzed, thus affecting circulation. Such patients may complain of dizziness and should be permitted to lie recumbent for a period of time. The rate of FES training should then be carefully monitored.

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Selected Publications

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2. A. Roshani and A. Erfanian, A modular robust control framework for control of movement elicited by multi-electrode intraspinal microstimulation, *J. Neural Eng.*, vol. 13, no. 4, 2016
3. A. Roshani and A. Erfanian, "The effects of stimulation strategy on joint movement elicited by intraspinal Microstimulation," *IEEE Trans. Neural Systems and Rehabilitation Eng.,* vol. 24, no. 7, pp. 794-805, July 2016.
4. A. Farhoud and A. Erfanian, "Fully automatic control of paraplegic FES pedaling using higher-order sliding mode and fuzzy logic control," *IEEE Trans. Neural Systems and Rehabilitation Eng.,* vol. 22, no. 3, pp. 533-542, May 2014.
5. V. Nekoukar and A. Erfanian, Dynamic Optimization of Walker-Assisted FES-Activated Paraplegic Walking: Simulation and Experimental Studies, *Medical Engineering & Physics,* vol. 35, pp. 1659-1668, Nov. 2013.
6. A. Roshani and A. Erfanian, "Restoring Motor Functions in Paralyzed Limbs through Intraspinal Multielectrode Microstimulation Using Fuzzy Logic Control and Lag Compensator," *Basic and Clinical Neuroscience*, vol. 4, no. 3, pp. 50-61, August, 2013.
7. V. Nekoukar and A. Erfanian, "A Decentralized Modular Control Framework for Robust Control of FES-Activated Walker-Assisted Paraplegic Walking Using Terminal Sliding Mode and Fuzzy Logic Control," *IEEE Trans.* Biomed. Eng., vol. 59, no. 10, Oct. 2012, pp. 2818-27.
8. A.-R. Asadi and A. Erfanian, "Adaptive neuro-fuzzy sliding mode control of multi-joint movement using intraspinal microstimulation," *IEEE Trans. Neural Systems and Rehabilitation Eng.*, vol. 20, no. 4, July 2012, pp. 2818-27.
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11. V. Nekoukar and A. Erfanian, Adaptive fuzzy terminal sliding mode control for a class of MIMO uncertain nonlinear systems, *Fuzzy Sets and Systems,* vol. 179, no. 1, Sept. 16, 2011, pp. 2818-27.
12. H.-R. Kobravi and A. Erfanian, "A decentralized adaptive robust method for chaos control," *Chaos*, *American Institute of Physics,* vol. 19, 2009, pp. 033111-1, 033111-7
13. H.-R. Kobravi and A. Erfanian, "A decentralized adaptive robust control based on sliding mode and nonlinear compensator for control of ankle movement using functional electrical stimulation of agonist-antagonist muscles," *J. Neural Eng.* vol. 6, 2009, pp. 2818-27.
14. A. Ajoudani and A. Erfanian, "A neuro-sliding mode control with adaptive modeling of uncertainty for control of movement in paralyzed limbs using functional electrical stimulation," *IEEE Trans. Biomed. Eng.* vol. 56, no. 7, pp. 1771-1780, July 2009.
15. M.-M. Ebrahimpour and A. Erfanian, "Comments on 'Sliding Mode Closed-Loop Control of FES: Controlling the Shank Movement'," *IEEE Trans. Biomed. Eng.,* vol. 55, no. 12, Dec. 2008.
16. **A. Erfanian,** H.J. Chizeck, and R. M. Hashemi, "Using evoked EMG as a synthatic force sensor of isometric electrically stimulated muscle," *IEEE Trans. Biomed. Eng.,* vol. 45, no. 2 pp. 188-202, 1998.
17. **A. Erfanian,** H. J. Chizeck, and R. M. Hashemi, "Functional Neuromuscular Stimulation: The EMG-Joint Angle Relationships in Electrically Stimulated Muscle," *Scientific Journal of Shahed University*, no.7-8, 1996.
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29. V. Nekoukar and A. Erfanian, "Optimal walking trajectories estimation using wavelet neural network for FES-assisted arm-supported paraplegic walking," 10th Vienna International Workshop on FES and 15th IFESS Conference, Vienna, Austria, Sept. 8-12, 2010.
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39. A. Roshani and A. Erfanian, Recruitment Properties of Intraspinal Microstimulation Using Pulse Amplitude Modulation and Pulse Width Modulation, 1th Basic and Clinical Neuroscience Congress, Nov. 7-9, 2012, Tehran, Iran.
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NeuroTekTronix Inc.
Nramak, Hengam Street, Iran University of Science and Technology
Tehran, IRAN
Phone: +98-21-77240465
Mobile: 09368790892
Email: erfanian@iust.ac.ir
www.aparat.com/neurotektronix
www.neurotek.ir