RUPERT™
A Device for Robotic Upper Extremity Repetitive Therapy

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Stroke is the third largest cause of death ranking behind heart disease and all forms of cancer. It is a type of cardiovascular disease that affects the arteries that lead to and from the brain. If one of these bursts or becomes blocked then oxygen will not get to the brain and it begins to die. Stroke kills nearly 163,000 people every year and is the leading cause of serious long term disability in the United States. Stroke can cause paralysis, affect language and vision, and lead to memory loss.

Researchers at Arizona State University are working with a local company Kinetic Muscles, Inc., to develop a robotic arm that will help stroke survivors regain the ability to perform basic tasks of everyday life. The RUPERT™ stands for Robotic Upper Extremity Repetitive Therapy and is a rehabilitative device that aids in task oriented repetitive therapy. Dr. Jiping He leads the research team of the Bio-design Institute at Arizona State University that has created this device. Kinetic Muscles, Inc. started to produce prototypes in 2005, which was funded with a $1.6 million grant for the National Institutes of Health.

The RUPERT™ is being developed to provide a low cost, safe and easy-to-use, robotic-device that can assist and benefit a patient and therapist in a clinic or home environment. The device is wearable, lightweight, and portable and can be worn sitting or standing to perform the repetitive activities. The RUPERT™ has five actuated degrees of freedom driven by compliant and safe pneumatic muscle actuators (PMA). This device assists in shoulder elevation, humeral external rotation, elbow extension, forearm supination and wrist/hand extension. This device also adjusts to each individuals arm length and body sizes. It is designed to extend the arm and move in 3 dimensional spaces and is also created so that gravity is not compensated for, so that the patient is practicing in a natural environment.

The device uses a closed-loop controller combining feed back and feed forward. It uses a proportional integral derivative controller or a PID-based feedback. This is a generic control loop feedback that attempts to correct error between a measured variable and a desired set-point by calculating and outputting the correct action that can adjust the process going on. This device also uses an iterative learning controller (ILC)-based feed forward controller. This type of control can aid in overcoming the nonlinear nature of the patients control while adapting to all type of patient who perform differently. The sensors feed back the position and force information for quantitative assessment of the task. This can also provide real-time assessment of functional improvement of the patient.

This device is beneficial to stroke victims because it is able to mimic a natural extension of the arm using the PMA's. Secondly, this device is able to be individually programmed for repetitive exercises that improve hand and arm strength and flexibility. The first prototyped RUPERT™ was fitted and tested on able bodied individuals and stroke survivors. There were 8 able-bodied testers that tried the device to see how well is adjusted to fit each individual case. The device was used by two stroke survivors that completed a three-week course of intensive repetitive therapy. At the moment RUPERT™ II, which is the second generation prototype, is under development using the data collected by previous evaluations.

Most labor intensive repetitive physical therapies are very expensive which health insures may limit or deny coverage. Recent research has suggested that performing repetitive motor function exercises over a period of time can help stroke survivors recover significant use of their limbs. Dr. Jiping He hopes that the availability of the RUPERT™ will provide a low cost, safe and easy-to-use, robotic-device that can assist and benefit a patient at home or in the clinic

References:

Jiping He, Edward Koeneman, James Koeneman, et al. "Design and Control of RUPERT: A Device for Robotic Upper Extremity Repetitive Therapy." IEEE Transactions on Neural Systems and Rehabilitation Engineering. September 2007; 15: 336-346.

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