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Soft Robotic Haptic Interface for Rehabilitation of Sensorimotor Hand Function

Complex sensorimotor functions in the hand, such as proprioception and neuromuscular control, can be impaired by musculoskeletal disorders, neurological diseases and traumatic injuries. Traditional rehabilitation has shown to be effective at restoring some function back to an impaired hand, however, plasticity of the central nervous system to relearn and remodel the brain plays a critical role in recovery of sensorimotor function. Training specific parts of the brain with increasingly difficult motor tasks may contribute to neuroplasticity and further augment traditional rehabilitation strategies. Unfortunately, current objects used in rehabilitation therapies have a limited range of stiffness because of the mechanisms employed in their variable stiffness actuators. Thus, patients are required to use multiple objects of varying stiffness so that they can experience a wide range of strength training.

Researchers at Arizona State University have developed a novel, cylindrical, soft robotic haptic device for neuromuscular rehabilitation of the hand, which provides adjustable stiffness in a single device. This device utilizes a pneumatic soft structure made with materials that act as the actuator and the body of the haptic device. Interchangeable sleeves, which fit over the device, can be customized to include materials of varying stiffness to increase the upper limit of the variable stiffness range. This device can be used in both home and clinical settings. The device was tested with 17 participants asked to grasp the device at varying stiffness settings and showed that healthy participants could distinguish the variance in stiffness of the device.

This soft-robotic device, with its variable stiffness settings, eliminates the need for multiple devices and enables effective rehabilitation of sensorimotor hand function in a single device.

Potential Applications

- Rehabilitation of sensorimotor hand function

Benefits and Advantages

- Eliminates the need for multiple devices
- Low cost, low complexity & high throughput manufacturing – uses existing 3D printing and polymer molding and casting techniques
- Flexibility - the haptic interface is linked to either an effective open-loop or closed-loop control system depending on the desired mode of actuation
  - The open-loop system allows for an increased pressure during usage
  - The closed-loop system provides pressure regulation in accordance to the stiffness the user specifies
- Allows for greater range of stiffness to be implemented because there is minimal or no impedance to the initial stiffness of the device
- The height of the device is long enough to fit even large width hands
- Multiple methods to increase stiffness and tailor task difficulty or characteristics to individual patient's sensorimotor deficits

For more information about this opportunity, please see Sebastian et al - Front. Robot. AI - 2017

For more information about the inventor(s) and their research, please see Dr. Santello's departmental webpage

Dr. Polygerino's laboratory webpage