Engineer: Computer learning, electrical stimulation offer hope for paralyzed

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Trainers have used it for decades to help athletes build muscle. Late-night TV commercials hawk it as an effortless flab buster.

But a University of Florida engineering researcher says electrical stimulation — a simple, decades-old technique to prompt muscles to contract — can be combined with sophisticated computer learning technology to help people regain more precise, more life-like control of paralyzed limbs.

Although his research is still exploring the fundamentals, his progress so far suggests computer-adapted electrical stimulation could one day help the estimated 700,000 Americans who suffer from strokes and the 11,000 who suffer from cord injuries annually.

"It's an adaptive scheme to do electrical stimulation more efficiently, with less fatigue and more accuracy," said Warren Dixon, an associate professor of mechanical and aerospace engineering, explaining that existing techniques do little more than apply a set current to a designated muscle.

Stroke victims may be among the first to benefit. Dixon said stroke sufferers who work at regaining the ability to walk often unconsciously drag their toes, causing them to stumble. He said his goal is to develop techniques for a wearable, pacemaker-sized device. The device would deliver just the right stimulation to the calf at just the right moment in a person's gait, lifting the toe just enough to avoid a stumble and walk naturally.

The device would adapt to individuals, adjusting itself to weight, activity and diet, he said. It might even act as a kind of robotic therapist to the patient, guiding him or her in the proper action while very slowly backing off its own electrical input.

Dixon, who has published several papers on his research since receiving a prestigious National Science Foundation Faculty Early Development Career Development Program award in 2006, recently authored a paper accepted in the *IEEE Transactions on Neural Systems and* Rehabilitation Engineering. Publication is anticipated for this summer.

At its most basic level, electrical stimulation is a simple and well-understood process.

Electrical pads are placed on the skin, and when a small current is applied, the muscle contracts involuntarily.

Trainers have long used the technique, which may cause a slight tingling sensation but is not painful, to build or tone athletes' muscles. Electrical stimulation is also at the heart of products touted, for example, to help people build "six-pack abs" without working out.

But the most promising application may be in physical rehabilitation, Dixon said. Specialists already use electrical stimulation to prevent unused muscle from atrophying - in effect, "exercising" the muscle even though the patient has lost the ability to move it herself.

Physical therapists and some products also use electrical stimulation for purposeful movement. One commercially available walker, for example, taps preprogrammed stimulation patterns to help paralyzed people stand for brief periods of time.

Dixon said that while the current state-of-the-art shows the potential, it only applies a predetermined and relatively high voltage to a designated muscle.

That means that while the muscle may move, it can easily fatigue, becoming less responsive and sore. Also, electrically stimulated movements tend to be rough, without the degree of control and variation — the subtle bends or twists that make all the difference in so much common movement — that people with functioning limbs take for granted.

Dixon and his graduate students are developing methods aimed at improving that model using techniques of "adaptive learning," or giving a computer the ability to learn from a patient's actions and reactions and adjust its muscular stimulation accordingly.

One of their main tools: a standard leg lift, or leg extension, exercise machine modified with electrical pads and sensors, and networked with a computer. The system measures and compares electrical stimulation and subsequent leg movement and direction — the "patient" is actually a healthy graduate student — to steadily determine pathways to become more sensitive and responsive to the user.

"We start with a desired trajectory, we do the leg extension, encode that in a computer and measure the motion," Dixon said. "Then we develop control methods to intelligently stimulate the muscle to make it behave the way it should."

Source: University of Florida (news : web)