

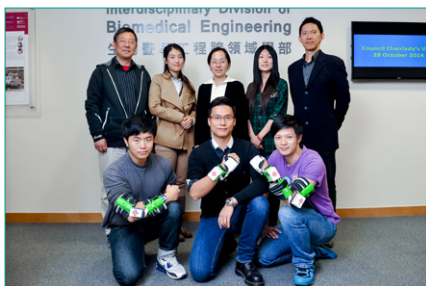
Technology Frontier

News Bite on PolyU's Innovation

Intention driven Rehabilitation Sleeve

A hybrid approach to motor re-learning among stroke patients

Rehabilitation training for stroke patients is repetitive and boring. Mere physical therapy doesn't always guarantee good rehab results either. To improve rehabilitation for stroke patients, the Interdisciplinary Division of Biomedical Engineering developed an innovative rehabilitation device that combines both Functional Electrical Stimulation (FES) and robot-assisted therapy, proven to help stroke patients regain sensorimotor functions better and faster than either device alone.



Dr Xiaoling Hu (back row, middle) and the research team



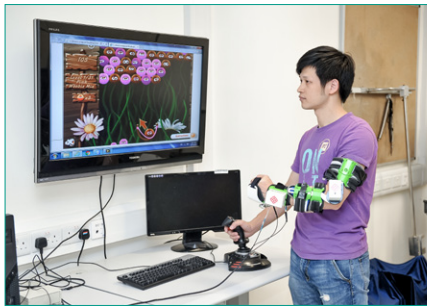
The Rehabilitation Sleeve combining FES and robotic technologies

In the U.S. alone, a stroke occurs every 40 seconds¹. In severe cases, patients suffer from paralysis and are unable to take care of themselves. Post-stroke rehabilitation has been useful for patients to relearn skills that are lost when part of the brain is damaged, such as walking and moving their hands. Yet, physical therapy is a long and repetitive process that many patients find frustrating. In recent years, robot-assisted therapy and Functional Electrical Stimulation (FES) have been employed in post-stroke rehab. They work in different ways and have their own merits. Dr Xiaoling Hu, Assistant Professor of the Interdisciplinary Division of Biomedical Engineering, and her

team combined the two approaches and invented Rehabilitation Sleeve. "Neither robotics nor FES is new technology, but it's new to combine both in one single rehab device that is controlled by a user's voluntary intention," said Dr Hu.

FES and robotic

In FES treatment, small electrical pulses are applied on the paralysed muscles to create artificial contractions. "The principle behind is to generate repeated muscle contractions while causing a sensory feeling. That would stimulate the brain to develop alternative neural pathways around the damaged or blocked ones, and to re-build a motor centre. That's



Computer games can be incorporated in interactive training programmes, where user's limb movements are interpreted as mouse inputs.



The project reaped a gold medal and a special merit award at the 43rd International Exhibition of Inventions of Geneva.

how patients regain some motor skills after stroke," said Dr Hu. On the other hand, robotic therapy involves the use of external machines to help patients move. "It's more about training joint motions than rewiring neural pathways for individual muscles. There are active and passive robot-assisted therapies. Active devices provide interactive assistance to patients when they want to move, while passive devices only dominate the limb motions without effort from the users," she added.

Combining both with voluntary intention

Rehabilitation Sleeve developed by Dr Hu features both FES and robotic elements to help stroke patients recover faster and better. "The Rehabilitation Sleeve is a voluntary intention driven system. Even though stroke patients may not be able to move their limbs freely, there is a small current that passes through their residual muscles when they want to move. Such current is detected by skin sensors before interactive robotic assistance and FES are applied. In other words, we need the patients to make an effort to move no matter how little the movement is because that's the key to rehabilitation," explained Dr Hu. The hybrid system also has the advantage to tell whether the right muscles are engaged in a certain motion as indicated by the FES applied on the target muscles.

Wearing comfort is also important. No matter how effective the treatment is, the device isn't useful if patients refuse to use it. Rehabilitation Sleeve adopts an advanced bracing system with special fabric technology developed by the Institute of Textiles and Clothing that can manage moisture and pressure so that patients won't feel uncomfortable even after prolonged usage. To make rehab training more engaging, the Sleeve can translate user's motion into mouse inputs and send them to a computer. Various game apps will surely put some fun in the otherwise long and boring rehab process. "Clinical tests show that our FES-robot hybrid system helps stroke patients regain sensorimotor functions in upper limbs 40% faster than robotic therapy or FES alone. They also recover 30 to 40% more in terms of motor skills. Apart from stroke patients, Rehabilitation Sleeve also works for those with partial spinal cord injury, brain trauma or cerebral palsy. In fact, it's also possible to modify the Sleeve into a rehab device for the lower limbs," added Dr Hu.

In April 2015, Rehabilitation Sleeve won a gold medal and a special merit award in the 43rd International Exhibition of Inventions of Geneva, Switzerland.

¹ American Stroke Association. "Impact of Stroke (Stroke statistics)" July 22, 2015. Retrieved from http://www.strokeassociation.org/STROKEORG/AboutStroke/Impact-of-Stroke-Stroke-statistics_UCM_310728_Article.jsp